

Mapping of Global literature on Digital Divide in Education: A Scientometrics Analysis based on Scopus Database

Mohamed Majeed Mashroofa¹, Ayush Kumar Patel², Kunwar Singh³,
Neelam Thapa⁴, Avadhesh Kumar Patel⁵, Madan Singh⁶ and Marisennayya
Senapathy⁷

Abstract

Education is of vital importance for the development and growth of a society.
Due to the advancement in educational technologies, there have

¹ Senior Assistant Librarian, Science Library, The South Eastern University of Sri Lanka

Email: mashroof@seu.ac.lk  <https://orcid.org/0000-0002-2250-2445>

² Junior Research Fellow, Department of Library and Information Science, Banaras Hindu University, Varanasi-221005, Uttar Pradesh, India

Email: ayush.kumarvns2012@gmail.com  <http://orcid.org/0000-0002-5668-1103>

³ Assistant Professor, Department of Library and Information Science, Banaras Hindu University, Varanasi-221005, Uttar Pradesh, India

Email: singhdisbhu2015@gmail.com  <http://orcid.org/0000-0002-5615-5656>

⁴ Assistant Professor, Department of Library and Information Science, Dr. Harisingh Gour University, Sagar, Madhya Pradesh, India

Email: thapaneelam05@yahoo.com  <http://orcid.org/0000-0001-8190-5730>

⁵ Junior Research Fellow, Department of Library and Information Science, Banaras Hindu University, Varanasi-221005, Uttar Pradesh, India

Email: akpbhu20@gmail.com  <http://orcid.org/0000-0002-7989-091X>

⁶ Librarian, Jawahar Navodaya Vidyalaya, Khairasain, Pauri Garhwal Uttarakhand-246172, India

Email: madanrawatgeit@gmail.com  <http://orcid.org/0000-0001-8906-151X>

⁷ Associate Professor, Department of Rural Development and Agricultural Extension, Wolaita Sodo University, Ethiopia, East Africa

Email: drsenapathy@gmail.com  <http://orcid.org/0000-0002-8371-3035>



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been significant changes in teaching and learning processes. The digital divide has impacted significantly on teaching and learning, at present, especially after the COVID-19 pandemic. Considering this transformation, a scientometric analysis of the global literature on the digital divide in education was conducted in this study. The bibliographic data was gathered through the Scopus database for the period 2001–2021, and a total of 1865 publications were retrieved. VOSviewer and Gephi visualization software were used to analyze data and create network maps. The findings revealed that the average number of citations per paper (ACPP) for the study period is 15.51, and the relative citation impact (RCI) ranges from 0.21 in 2003 to 19.81 in 2021. Among published articles, the contribution of co-authors is greater than that of single authors. Furthermore, the United States was the leading country, with 613 publications on the digital divide. With 11 publications on the digital divide in education, Pick, J.B., from the School of Business, University of Redlands, United States, was the most prolific author. It is believed that these findings would benefit researchers worldwide, as scientometric mapping is an exciting method that provides a comprehensive overview of a scientific issue and insights for future research.

Keywords: Digital Divide, Education, Scientometrics, Publication Trends, Relative Citation Impact, Scopus Database, VOSviewer, Gephi

Introduction

Digital technology has now become ingrained in people's lives and has brought new opportunities and values, continuously making changes in every process. Due to adverse circumstances such as the COVID-19 pandemic, delivering school and university curricula have recently been transformed into a digital mode ([Milanesi, 2020](#)). Many people are being exposed to digital technology because of this situation, and they are being forced to adopt solutions to accomplish their work ([Malchenko, 2020](#)). It is evident that information and communication technology (ICT) helps improve people's lives. However, not the entire nation has equitable access to technology. The inequality in accessing technology is popularly known as the "digital divide". The digital divide has become so endured in our lives that it prevents people who do not have or have restricted access to ICT from fully participating in society ([Soomro et al., 2020](#)).

The term 'digital divide' describes the disparity in access to information and communication technologies (ICT). It is not a new phenomenon. In the late 1980s and early 1990s, talking about the information-rich and the information-poor ([Tarman, 2003](#)) gained popularity. "Digital divide" was defined by several scholars while also describing various aspects of it. The arrival of the public Internet created an information divide between the "haves" and the "have-nots" ([Cronin, 2002](#)). The digital divide can be defined as the gap between individuals who have all the digital resources they need and those who do not ([Chen & Wellman, 2004](#); [Eynon, 2009](#)). Different social groups, such as legislators, educators, and parents, have long viewed education as a panacea for all social ills ([Beatty, 1995](#)). As a result, education is now regarded as a means of bridging the digital divide. Many people believe that education may help bridge this gap ([Cuban, 2002](#)). However, they

overlook a pertinent point: if the problem has already taken complex forms, such as urban vs. rural, private vs. public, or large vs. small, education will be ineffective ([Tarman, 2003](#)). Therefore, the digital divide in education is a significant issue in today's modern society. It has significantly impacted on the electronic delivery process of education, particularly in developing countries. The necessity of providing e-learning facilities even to rural students/citizens is highly realized during the COVID-19 pandemic and post-pandemic periods. At present, the impact of the digital divide on the successful delivery of education is a hot topic for research and discussion. In the COVID-19 pandemic situation, the education system adopted techniques like online classes, online conferencing, etc., which resulted an increase the digital gap.

