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Citation Analysis of Research Output of India on SDG-4 During 2017 to 2021

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ARTICLE INFO	ABSTRACT
	The study examines research productivity and citation impact of the research in the area of SDG-4 (Quality Education) for a period of five years from 2017 to 2021. SCOPUS bibliographic database was used as source to harvest the data of the research publications. Pajek and Bibexcel software's were used for data manipulation and rectification and creating the citation graphs. The paper describes highly productive authors, institutions, source journals, areas of research under different subjects' domains. The paper reveals about the highly cited papers, Co-authorship, conceptual relation among the key words as well as relation among the highly cited papers and H-Index of the top 20 authors. The paper also shows the research trend in the field of quality education. **Keywords:** Quality Education, Citation Analysis, SDG-4, Research Productivity.

Introduction:

Education plays a significant role in the advancement of the society for growth of the human being in all aspects of life. The seventeen (17) Sustainable Development Goals (SDGs) are adapted by 193 Member States of the United Nations (UN) in 2015 as an agenda for Sustainable Development 2030. These goals have come into effect on 1st January 2016. India is a union of 28 states and 8 union territories. These SDGs are blueprint for peace and prosperity for international society as well as for the betterment of this planet. India played an important role in devising the SDG agenda 2030. India is second largest country in the world having more than 1.35 billion populations. Therefore, India's progress on SDG plays a major role in the progress of SDG for United Nation's countries. The NITI (National Institution for Transforming India) Aayog of India has taken the lead role and carried out the SDG India Index 2020-21[1].

Due to the lack of technological advancement, sufficient teachers and infrastructure in Indian educational institutions, the quality of education needs to improve for betterment of the Indians as well as humanity as whole. Quality of education includes various aspects i.e. students, teachers, teaching learning process, ICT infrastructure, curriculum, learning environment, pedagogy, assessment process etc. Quality education is fourth SDG of UN in the SDG agenda 2030. India has made significant progress in education. In India, the youth (Age 15-24) literacy rate is 94% for males and 92% for females[2]. Recently, the Government has been implemented National Education Policy (NEP) 2020 in schools, colleges and universities of India. As per the goal of NEP, it will contribute to SDG-4 through quality education and lifelong learning. The Indian Government has been working on achieving quality education from school level to higher education for all the Indians.

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Development of quality education in Universities and Colleges is one of the key visions for India's Higher Education System in NEP 2020. Higher education plays an enormously important role in promoting the human being & society. The Indian government has been taken various initiatives to strengthen the higher education & research in India. Research and publication activities have been carrying out by the research & higher education institutions in the country. The key purpose of the study is to know India's the contribution in SDG-4 in the form of publications and their citations during last five years from 2017 to 2021. According to the AISHE report 2020, there are 1043 Universities, 42343 Colleges and 11779 Stand Alone Institutions listed on AISHE web portal. Among these, 396 Universities are privately managed. 420 Universities are located in rural area. There are 522 General, 177 Technical, 63 Agriculture & Allied, 66 Medical, 23 Law, 12 Sanskrit and 11 Language Universities and rest 145 Universities are of other Categories. According to the report, total enrolment in higher education has been estimated to be 38.5 million with 19.6 million boys and 18.9 million females. Females constitute 49% of the total enrolment. As per the study report, 38,986 students were awarded PhD level degree during 2019 with 21,577 male and 17,409 female[3].

Review of Literature:

Many studies have examined efficacy, quality, effectiveness, reflectivity or other aspects of citations & numerous studies have also been discussed about the publications and research impact under different subjects[4]. One of the most capable and specialized tools is Pajek, presented by Batagelj and Mrvar[5]. Pajek can be used for handling large networks of any kind and decompose sub-networks, find paths, and calculate layouts automatically. Science maps such as direct citation, co-citation, or bibliographic coupling networks helped improve understanding of knowledge relationships[6].

Garfield (1955) proposed that counting citations evaluates the influence of research journals scientifically. Instead of calculating the absolute number of total citations to journal articles, impact factor measures ratio obtained from dividing citations received in one year by papers published in the two previous years[7].

Emami, Riahinia, and Soheili (2019) also analysed the co-occurrence of words in the field of medical and laboratory equipment from 1984 to 2014, and the results indicated that co-word mapping have shown changes and stability in concepts and terms related to this scientific field[8].

Donner (2021) investigates the potential of citation analysis of the German theses submitted during 1996-2018 using the citation data from Scopus and Google Books and found to be sufficient to obtain quantitative estimates of early career researchers' performance and use of their Theses as reflected in citations. It was found that Scopus and Google citations co-relation and minor overlap[9].

