Digital Humanities in Action: Bibliometric Analysis of Peer-Reviewed Research on Critical Thinking

Richa Mishra[A]

Abstract: **Bibliometrics is a subfield within the digital humanities that focuses on the quantitative analysis of scholarly publications, particularly their citations and references. It plays a crucial role in understanding the structure and impact of academic research, as well as in shaping the field of digital humanities itself. This research paper examines the concept of critical thinking and underscores the pivotal role of bibliometric analysis in comprehending the landscape of research work in this critical domain. Critical thinking is a cognitive skill which is fundamental to the development of informed and responsible citizens, effective problem-solvers, and successful professionals. Its significance spans various disciplines and sectors, making it a cornerstone of academic and practical discourse. However, the extant body of research on critical thinking is vast and diverse, encompassing a plethora of publications in numerous academic journals and repositories. In this context, bibliometric analysis emerges as a valuable tool for assessing the quality, impact, and evolution of research in the field of critical thinking. It also serves as a foundational framework for future investigations and discussions, intending to enhance the cultivation and application of critical thinking skills in both academic and real-world contexts. This research work uses bibliometric analysis, data analysis and data visualization to map scholarship of Critical Thinking.**

***Index Terms*- Critical Thinking, Bibliometric, Digital Humanities, Data Visualization**

I. INTRODUCTION

A. Background and Motivation

WEF Global Competitiveness Index 2019 was based on 103 key indicators including Critical Thinking in teaching. India ranked in Skills 107 out of 144 countries, which is due to owing to insufficiency prevalent in our education system, leading to the failure to infuse critical thinking skills [1], the United States of America was ranked one.

5.01	Healthy life expectancy Years	67.8	86.8 ↓	44	Multiple (4)
	Pillar 6: Skills 0-100 (best)	-	68.7 ↓	47	**Finland**
6.01	Mean years of schooling Years	10.2	68.0 =	54	Finland
6.02	Extent of staff training 1-7 (best)	4.0	49.5 ↓	62	Switzerland
6.03	Quality of vocational training 1-7 (best)	3.9	49.1 ↓	76	Switzerland
6.04	Skillset of graduates 1-7 (best)	4.2	53.4 ↓	55	Switzerland
6.05	Digital skills among population 1-7 (best)	4.7	61.2 ↓	44	Sweden
6.06	Ease of finding skilled employees 1-7 (best)	4.0	50.5 ↓	74	United States
6.07	School life expectancy Years	15.4	85.4 ↑	47	Multiple (9)
6.08	Critical thinking in teaching 1-7 (best)	4.5	58.0 ↓	19	United States
6.09	Pupil-to-teacher ratio in primary education Ratio	18.2	79.5 ↓	66	Multiple (6)

Fig. 1. Global Competitiveness Index Report [3]

First A. Author is with the Department of Humanities and Social Sciences, Institute of Technology, Nirma University, Ahmedabad, India (e-mail: richa.mishra@nirmauni.ac.in)

After World War II there was an incremental rise in the number of post-secondary students attending American colleges and universities. To enroll a greater number of these students the three types of higher education institutions: professional and science-based universities, state-supported vocation-based colleges and universities, and private liberal arts colleges, expanded their missions in a manner that blurred the distinctions among them [2]. That was the time when Bloom and colleagues (1956) developed a taxonomy of six educational objectives for college and university faculty to describe the thinking skills of their students [3]. They developed these objectives to provide a solution to their opinion that college students were developing inadequate thinking skills [4]. These authors discussed student thinking skills progressing from lower-order ones such as knowledge and comprehension to higher-order ones such as application, analysis, synthesis, and evaluation. Higher-order thinking skills such as those listed are considered components of critical thinking [5]. These skills are valued in all academic disciplines with writers from the sciences, arts, and humanities reporting the importance of critical thinking within their disciplines. However, the descriptions and definitions of critical thinking have varied across the disciplines. Bloom and colleagues [6] discussed student thinking skills as indicated in the figure