The purpose of this study is to examine current studies on digital divide and associated educational problems. This study will evaluate research trends and factors impacting research publications by mining bibliographic data using scientometric analysis. In the area of study known as scientometrics, publications in the scientific community are examined to ascertain the direction and expansion of research. Using the translation of the Russian word "naukometriya" (science measuring), Nalimov and Mulchenko created the term "scientometrics" in 1969 ([Zhao & Zhao, 2014](#); [Patel et al., 2021a](#)). The scientometric approach has been widely utilized in many scientific fields to investigate and assess the research efforts and developments of academics, nations, and even journals in a particular subject area ([Konur, 2012](#); [Zandi et al., 2019](#)).

Literature Review

Education research has grown in prominence due to significant innovations in technology. In this field, numerous related scientometric and

bibliometric studies have been published. Some examples of such related research studies are as follows:

[Park et al. \(2020\)](#) investigated research trends in digital literacy and related concepts, focusing on education. Using the scientometric method, this study examined co-authorship, keywords, and cited publications in digital literacy, and discovered that co-authorship clusters were primarily formed in European and American countries. [Marín-Suelves et al. \(2020\)](#) reported the findings of a scientometric analysis of scientific production on digital competence in the educational sphere, which was based on 150 Scopus documents. The study's key finding revealed that most of it were articles (77.3 percent). Spain was the most productive country, accounting for 38% of all contributions to digital competence in the educational sphere. [Purnomo et al. \(2020\)](#) carried out a scientometric study of digital literacy research internationally indexed by Scopus over the past 22 years. As per this study, the most productive author was Marsh, J., who published 11 articles, and the United States was the most productive country in digital literacy research with 735 articles. [Rawat and Sood \(2020\)](#) looked at the scientometric aspects of articles published in the education field using ICT from 2011 to 2020. The study's findings revealed that 'Computer and Education' and 'Computer Applications in Engineering Education' were the most popular, productive, and highly referenced journals in the field. [Alagu and Thanuskodi \(2019\)](#) used the Web of Science database to evaluate 512 papers on digital literacy research published between 1992 and 2011. The study concluded that most of the papers were published in English, with 466 records, and that the United States was the most productive nation in this area, with 169 articles. Although the digital divide has a significant impact on education, especially during pandemic, few scientometric studies are conducted to learn about the research

trend. The researchers found a dearth of literature that explores the scientometric analysis on the digital divide and its impact on education. Therefore, this scientometric study on the digital divide in education was conducted in response to this research gap. This scientometric paper will contribute to the knowledge base on digital divide and help decision-makers and policymakers in the efforts of bridging the digital divide.

Objectives of the study

The following objectives are intended to be met by this study:

- To examine the publication trends with number of citations during the study period (2001-2021) including the COVID-19 pandemic situation;
- To calculate the collaborative measures like Degree of Collaboration (DC), Collaborative Index (CI), Relative Citation Impact (RCI), as well as measures based on institutions and countries;
- To explore the top fifteen highly preferred sources, languages, types of publications;
- To map the co-citation of cited references cited sources, and the co-occurrence pattern of authors' favoured keywords.

Methodology

Data Collection

The present study deals with a scientometric assessment of global publications on the Digital Divide in Education research. The data retrieved from the Scopus database covers 20 years from 2001 to 2021 ([Scopus, n.d.](#)). The search keyword was "digital divide in education". The search string used for the study was "TITLE-ABS-KEY (digital divide in education) AND

(LIMIT-TO (PUBYEAR,2021) OR LIMIT-TO (PUBYEAR,2001) AND (LIMIT-TO (PUBSTAGE, "final"))" accessed on August 11, 2021. A total of 1896 records were extracted and exported as ".xlsx" and ".csv" files.

Scientometric Analysis

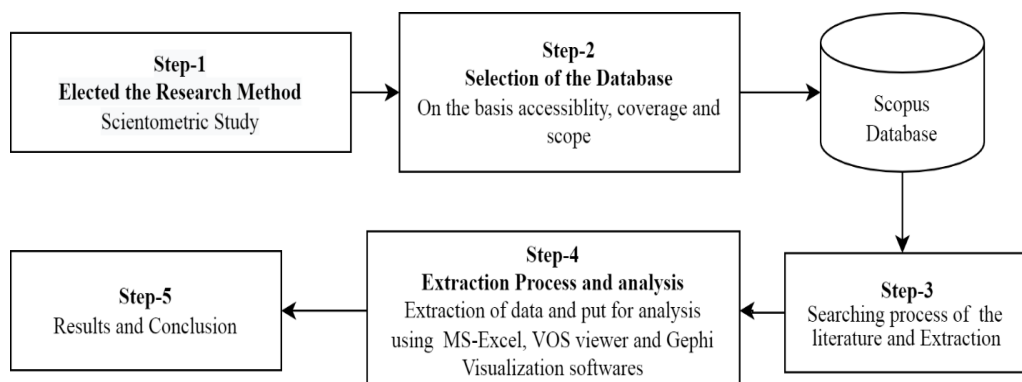
After extraction, data were analyzed and visualized for proper visibility of results. The study focused on several scientometrics metrics, including year-wise growth, relative citation impact, degree of collaboration and collaboration index, highly collaborative measures based on authors, institutions, and countries, co-citations of cited references and sources, the occurrence of keywords, preferred language, and publication types.