Linga (2023) analysed the research publication on gas hydrates for the period 1901-2020 and identified the top publishing countries, top cited articles and top source journals. The citation rate trends were analysed and presented. Network visualization maps were presented for countries, sources, and organizations by analysing citations through VOSviewer software. The Co-occurrence analysis was also done to identify the top keywords and their links through network visualization based on VOSviewer[10].

It is very much clear from the above literature studies that the citation analysis identifies the flows of the knowledge from a research work to another by analysing the cited work to the citing one and co-relates a link between them. The relationship can be shown as an edge or an arc or node from the prior document to the next one which cites it. The citation can be mapped to a link or edge or nodes between the documents. The network of citations is in fact a graph, where the nodes are citing and cited documents and edges are the citations themselves.

Scope and data for the study:

The present study covers citations analysis of research output of Indian researchers on quality education in the form of publications which are indexed in SCOPUS[11] database. SCOPUS is one of the leading indexing & citation databases of quality publications at international level. Data on quality

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education of India are extracted through a search string (Annexure-1) form SCOPUS database for the period of five years form the year 2017 to 2021. For the study of citation analysis, both citing and cited articles were extracted from the retrieved records. The search results found 716 records/articles. There are 23415 cited references for the 716 harvested articles.

Citation Analysis, Tools & Techniques:

Citation analysis has become important for establishing relation between subjects, authors, journals, etc. The citations (i.e. references) of 716 articles on SDG-4 retrieved form SCOPUS have analysed with the help of Bibexcel, MS-Excel and Pajek software. There are 23415 cited references found in 716 articles. The data have also been collected through SCOPUS analysis reports. The citations of the 716 articles have analysed through Bibexcel software. Citation network maps are prepared by Pajek software using the data collected through SCOPUS.

Analysis of Research outputs:

The top 10 affiliation, authors, country and sources from the retrieved data have mentioned in the **table-1** with their frequencies. The data have been collected through analysis reports of SCOPUS. The data shows that University of Delhi has contributed highest number of 44 papers followed by JNU, Manipal Academy, TISS, Amity Univ., IGNOU etc. It is found that J. Raina has published highest 5 papers as an individual author. The international collaborations shows that 58 articles are published in collaboration with United States. The study shows that the United States is preferred country for collaboration followed by United Kingdom, Australia, Canada etc, Further, it is found that highest 29 articles are published in the "Economic and Political Weekly" followed by International Journal of Educational Development, Journal of Critical Reviews and Journal of Engineering Education Transformations with publishing 10 articles each. So "Economic and Political Weekly" is the preferred journal for publishing articles.

Table-1: Top 10 contribution of research articles

Rank	Affiliation / Institute	*Publications*	Author	*Publications*	Collaboration -Country	*Publications*	Publication Source	*Publications*
1	University of Delhi	44	Raina, J.	5	United States	58	Economic And Political Weekly	29
2	Jawaharlal Nehru University	18	Choudhury, P.K.	4	United Kingdom	36	International Journal of Educational Development	10
3	Manipal Academy of Higher Education	14	Mukherjee, M.	4	Australia	17	Journal Of Critical Reviews	10
4	Tata Institute of Social Sciences	13	ChakrabortY.B.	3	Canada	17	Journal Of Engineering Education Transformations	10
5	Amity University	13	Chennat, S.	3	China	9	Journal Of Advanced Research In Dynamical And Control Systems	9

6	Indira Gandhi National Open University	11	Chimala konda, S.	3	Germany	9	Indian Journal Of Public Health Research And Development	8
7	Azim Premji University	11	Collumb ien, M.	3	France	8	International Journal Of Advanced Science And Technology	8
8	Symbiosis International Deemed University	10	Deb, P.	3	Malaysia	7	International Journal Of Scientific And Technology Research	7
9	O.P. Jindal Global University	8	Indraka nti, V.	3	Netherlands	6	International Journal Of Recent Technology And Engineering	6
10	All India Institute of Medical Sciences, New Delhi	7	Jose, D.	3	South Africa	6	Advances In Intelligent Systems And Computing	5

Subject Area wise research out puts:

The table-2 shows the subject-wise breakup of 716 articles published in the area of quality education from India during 2017-21 which are indexed in SCOPUS. The data shows that highest contribution i.e. 382 articles in the area of social sciences followed by medicine i.e. 139 articles. There are good number of articles published in the computer science, engineering, economics etc. on quality education from India. There are very less contribution on quality education from India in the area of veterinary, dentistry, chemistry, immunology and microbiology, etc.