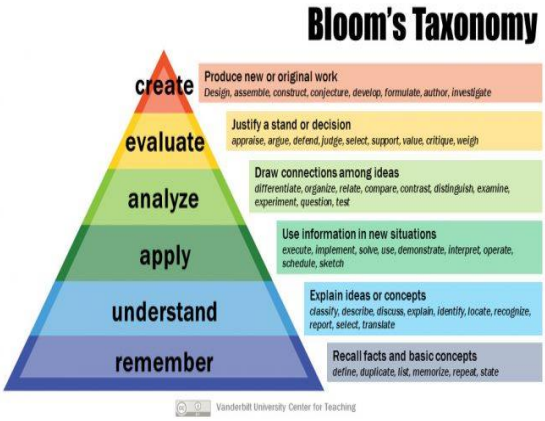

Fig. 2. Vanderbilt University Centre for Teaching

One construct of critical thinking defines it as a pattern of being habitually inquisitive, a 'habit of mind that is part of one's character [7]. Brookfield [8] outlined four key components of critical thinking: First, one must identify and challenge any assumptions for truth and validity. Second, critical thinkers are aware of how context can alter perceptions, understandings, and interpretations of the world.

Third, critical thinkers are constantly trying to discover new ways of perceiving the world to develop alternative explanations for the data they observe. Finally, critical thinkers need to exhibit reflective scepticism. Scepticism cautions one from blindly accepting the ideas, opinions, and beliefs expressed by others. Thus, Brookfield's (1987) description of critical thinking includes these thinking skills and the way people employ to use these skills[9]. One might think that intelligent, well-educated people would regularly engage in critical thinking. However, this assumption is not supported by the available data. Shermer stated [10] that no correlation exists between intelligence or education and well-reasoned beliefs. Like Shermer's finding concerning intelligence, research has shown that only 64% of college graduates have exhibited improvements in their critical thinking skills after their college education [11]. These data indicate that the education of these college students resulted in little change in their critical thinking skills. The United States Department of Education (USDOE) (2006) [12] has raised fears about a decrease in critical thinking, writing, and problem-solving among university student learning. It means more college graduates may engage in thinking errors. Shermer [13] pointed out some common thinking errors are confirmation bias (observing what people believe even when the evidence contradicts the belief), evidence extension (generating a general belief based on a limited amount of evidence), overconfidence (having more confidence in an opinion or finding than data to support that position), and assuming causality (believing that two events are causally related when the relationship between the events could be correlation or coincidence).

These thinking errors even occur among those with advanced degrees. Bishop and Trout [14] reported that scientists and other educated professionals experience overconfidence in the reliability of their subjective reasoning abilities. The educated professionals in their study exhibited thinking errors based on a failure to use the reasoning skills that they had. Nearly everyone uses critical thinking skills on occasion; however, most people do so intermittently. Most of the time, people of all education levels rely on their subjective impressions concerning information or events [15]. This finding agrees with Green's (2015) statement that the human brain tries to be most energy-efficient and thus it operates in a manner to do the least amount of cognitive work. Since reflective, critical, or skeptical reasoning involves more cognitive work, people don't use it effectively. To train graduates, the onus is on educators to help students develop the disposition to use higher-order critical thinking skills regularly and consciously.

The rapidly changing workspace; globalisation; deep complexity of the social fabric; the need for innovative solutions to societal problems; and information abundance yet not from credible sources - all indicate the need for reflective thinking skills in students and individuals.

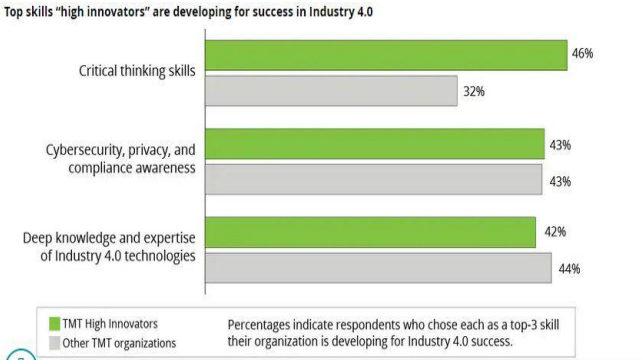

Fig. 3. Top skills for success in industry 4.0

Critical thinking rivals technical skills for Industry 4.0 success Innovative TMT companies value the human factor [16]. According to a Forbes magazine article doing any job critical thinking (found in 9 out of the 10 most in-demand jobs) is the most sought-after [17]. According to the article, it is "using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems". The revival of this very acknowledgement of the need for critical thinking skills can be the building block of having a course on critical thinking in the curriculum.