Tools and Techniques

In this study, different tools and techniques were used for analyzing and visualising the study's data. MS Excel, Google Sheets, VOSviewer and Gephi visualization software were used. Here, the VOS (Visualization of Similarities) viewer is a tool developed by Nees Jan van Eck and Ludo Waltman of Center for Science and Technology Studies, Leiden University (Wang et al., 2021). The primary advantage of VOSviewer software is its simplicity in displaying bibliographic information (Fabregat-Aibar et al., 2019). Further, it has the ability to perform co-author and co-citation analyses (Patel et al., 2021b). Gephi is a free and open-source network visualization and analysis software. Students of the University of Technology of Compiègne (UTC) in France created this software (Gephi, n.d.). It focuses on network visualization using node-link diagrams, real-time data interaction (e.g. node grouping, filtering, and presentation of statistical results), and the development of a visual language (Heymann & Grand, 2013). A systematic workflow of the research process is given below in Figure 1.

Figure 1

Workflow of the research process



Formula Used

For a more precise measurement of the outcomes, the following equations were applied in this study.

Relative Citation Impact (RCI)

The formula given below was used to find the Relative Citation Impact (Kumari, 2009):

$$RCI = \frac{\text{Number of Citations} / \text{Total Citations}}{\text{Number of Documents} / \text{Total Documents}}$$

Degree of Collaboration (DC)

The degree of research collaboration (DC) in this study was calculated using the formula laid by Subramanyam (1983).

$$DC = \frac{Nm}{Nm + Ns}$$

Where

Nm is the total number of papers with multiple authors, and Ns is the total number of papers with a single author in the field.

Collaboration Index (CI)

It is the average number of authors for a group project. Articles with a single author were not included as the CI is always equal to 1. The average number of authors per jointly authored publication was determined using the formula ([Lawani, 1986](#)) shown below.

$$CI = \frac{\text{Total number of authors of multi authored papers (TAMP)}}{\text{Total number of multi authored papers (Nm)}}$$

Result and Discussion

Year-wise growth trends of papers with citations

One of the essential measures of research progress in a particular discipline is the quantity of literature produced. By examining the annual variance in the volume of literature output, we may track the historical increase and decreases of literary output in the field. The year-wise distribution of the 1896 publications on ‘digital divide in educational research’ that were published between 2001-2021 is shown in Table 1. The table shows that the tendency of research on the digital divide in education increases slightly with a little fluctuation. The end of the catastrophic worldwide subprime crisis, the global education rebound, and global organizations conducting various

education-based projects could increase the number of articles. The year 2020 depicts a peak with 189(9.97%) articles which is the highest in number.

Table 1: *Year-wise distribution of publications with number of citations, ACPP and RCI*

Year	TD	TC	ACPP	RCI	Year	TD	TC	ACPP	RCI
2001	27	693	25.67	0.60	2012	79	870	11.01	1.41
2002	31	373	12.03	1.29	2013	82	1514	18.46	0.84
2003	44	3295	74.89	0.21	2014	82	1753	21.38	0.73
2004	35	1766	50.46	0.31	2015	114	1685	14.78	1.05
2005	69	1112	16.12	0.96	2016	124	1367	11.02	1.41
2006	81	1246	15.38	1.01	2017	125	1633	13.06	1.19
2007	74	1204	16.27	0.95	2018	95	728	7.66	2.02
2008	87	2299	26.43	0.59	2019	129	803	6.22	2.49
2009	103	1954	18.97	0.82	2020	189	645	3.41	4.54
2010	128	2335	18.24	0.85	2021	115	90	0.78	19.81
2011	83	2033	24.49	0.63	Total	1896	29398	15.51	1.00

*TD=Total Document, * TC=Total Citations, * ACPP=Average number Citations Per Paper, *RCI= Relative Citation Impact

However, 129(6.80%) were released in 2019, while 128(6.75%) were published in 2010. In 2001, it has been the fewest publications, with only 27(1.42%) articles. An average number of 90 publications were produced annually over the study periods. The Pearson correlation coefficient between the number of publications and the number of citations is -0.13, indicating no relationship. It indicates that the relationship between number of publications and citations is not linear. As the highest number of papers published on the digital divide in education in 2020, this can be assumed that the COVID-19 pandemic might have influenced the researchers to explore and research in this particular area. It is predicted that the number of publications was in a higher level during COVID-19 rather than normal situations.

Furthermore, the researchers looked at the number of citations and average number of citations for individual publications. Out of 29398 total citations, the highest number was in the year 2003 with 3295(11.21%), followed by the year 2010 with 2335(7.94%) citations, the year 2008 with 2299(7.82%) citations, the year 2011 with 2033(6.92%) citations, the year 2009 with 1954(6.65%) citations. The average number of citations per paper is 15.51 for the study periods. The relative citation impact varies from 0.21 in the year 2003 to 19.81 in the year 2021.

Degree of Collaboration (DC) and Collaboration Index (CI)

The total degree of collaboration (DC) from 2001 to 2021 is 0.73. However, when we calculated the percentage of collaboration per year over the study period, the results varied widely. Table 2 shows the number of publications published each year and the type of collaboration. In the study, the participation rate was almost the same every year and the average score was 0.49.