Table-2: Subject Area of research output/articles

Sl. No.	Subject Area	Frequency
1	Social Sciences	382
2	Medicine	139
3	Computer Science	108
4	Engineering	104
5	Economics, Econometrics and Finance	95
6	Business, Management and Accounting	82
7	Arts and Humanities	49
8	Environmental Science	44
9	Psychology	43
10	Pharmacology, Toxicology and Pharmaceutics	27
11	Decision Sciences	24
12	Mathematics	23
13	Energy	22
14	Agricultural and Biological Sciences	19
15	Biochemistry, Genetics and Molecular Biology	18
16	Health Professions	11

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17	Nursing	11
18	Earth and Planetary Sciences	9
19	Physics and Astronomy	9
20	Materials Science	5
21	Multidisciplinary	3
22	Neuroscience	3
23	Chemical Engineering	2
24	Chemistry	2
25	Immunology and Microbiology	2
26	Dentistry	1
27	Veterinary	1

Co-Authorship Analysis:

Research collaboration may be of various types like inter-institutional, inter-country, inter-state, etc. Research collaboration finds out the similarity between two or more researchers in a particular discipline. Co-authorship analysis is a research method to study research collaboration among authors. Co-authorship shows intellectual, social and research relationship between two authors. Network of the co-authors is prepared through Pajek software. Collaboration pattern between authors have shown through co-authorship analysis (Figure-1). Collaboration between authors i.e. Kumar A and Gupta M, Gupta M and Singh R, Singh R and Sharma R, Verma A and Sharma A, etc. has shown in the figure-1. The size of the nodes shows the collaborative bonding between or among the authors.
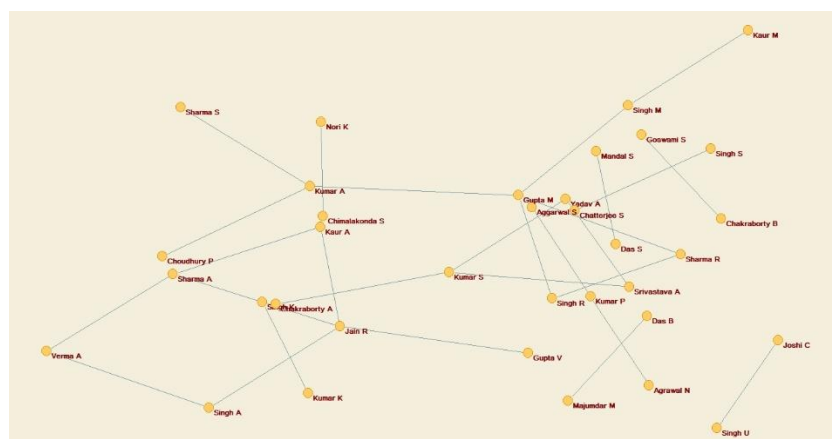

Figure-1: Co-authorship analysis graph

Co-Citation Analysis:

Co-citation measures how many papers are cited simultaneously in the same document. Co-citation is used as a measure of the connection between two authors' research area while co-authorship is used to study of research collaborations. Co-citation analysis is used to understand the intellectual structure of particular area of research. Bibexcel software is used for co-citation analysis of the collected data. Data files are converted in the desired format used in Bibexcel. In the present study, minimum documents for an author are five and minimum five citations of an author are considered while generating the co-citation graph vector graph. The vector graph (Figure-2) has prepared through the citation data of 716 articles using the Pajek software.

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Figure-2: Co-citation Analysis Graph

Highly Cited Authors:

Top 20 highly cited authors have been shown in the table-3. The study shows (table-3) that J.B.G. Tilak is ranked first having 119 citations. Further A. Kumar, S. Kumar and J.A. Bhutta are on 2nd, 3rd, and 4th position having 50, 41, and 38 citations respectively.

Table-3: Top 20 Cited Authors

S. No.	Name of Author	No. of Citations
1.	Tilak, J.B.G.	119
2.	Kumar, A.	50
3.	Kumar, S.	41
4.	Bhutta, J.A.	38
5.	Singh, A.	36
6.	Sen, A.	35
7.	Kumar, R.	34
8.	Sharma, A.	33
9.	Banerjee, A.	29
10.	Kumar, K.	29
11.	Singh, S.	28
12.	Sharma, S.	27
13.	Gupta. S.	26
14.	Mitra, S.	25
15.	Gupta. A.	24
16.	Liu, Y,	23
17.	Samways, M.J.	23
18.	Duflo, E.	22
19.	Patel, V.	22
20.	Psacharopoulos, G.	22

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H-Index of the Authors:

The H-Index of the top 20 authors were also calculated using the citation analysis. The table-4 shows the h-Index of top 20 authors. It is worth mentioning that although the authors have good citations but very less number of papers which are reflected as lower H-Index.