The impact of technology on Critical thinking is yet to be seen. The smart apps and gadgets making us smarter or dumber? The heavy reliance of users on technology for information, knowledge and relevance has turned gadgets into an appendage. We have yet to see the impact of ready-made information on the critical thinking skills of students. "Post-truth", was Oxford Dictionary's 2016 Word of the Year. It is related to not using objective facts to shape public opinion but appealing to emotion and personal belief," The word also is associated with the concept of "fake news" or the "post-factual". Right now social media texts and worldwide content can be seen as the largest source of public opinion.

Fig. 4. An example of misinformation - A picture of migrants arriving in Prague by train.

The video grab is actually of England [18]. Reliability to such information is creating an environment of misinformation. And creating an era of ambiguity and confusion among youth, the maximum user of social media [19].

II. BIBLIOMETRIC ANALYSIS

A. About Bibliometric Analysis

Bibliometric analysis has become extremely popular and powerful in research in recent years because of the convenience and availability of databases such as Scopus and Web of Science. Ease of use of data visualization tools such as VOSviewer. Bibliometric analysis is multidisciplinary [20]. This analysis is taking a strong postulation when it comes to research because of its ability to handle a large volume of data and then give accurate high research results.

For this paper, the author has used bibliometric analysis to understand the landscape of Critical thinking and related research work. Discussions on bibliometrics have been present since the 1950s [21]. The last decade showed an exponential increase in the use of this tool, owing to the availability of the data and also tools. For this research work, Bibliometric analysis was used since most of the data was readily available in the form of a Scopus database.

Qualitative analysis of huge data is a boon and a bane. Big data ensures deep insight but can be accurate if proper tools for analysis are not used. Bibliometric analysis helps the researcher in accumulating and categorizing the data. The data collected in this meticulous form can then be analysed using various tools including data visualization tools.

Critical thinking and its history go back to the 19th century. Critical thinking and issues are present in almost all domains of science, and arts but the author could not find any detailed study and bibliometric analysis of the existing literature till now.

Thus, this work will contribute in a manifold manner:

1. This work has collected and analysed the data from different domains thus putting the spotlight on the domains where critical thinking is not only more prominent but also researchers are working actively.
2. This work has mapped the intellectual landscape of the digital humanities.
3. By analyzing the connections between different works, researchers can identify key themes, trends, and influential scholars within the field.
4. This work has streamlined the data and translated it into bibliometric analysis for better data reading.
5. This work has surveyed the most active agencies actively involved in this much-needed area

This research work is structured as follows: Strategy and Methodology with details of keyword and search strategy. The next part of the work has results using various data visualization tools and bibliometric analysis. This paper summarises the findings, constraints and future scope in its conclusion.

III. STRATEGY AND METHODOLOGY

A. Scopus Database

One of the major research work and citation databases present today in digital form is the Scopus database. Since 2004, Scopus has been a platform for deep-insightful, credible, peer reviews and cutting-edge research papers that gain high citations. Scopus has nearly 36,825 titles from approximately 27081 journal publishers. It is also emerging as a platform that brings researchers, research ideas and organizations together.

Bibliometric analysis can be done on data taken by various indexing agencies but this work has used Scopus as the data source.

The search process started with identifying the keyword and understanding how it is used. Later on, steps were taken for collection-extraction-analysis-visualization. Data collection was done by using keywords which helped in retrieving documents as the primary source. The same keyword gave the result of the secondary source. These sources were not analysed further since they thought they were extracted from a Scopus document reference list but they are not indexed by Scopus.

The data gathered was immense. To make data easier to read and bring out trends, patterns and outliers, data visualization tools are used.

One of the most interesting findings was the publication of the first document on critical thinking dating back to 1880. The author has taken into account publications from 1880 to April 2023.

The author has used digital tools to construe the work and data mined from Scopus.