Table 2: Degree of collaboration (DC) and Collaboration index (CI)

Year	Ns	Nm	Ns + Nm	DC	TAMP	CI
2001	11	14	25	0.56	52	3.71
2002	15	16	31	0.52	48	3.00
2003	18	26	44	0.59	84	3.23
2004	15	20	35	0.57	70	3.50
2005	24	41	65	0.63	129	3.15
2006	25	54	79	0.68	177	3.28
2007	17	54	71	0.76	174	3.22
2008	21	65	86	0.76	199	3.06
2009	41	61	102	0.60	193	3.16
2010	43	84	127	0.66	265	3.15
2011	16	67	83	0.81	195	2.91
2012	23	55	78	0.71	166	3.02
2013	14	64	78	0.82	216	3.38
2014	28	53	81	0.65	161	3.04
2015	28	82	110	0.75	261	3.18
2016	29	94	123	0.76	329	3.50
2017	31	92	123	0.75	314	3.41
2018	22	72	94	0.77	242	3.36
2019	21	108	129	0.84	422	3.91
2020	33	153	186	0.82	596	3.90
2021	28	87	115	0.76	321	3.69
Total	503	1362	1865	0.73	4614	3.39

*Ns= No. of Single Authored Papers, *Nm= No. of Multiple Authored Papers, *TAMP= Total Authors of multi-authored papers

Geographical Variations

The contributions by countries are listed along with number of publications, number of citations and RCI (Table 3).

Table 3: *Geographical variations*

Country/Territory	Documents	Citations	RCI
United States	613	15570	1.29
United Kingdom	151	3762	1.26
Spain	135	1161	0.44
India	102	836	0.41
Australia	98	1313	0.68
South Africa	75	745	0.50
Canada	64	1176	0.93
Germany	53	946	0.90
China	46	588	0.65
South Korea	45	185	0.21
Taiwan	36	268	0.38
Netherlands	34	2936	4.37
Malaysia	28	113	0.20
Finland	27	493	0.92
Italy	27	225	0.42
Total	1534	30317	1.00

This study reveals that the publications related to the digital divide in education are globally distributed in the world. The US and UK are the most highly productive countries with 613 publications & 15570 citations and 151 publications & 3762 citations respectively, followed by Spain with 135 articles and India with 102 articles. Table 3 shows the distribution of top fifteen geographical areas globally, the highest contributors in this study. India has the fourth rank in the contribution of publications on the digital divide in education. Digital India initiatives have led to many reforms and developments in the education system in India ([Digital education initiatives, n.d.](#)).

Most Productive Authors

Table 4 depicts the distribution of top collaborative authors with their institutions, documents, and country. The researchers observed that author J.B. Pick, with 11 publications, and R. Azari, with 9 publications, both from the School of Business at the University of Redlands in the United States, hold the top two positions in the table, followed by A.J.A.M. Van Deursen, B. Niehaves, M. Doodel, H. Farley, and others. Most of the top contributors are from the United States, Germany, and Australia.

Table 4: Most productive authors

Authors	Affiliation	Doc.	Country
Pick, J.B.	School of Business, University of Redlands	11	United States
Azari, R.	School of Business, University of Redlands	9	United States
Van Deursen, A.J.A.M.	University of Twente	7	Netherlands
Niehaves, B.	University of Muenster	6	Germany
Dodel, M.	Universidad Catolica del Uruguay	5	Uruguay
Farley, H.	University of Southern Queensland	5	Australia
Murray, E.	University College London	5	United Kingdom
Sarkar, A.	School of Business, University of Redlands	5	United States
Becker, J.	Westfälische Wilhelms-Universität Münster	4	Germany
Bergener, P.	Westfälische Wilhelms-Universität Münster	4	Germany
Billon, M.	Universidad Autónoma de Madrid	4	Spain
Broadbent, R.	Victoria University	4	Australia
Davis, N.	University of Canterbury	4	New Zealand
Fairlie, R.W.	University of California, Santa Cruz	4	United States
Geissbuhler, A.	Hôpitaux Universitaires de Genève	4	Switzerland

Top Fifteen Sources

Table 5 provides a list of the preferable sources that published the highest number of the publications on digital divide in education. During the study period, the ACM (Association of Computing Machinery) International Conference Proceeding Series was the highest-ranked selected source for 30 publications, with 0.182 SJR, 0.296 SNIP, and 1.2 Citescore. In the United States, the Association for Computing Machinery publishes this

Table 5: Top Fifteen Sources

SOURCE TITLE	TD	SJR	SNIP	Citescore	IF
ACM International Conference Proceeding Series	30	0.182	0.296	1.2	
Lecture Notes in CS Including Subseries Lecture Notes in AI and Lecture Notes in Bioinformatics	28	0.249	0.628	1.8	
Telecommunications Policy	25	0.84	1.552	5.1	3.036
Journal of Medical Internet Research	21	1.446	2.07	6.4	
Computers and Education	19	3.026	4.411	14.4	8.538
IFIP Advances in Information and Communication Technology	18	0.189	0.39	1	
Information Communication and Society	16	2.806	3.114	9.7	
Communications In Computer and Information Science	15	0.16	0.32	0.8	
New Media and Society	13	3.501	3.915	11.4	8.061
Proceedings of the Annual Hawaii International Conference on System Sciences	13	0.612	1.242	3.9	3.251
Sustainability Switzerland	13	1.567	2.912	13.2	6.182
Telematics and Informatics	11	0.919	1.964	5.4	2.917
International Review of Research in Open and Distance Learning	10	1.436	1.938	5.8	0.734
Technology in Society	10	0.819	1.674	4.2	4.192
British Journal of Educational Technology	9	1.79	2.494	7.6	4.929