Table-4: H-Index of the top 20 Authors

S. No.	Author	Total Publications	Total Citations	H-Index
1.	Collumbien, M.	3	58	3
2.	Joshi, C.	3	50	3
3.	Singh, U.K.	3	50	3
4.	Sharma, S.	5	49	3
5.	Singh, R.	6	38	3
6.	Gupta, M.	5	13	3
7.	Bhutta, Z.A.	2	112	2
8.	White, H.	2	74	2
9.	Aggarwal, S.	3	71	2
10.	Moses, S.	2	50	2
11.	Murthy, S.	2	50	2
12.	Bhattacharjee, P.	2	50	2
13.	Thalinja, R.	2	50	2
14.	Prakash, R.	2	50	2
15.	Beattie, T.	2	50	2
16.	Javalkar, P.	2	50	2
17.	Isac, S.	2	50	2
18.	Ramanaik, S.	2	50	2
19.	Qureshi, R.	2	44	2
20.	Jain, T.	2	35	2

Key Word Analysis:

Co-occurrences of the words are used for content analysis that builds relationships and makes the conceptual structure of the domain by using keyword in documents. The underlying idea behind this method is that the frequent cooccurrence of words in a document indicates a close relationship among the concepts behind words. The keyword clustering graph has been shown as figure-3 based on the harvested data using Bibexcel and Pajek softwares.
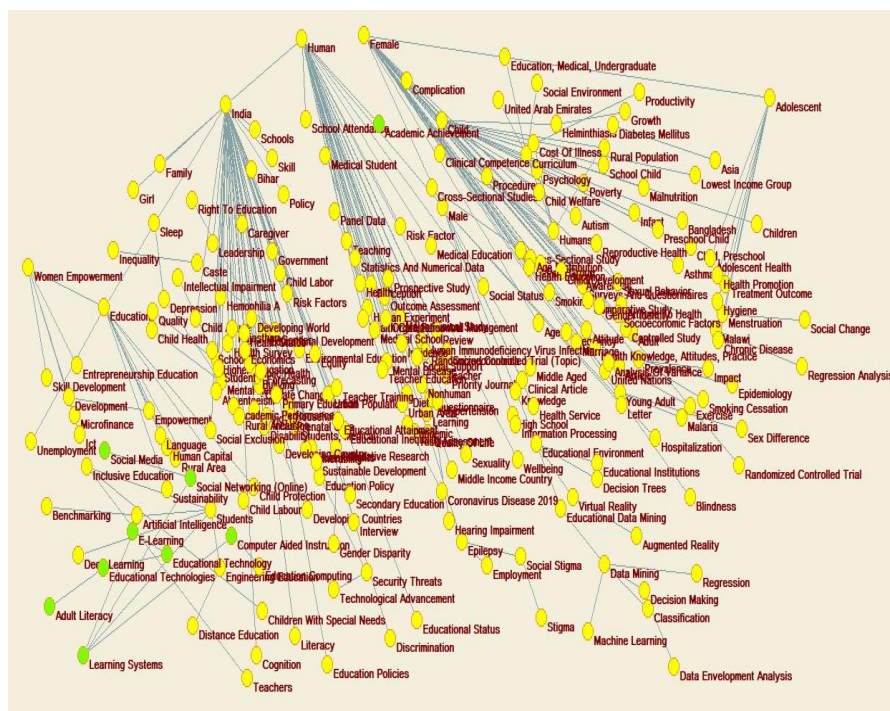
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Figure-3: Keyword Clustering Graph

Conclusions:

Citation analysis of research publications is a tool that is used to find out the important indicators hidden behind the research data. The obtained results inform and support the decisions making process as well as help to be used effectively for further course of research and studies. The Citation analysis of the research articles on quality education (SDG-4) shows that in last five years only 716 papers have been published. Majority of the papers were published in social sciences followed by Medicines, Computer Science and Engineering domains. The most collaborative country is United States followed by UK, Australia, Canada and China respectively. Three Asian countries and seven western countries are among most collaborative countries. Out of top 10 most productive institutions, 50% are private universities. The publication pattern, choice of publishing journals as well as key words analysis graph shows the potentiality of interdisciplinary research in the area of quality education (SDG-4). The citation impact of the research papers shows it as emerging field of research, but the H-Index of the authors are not impressive and shows long way to go ahead in this domain of research.

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