B. Data collection

Keywords are the gateway to immense data present. They are like a compass in directing us to the right and relevant topics and data sets. Precise and accurate keywords can give you a clear picture of the prevalence of the topic as the research problem. For this research work, only "Critical Thinking" is used.

To avoid ambiguity and replication, the keyword so chosen was "Critical AND Thinking " After the use of this keyword and also without any filter applied, a total of **36825** primary documents were found. The data was collected on April 12, 2023.

Table 1. Key Word and result (Data accessed till April 21, 2023).

Sr No	Key Word	Primary Source
1	**Critical AND Thinking**	**36825**

The documents were distributed as follows:

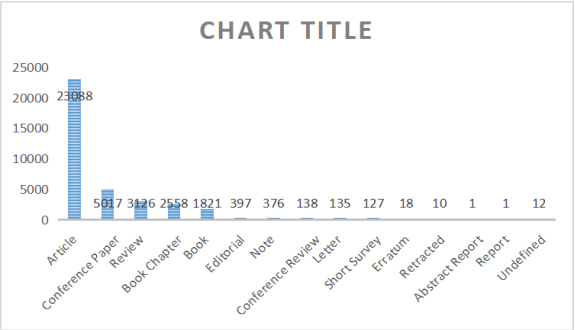

Fig. 5. Distribution of the sources.

The Co-occurrences of the keywords are shown below. The size of the node is indicative of the frequency of occurrence whereas the curve indicates the site of the occurrence(publications).

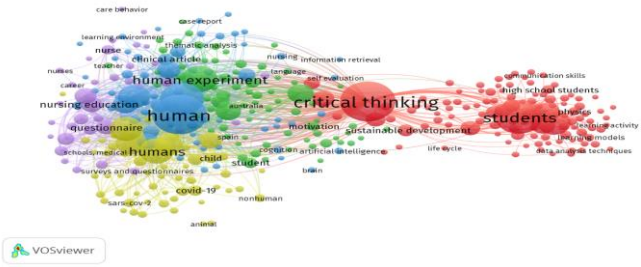

Fig. 6. Co-occurrence of the indexed keywords using VOSviewer

IV BIBLIOMETRIC ANALYSIS OF LITERATURE

This is the age of Data analytics; we now know how to use different tools to analyse the data and make sense of it. This is also the age of concept. This conceptual age gives us a picture of insights and patterns from the raw data. This analysis is multifunctional. It analyses the presence and influence of different journals [22] it also suggests how the field is moving and heading [23] This study will connect the dots and explore the trend in terms of publication year. Country-wise, universities were active in this area etc.

A. Analysis of Publication and Sources:

Out of the total 36825 sources retrieved on April 12, 2023, Major research work published was in the form of research articles. There were 23088 articles on various issues related to Critical Thinking 5017 research works were conference papers whereas 1821 books were written on this subject. An analysis of the publications by the source is given in Figure 2.

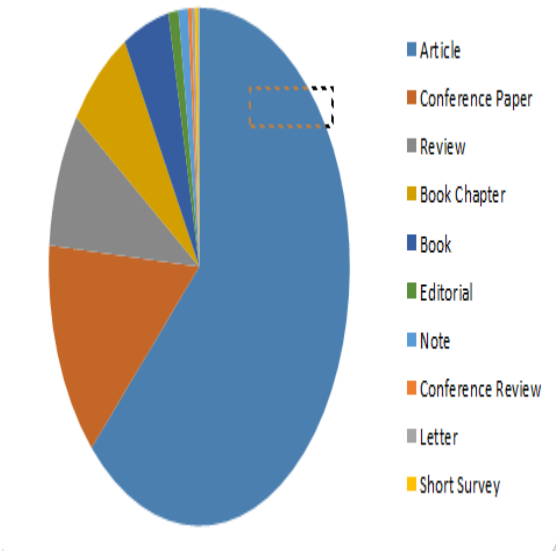

Fig. 7. Publications by sources

B. Analysis of publications by year

The trend analysis at first glance indicates the number of publications in this research area has increased steadily over the years. The first documented article is from 1880 and then the year 1925/1928 more research work was found. The highest number of works was documented for the year 2020. This indicates growing concerns about the lack and importance of Critical Thinking.