Note* TD= Total no. of Documents, SCImago Journal Rank (SJR), Source Normalized Impact per Paper (SNIP), and Citescore were calculated as per 2020.

journal. This was followed by Lecture Notes in Computer Science including the subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics by Springer Nature, which has 28 issues; Elsevier Telecommunications Policy, which has 25 publications and is in the top quartile; and the Journal of Medical Internet Research, a Canadian journal that also has 21 issues. The fifth, Computers and Education, also lies in the first quartile and is published by Elsevier in the United Kingdom. It has 19 publications, 3.026 SJR, 4.411 SNIP, 14.4 Citescore, and 8.538 Impact Factor. Most of the top sources lie in the first quartile and have higher Citescore and Impact factors.

Affiliations and Sponsoring Affiliations

Table 6 lists the highly productive institutions and funding affiliations that have collaborated on digital divide research in education. As per the table, the Universidad Complutense de Madrid (the Complutense University of Madrid (founded in Alcalá in 1293) is a public research university located in Madrid, Spain in 1836 and is one of the world's oldest operating university and the University of Redlands collaborated on 16 publications each, followed by the Universiteit Twente and Columbia University on 13 publications each, Pennsylvania State University, the University of Texas at Austin, and the University of California, Los Angeles on 12 publications each, and other top collaborating institutions on 10 to 11 publications. Some institutes have funding organizations for research publications. Table 6 lists the fifteen top organizations, which are more frequent in funding research and development publications. The US Department of Health and Human Services tops the list with 47 publications. It is a cabinet-level executive branch of the department of United States federal government established to protect all Americans' health and provide essential human services.

Table 6: a) *List of affiliations* and b) *List of funding sponsors*

Affiliations	Doc.
Universidad Complutense de Madrid: Complutense University of Madrid	16
University of Redlands	16
Universiteit Twente	13
Columbia University	13
Pennsylvania State University	12
The University of Texas at Austin	12
University of California, Los Angeles	12
Seoul National University	11
Universidad Nacional de Educación a Distancia	11
Rutgers University “New Brunswick	11
University of Cape Town	10
University of South Africa	10
Turun yliopisto	10
University of Washington	10
University of Southern Queensland	10

Funding sponsors	Doc.
U.S. Department of Health and Human Services	47
National Institutes of Health	44
European Commission	24
National Cancer Institute	15
National Science Foundation	15
European Regional Development Fund	11
National Institute of Mental Health	9
Government of Canada	8
Academy of Finland	7
Ministerio de Economía y Competitividad	6
National Research Foundation of Korea	6
Social Sciences and Humanities Research Council of Canada	6
U.S. National Library of Medicine	6
Agency for Healthcare Research and Quality	5
Japan Society for the Promotion of Science	5

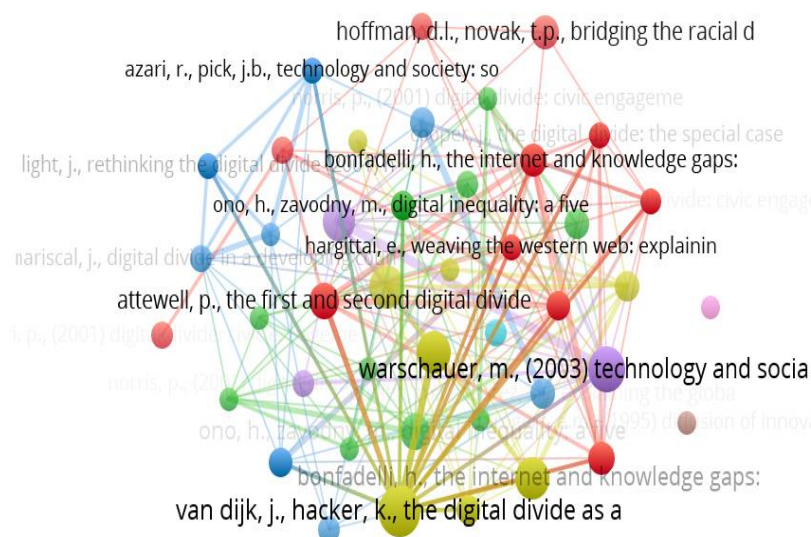
Its motto is "Improving America's health, safety, and well-being." It is followed by the National Institutes of Health with 44 publications; the European Commission with 24 publications; National Cancer Institute, and National Science Foundation with 15 publications each. These are primarily funding organizations from the United States. Therefore, the United States has more publications in research on the digital divide in education.

Co-citation

The frequency with which two publications are cited together by other publications is referred to as co-citation ([Small, 1973](#)). If at least one other publication cites two publications that are co-cited, these publications are referred to as co-cited, and this analysis is referred to as co-citation analysis ([Singh et al., 2021](#)). The parameter for the minimum number of citations was set to 5, out of the total 30878 cited references, 44 met the threshold. It was found that 29944 were single citations out of 30878 cited references. The top three cited references are Van Dijk, J., Hacker, K., (2003) with 13 citations; Warschauer, M., (2003) with 11 citations; and Selwyn, N., (2004) with 11 citations. Figure 2 depicts a network visualization of the co-citation of cited references. These top-cited references of publications contain the contents for better explanations of the meaning, definition, and understanding of the digital divide and education ([Van Dijk & Hacker, 2003](#); [Selwyn, 2004](#)). The size of the circles describes the number of co-citations of cited references and the thickness of the lines shows the number of collaborations of cited references.

Figure 2

Co-citation of cited references

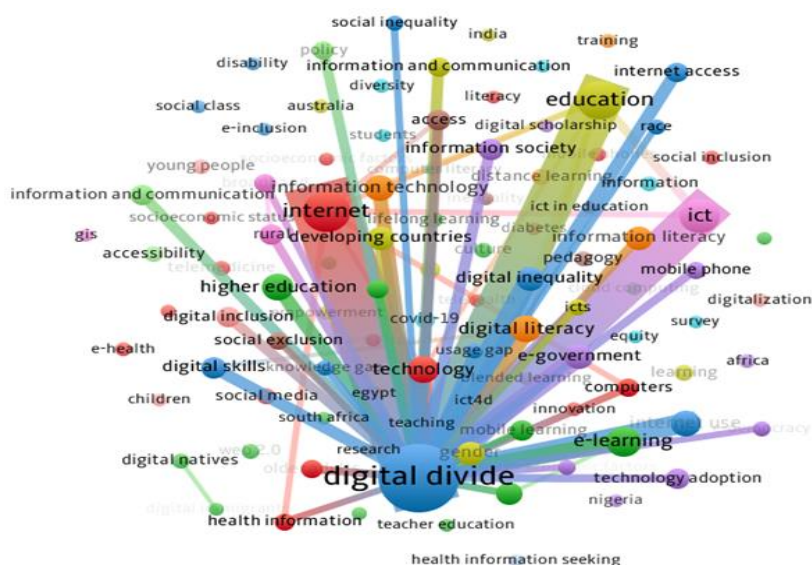


The co-citation of the cited source is shown in Figure 3, which is a network visualization. Here, it sets the parameters as a minimum of 20 citations of cited sources and 20 minimum strengths for visual effects. It was found that 105 met the threshold, out of the total of 17031. These outcomes were divided into 5 different clusters with corresponding colours. The Telecommunication Policy topped with 214 highest citations, the Information Society was the second with 151 citations and Computers & Education was the third with 137 citations. The Telecommunication Policy; Computers & Education are published by Elsevier, while the Information Society is maintained by Taylor and Francis Group.

the strength of the relationship between them. According to the Figure 4, the keyword “digital divide” (901 occurrences) has compact connectivity with “internet” (375 occurrences), “education” (361 occurrences), “ICT” (88 occurrences) and others. There are many other highly preferred keywords of authors like digital literacy, technology, e-learning, digital skills, e-government, higher education, digital inequality, digital inclusion, information society, and mobile phone, etc.

Figure 4

Network visualization of authors' preferred keywords



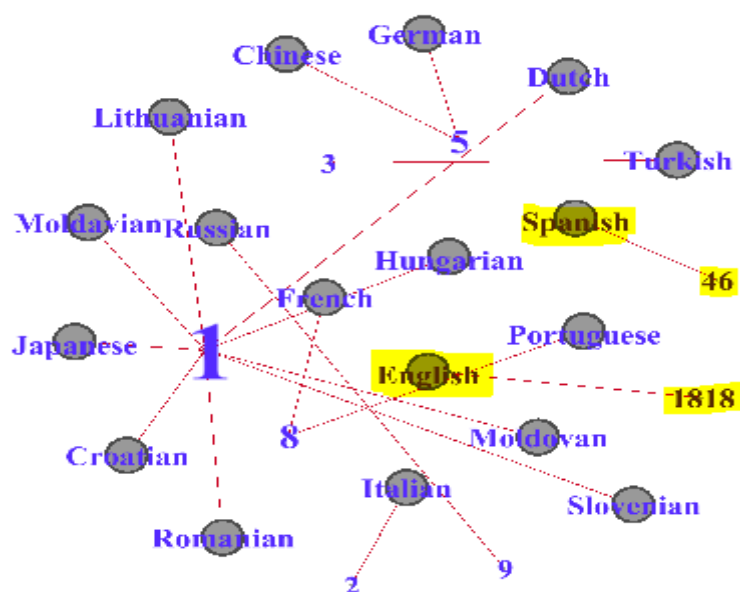
Communication Analysis

In this study, the languages used in scholarly communication were identified. It was found that the English language was the most favourable, which has 1818 publications in this research study. It was followed by the

Spanish language with 46 publications, Russian with 9 publications, French and Portuguese with 8 publications, and others. There are many languages with one publication in this research study. The United States and the United Kingdom have the highest number of publication and their national language is English, therefore, the highest number of publications were in the English language. Figure 5 shows the distribution of languages with corresponding values.