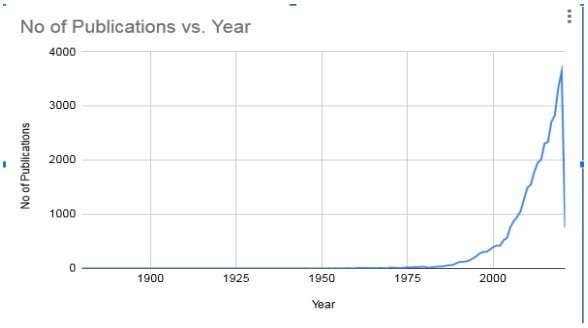

Fig. 8. Number of Publications year-wise

C. Analysis of Publications by Author

In the co-authorship type using the unit of authors, for each of the authors, a co-authorship link was calculated. Though some authors were not connected and the largest number of connected authors was 3, density visualization was used to depict the connections.

Out of the 5622 authors meeting the threshold 12 clusters and 9 items were depicted using VOSviewer.

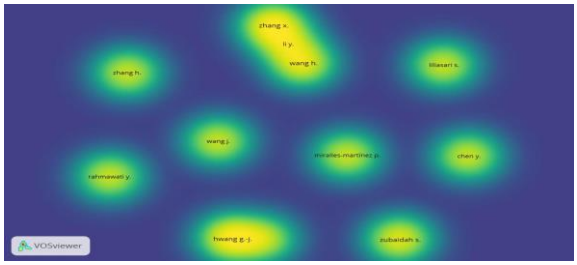

Fig. 9. Publications by author

D. Analysis of publications by subject area

In the literature from 1880 to 2023, Twenty-seven subject areas were involved which mentioned and worked upon Critical Thinking. Domains range from Agricultural science to social science as well as Nursing and Medical Science. Social Sciences have the highest number of documents (39 %).

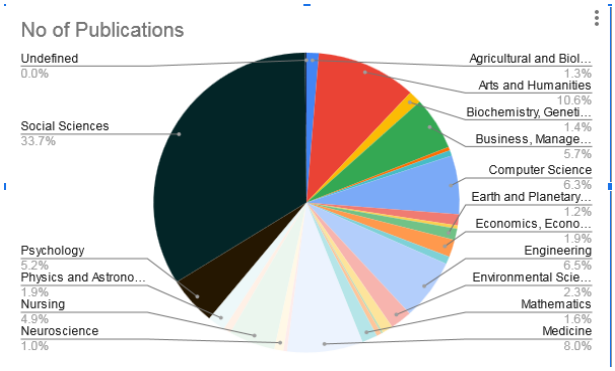

Fig. 10. Subject Area distributions

E. Trend in countries with active research works and funding agencies

We can't underplay the need and importance of critical thinking in every domain. Most countries are actively trying to work on research, policy-making and incorporating critical thinking. But few countries are taking an interest proactively and apparently, encouraging the research.

With 13556 articles out of 41924 total literatures on Critical Thinking, the United States of America is ahead in publication. It is followed by the United Kingdom and India. The graph below indicates the trend country-wise

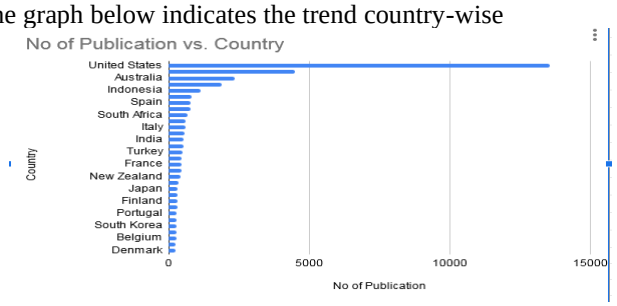

Fig. 11. Publication by country/ region

F. Funding agencies

Funding agencies can give impetus to the research work. They act as an essential part of the Research environment. A good funding agency guarantees good research work, method, outcome and impact. It provides a good researcher with the tools and motivation to chart uncharted areas. The analysis of funding agencies draws attention towards the priority areas of the agencies too. The topmost funding agency was the National Science Foundation with 17 papers; the European Commission with 16 research works; and the Economic and Social Research Council with 12 papers. Google funded 4 research works and Amazon Web Services funded 2 papers that are present in the Scopus database. Figure 6 shows the top 15 funding agencies on Critical thinking.