Figure 5

Preferred language



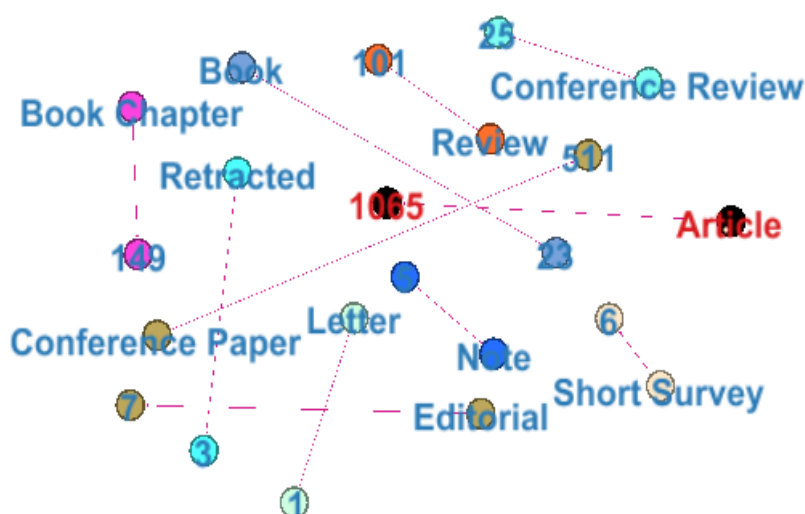
Types of Publications

Researchers must use a communication mode in order to gain more knowledge. In this study, it was found that many authors prefer to publish their research in the form of articles in this study (1,065 publications). Articles, which means a piece of writing, are easy to communicate to society.

Conference paper (511 publications) is the second preferred form of publication. There are many other forms of publication, such as reviews, book chapters, and others. Figure 6 shows the communication mode of publications with their number of publications.

Figure 6

Publication types



Conclusion

This study found that 1865 research papers on the digital divide in education have been published between 2001-2021 which were extracted from the Scopus database. During the study period, the number of articles moved up rapidly with the year but not linearly, it means fluctuations over a few years. Therefore, there is no definite growth pattern. In addition, the COVID-19 pandemic period, i.e., the years 2020 and 2021, showed a high number of

publications. These papers earned 29398 citations, with a steep increase in 2003 with 3295 (11.21%). The average number of citations per paper (ACPP) is 15.51 for the study period, and the relative citation impact (RCI) varies from 0.21 (2003) to 19.81 (2021). Among the published papers, 503 are single-authored and 1362 are multiple/collaborative research papers. The rate of collaboration, on the other hand, is nearly the same, with a mean value of 0.49. During the 20 years of study period, the average collaboration rate was 3.32.

In total, 124 countries have contributed to the knowledge base. The United States leads with 613 articles, 15570 citations, and a relative citation impact of 1.29. The most prominent author is Pick, J.B. from the School of Business, University of Redlands, USA, with 11 publications. The most authoritative sources are the ACM International Conference Proceeding Series, which published 30 papers, followed by the journal Lecture Notes in Computer Science with 28 publications, which also publishes the Lecture Notes in AI and Lecture Notes in Bioinformatics subseries. This study uses bibliographic measures, such as publication growth, citation growth, collaboration growth, and others, to reveal the contribution pattern of research publications on the digital divide in education. In the beginning of the COVID-19 pandemic situation, all communities felt the need for digital technologies, and the situation that followed demonstrates a significant digital gap in the educational system because of online classes, virtual meetings, video conferences, and other methods for serving education while creating social distance. The use of metrics like DC, RCI, CI, languages, types of publications, sources, etc. facilitated achieving all the goals of the study, demonstrating a quantitative and overall growth of research as well as the characteristics of research publications.

The digital divide is a complicated issue that manifests itself in a variety of ways across social classes and cultures. As a result, solutions must be found based on an understanding of local needs and conditions, as well as through effective and long-term integration of technology into society. The broad consensus is that education is the most important weapon needed for bridging the digital gap. This study aims to provide academicians and researchers in the field of education with clues for future research. They could look at the research contribution and the impact of digital divide on education, using a combination of Scopus and Web of Science data to measure quotations.

References

- Alagu, A., & Thanuskodi, S. (2019). Bibliometric analysis of digital Literacy research output: A global perspective. *Library Philosophy and Practice (e-journal)*, 2127, 1-19.
<http://digitalcommons.unl.edu/libphilprac/2127>
- Beatty, B. (1995). *Preschool education in America: The culture of young children from the colonial era to the present*, Yale University Press.
- Chen, W., & Wellman, B. (2004). The global digital divide—within and between countries. *IT & society*, 1(7), 39-45.
- Cronin, B. (2002). The digital divide. *Library Journal*, 127(3).
- Cuban, L. (2002). *Oversold and underused: computers in the classroom*. Harvard University Press.

- Digital education initiatives. (n.d.). *India Brand Equity Foundation*. Retrieved December 10, 2022, from <https://www.ibef.org/blogs/digital-education-initiatives>
- Eynon, R. (2009). Mapping the digital divide in Britain: implications for learning and education. *Learning, media and technology*, 34(4), 277-290. <https://doi.org/10.1080/17439880903345874>
- Fabregat-Aibar, L., Barberà-Mariné, M. G., Terceño, A., & Pié, L. (2019). A Bibliometric and Visualization Analysis of Socially Responsible Funds. *Sustainability*, 11(9), 2526. doi:10.3390/su11092526
- Gephi. (n.d.). *About*. Retrieved November 19, 2021, from <https://gephi.org/about/>
- Heymann, S., & Grand, B. L. (2013). Visual Analysis of Complex Networks for Business Intelligence with Gephi. In *2013 17th International Conference on Information Visualisation*. doi:10.1109/iv.2013.39
- Kumari, G. L. (2009). Synthetic Organic Chemistry Research: Analysis by Scientometric Indicators. *Scientometrics*, 80(3): 559-570.
- Konur, O. (2012). The evaluation of the global research on education: A scientometric approach. *Procedia - Social and Behavioral Sciences*, 47, 1363 – 1367.
- Lawani, S. (1986). Some bibliometric correlates of quality in scientific research. *Scientometrics*, 9(1-2), 13-25.
- Malchenko, Y. A. (2020). From digital divide to consumer adoption of smart city solutions: A systematic literature review and bibliometric analysis.

Vestnik of Saint Petersburg University, Management, 19(3), 316–335.
<https://doi.org/10.21638/11701/spbu08.2020.302>

Marín-Suelves, D., López-Gómez, S., Castro-Rodríguez, M. M., & Rodríguez-Rodríguez, J. (2020). Digital competence in schools: A bibliometric study. *IEEE Revista Iberoamericana de Tecnologías del Aprendizaje*, 15(4), 381-388. DOI: 10.1109/RITA.2020.3033207

Milanesi, C. (2020). *Digital Transformation And Digital Divide Post COVID-19*. *Forbes*. Retrieved November 13, 2021, from <https://www.forbes.com/sites/carolinamilanesi/2020/05/11/digital-transformation-and-digital-divide-post-covid-19/>

Park, H., Kim, H. S., & Park, H. W. (2020). A scientometric study of digital literacy, ICT literacy, information literacy, and media literacy. *Journal of Data and Information Science*, 6(2), 116-138. <https://doi.org/10.2478/jdis-2021-0001>

Patel, A. K., Singh, K., Parida, D. K., & Patel, A. K. (2022). Visualization of Global Research Output on Disruptive Innovation in Health Care. *Journal of Hospital Librarianship*, 22(4), 1-15. DOI: 10.1080/15323269.2022.2124802

Patel, A. K., Singh, K., Singh, M., & Patel, A. K. (2021a). Publication trends in Financial Inclusion: A Scientometric Assessment and Visualization. *Library Philosophy and Practice (e-journal)*, 5115, 1-20. <https://digitalcommons.unl.edu/libphilprac/5115>

Patel, A. K., Singh, M., Singh, K., Patel, A. K., Varma, A. K., & Kuri, R. (2021b). Visualizing Publication Trends in Webology Journal: A Bibliometric Review based on the Scopus Database (2006-2020).

- Library Philosophy and Practice (e-journal)*, 5995, 1-24.
<https://digitalcommons.unl.edu/libphilprac/5995>
- Purnomo, A., Sari, Y. K. P., Firdaus, M., Anam, F., & Royidah, E. (2020). Digital Literacy Research: A Scientometric Mapping over the Past 22 Years. In *2020 International Conference on Information Management and Technology (ICIMTech)* (pp. 108-113). IEEE. DOI: 10.1109/ICIMTech50083.2020.9211267
- Rawat, D. S., Singh, K., Singh, M., Patel, A. K., & Patel, A. K. (2021). Research Productivity of Wadia Institute of Himalayan Geology. *Library Philosophy and Practice (e-journal)*, 5804, 1-22.
<https://digitalcommons.unl.edu/libphilprac/5804>
- Rawat, K. S., & Sood, S. K. (2020). Knowledge mapping of computer applications in education using CiteSpace. *Computer Applications in Engineering Education*, 1-16. <https://doi.org/10.1002/cae.22388>
- Scopus. (n.d.). *Scopus Preview*. Retrieved August 11, 2021, from <https://www.scopus.com/>
- Selwyn, N. (2004). Reconsidering political and popular understandings of the digital divide. *New media & society*, 6(3), 341-362.
- Singh, I., Singh, P., Rawat, P., Patel, A. K., Singh, M., Singh, K., & Patel, A. K. (2021). Research Productivity of Forest Research Institute, Dehradun During 1990-2019: A Scientometric Approach. *Indian Forester*, 147(8), 767-777. DOI: 10.36808/if/2021/v147i8/164678
- Small, H. (1973). Co-citation in the scientific literature: A new measure of the relationship between two documents. *Journal of the American Society for Information Science*, 24(4), 265-269.

- Soomro, K. A., Kale, U., Curtis, R., Akcaoglu, M., & Bernstein, M. (2020). Digital divide among higher education faculty. *International Journal of Educational Technology in Higher Education*, 17(1), 1-16.
<https://doi.org/10.1186/s41239-020-00191-5>
- Subramanyam, K. (1983). Bibliometric studies of research collaboration: A review. *Journal of Information Science*, 6(1), 33-38.
<https://journals.sagepub.com/doi/abs/10.1177/0165555158300600105>
- Tarman, B. (2003, July). *The Digital Divide in Education* [Conference presentation]. International Conference for the History of Education, ISCHE XXV, Sao Palo, Brazil. <https://eric.ed.gov/?id=ED508213>
- Van Dijk, J., & Hacker, K. (2003). The digital divide as a complex and dynamic phenomenon. *The information society*, 19(4), 315-326.
- Wang, R. L., Hsu, T. F., & Hu, C. Z. (2021). A Bibliometric Study of Research Topics and Sustainability of Packaging in the Greater China Region. *Sustainability*, 13(10), 5384.
- Zandi, S., Nemati, B., Jahanianfard, D., Davarazar, M., Sheikhnejad, Y., Mostafaie, A., Kamali, M. & Aminabhavi, T. M. (2019). *Journal of Environmental Management*, 247, 462-473.
- Zhao, Y., & Zhao, R. (2014). Evolution of the Development of Scientometrics. In *iConference 2014 Proceedings*, 905– 912. doi:10.9776/14310