TABLE 2
TOP FUNDING AGENCIES

Sr No	Agencies	Projects Sponsored
1	National Science Foundation	449
2	National Institutes of Health	158
3	Economic and Social Research Council	134
4	National Natural Science Foundation of China	106
5	Social Sciences and Humanities Research Council of Canada	92
6	National Institute of Mental Health	82
7	European Commission	79
8	Australian Research Council	75
9	Japan Society for the Promotion of Science	55
10	Engineering and Physical Sciences Research Council	48
11	Deutsche Forschungsgemeinschaft	40
12	Ministry of Science and Technology, Taiwan	39
13	Eunice Kennedy Shriver National Institute of Child Health and Human Development	38
14	National Institute of Neurological Disorders and Stroke	37
15	National Institute on Ageing	37

Fig. 12. Most active Funding agencies

G. Analysis by Affiliations

Like funding agencies, universities and research agencies have thrust areas. Figure 7 highlights the most active agencies and organizations in the Critical Thinking research area.

The University of Toronto is actively working on this area with 247 research works whereas the University of Queensland has produced work amounting to 201 publications, respectively. The table shows the few most active organizations.

TABLE 3
MSOT ACTIVE ORGANIZATIONS

Sr No	Active Universities	No Work Produced
1	University of Toronto	247
2	The University of Queensland	201
3	Monash University	179
4	University of Melbourne	174
5	Pennsylvania State University	168
6	Purdue University	167

7	University College London	153
8	The University of Sydney	150
9	The University of British Columbia	147
10	Universitas Pendidikan Indonesia	144
11	University of Cambridge	137
12	Columbia University in the City of New York	136
13	University of Michigan, Ann Arbor	134
14	University of Alberta	134
15	Stanford University	129
16	University of Oxford	129
17	Universitas Negeri Malang	127
18	The University of Illinois Urbana-Champaign	125
19	Griffith University	124
20	University of Florida	122
21	The Ohio State University	120
22	The University of Hong Kong	120
23	University of Minnesota Twin Cities	119
24	UNSW Sydney	117

A graphical representation is shown

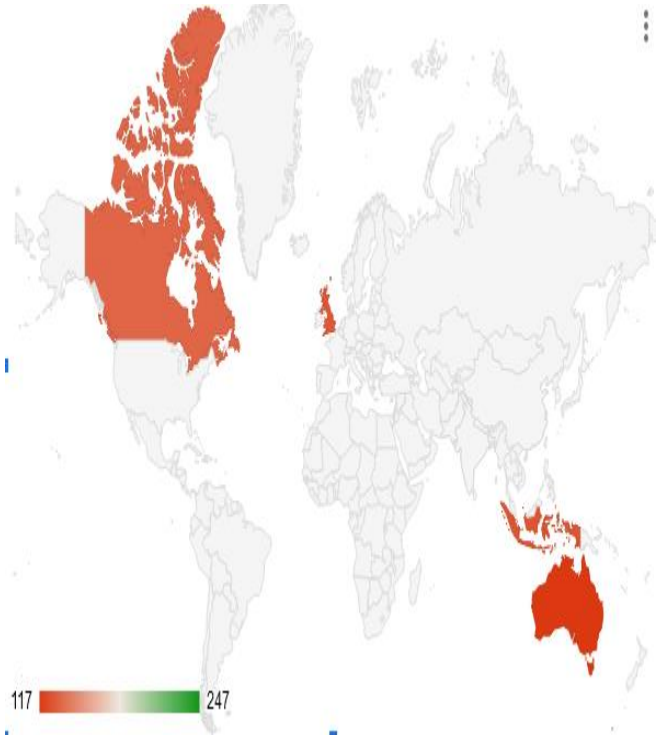

Fig. 13. Most active universities in the field of Critical Thinking

H. Co-occurrence network of the most frequently used author keywords.

A threshold of 5 was used. Out of 5638 keywords, 144 documents meet the threshold. The representation of this is done using VOSviewer. The bubble size refers to the total number of highly cited articles, while line thickness and colour refer to link strength and clustering, respectively.

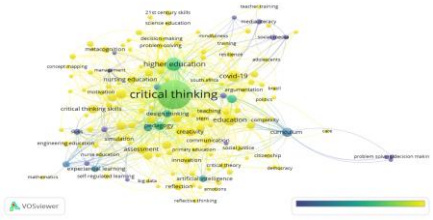

Fig. 14. Occurrences and keywords

V. DISCUSSIONS

The study threw the spotlight on various trends and limitations. The increase of work on Critical Thinking in Medical Sciences shows the importance policymakers need to make in curricula. Since the philosophy and science of critical thinking belong to social sciences, a substantial amount of work is done in these fields. it is now one of the active and fastest-growing research concerns and research work in Social sciences and also in the nursing domain. Since nurses are required to ask critical questions like the diagnostic tools.

The number of publications in 2023 proves that there is tremendous interest among social commentators and researchers on the topic. The author is sure that this interest and insights will only increase with the increase of false information, misinformation, millions of websites and content produced by them and so on. It is to be noted that massive work is done in a few countries but developing countries are still lagging.

This study observed that the most prominent subject area in the published literature is Social Sciences, followed by Medical Science and then the engineering domain.

This study has limitations as well since the database was taken from Scopus. Major databases like Web of Science, EBSCO, and HEIN were not taken into account for this research work. Since the database was huge and ever-growing, qualitative research could not be done on most cited papers. In future, a more comprehensive qualitative and qualitative survey should be taken.

VI CONCLUDING REMARKS

The analysis using bibliometric tools and other data visualization tools opens a new foray for digital humanities researchers [25]. It brings out the best of both worlds. The huge amount of data can be tackled effectively using technical

tools. Bibliometric analysis not only analyses the work in critical thinking but also is opening a new foray into digital humanities.

This bibliometric analysis can be used as a quick compass for aspiring researchers to understand the landscape of critical thinking research work.

This new Scopus research trend explores the rapid growth of publications in this area. Critical Thinking was always taken as an innate ability but now researchers are trying to understand and incorporate its inside-outside in various domains.

This work also shows that the majority of work is done in Canada and Australia. The need is to talk and disseminate this information worldwide so that more and more institutions can understand and implement a strategy to increase critical thinking skills. The need and demand and reflection upon Critical Thinking is urgent [26] and more work should be done on this.

REFERENCES

[1] India's fall on the competitiveness index is a reminder of its failings. (2021, December 6). BusinessLine. Retrieved from https://www.thehindubusinessline.com/opinion/editorial/indias-fall-on-the-competitiveness-index-is-a-reminder-of-its-failings/article29649177.ece

[2] World Economic Forum. (2018). The Global Competitiveness Report 2018. https://www3.weforum.org/docs/GCR2018/05FullReport/TheGlobalCompetitivenessReport2018.pdf.

[3] Bok, D. 2013. Higher education in America. Princeton, NJ: Princeton University Press.

[4] Bloom, B., Engelhart, M., Furst, E., Hill, W., & Krathwohl, D. (1956). Taxonomy of education objectives: The classification of educational goals handbook 1: Cognitive domain. New York, NY: David McKay.

[5] Bloom, B., Engelhart, M., Furst, E., Hill, W., & Krathwohl, D. (1956). Taxonomy of education objectives: The classification of educational goals handbook 1: Cognitive domain. New York, NY: David McKay.

[6] Beyer, B. K. (1987). Practical strategies for the teaching of thinking. Boston, MA: Allyn and Bacon

[7] Bloom, B., Engelhart, M., Furst, E., Hill, W., & Krathwohl, D. (1956). Taxonomy of education objectives: The classification of educational goals handbook 1: Cognitive domain. New York, NY: David McKay

[8] Facione, P. (1990). The Delphi report. Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction. Executive summary. Millbrae, California: The California Academic Press.

[9] Brookfield, S.D. (1987). Developing critical thinkers: Challenging adults to explore alternative ways of thinking and acting. San Fransisco: Jossey Bass.

[10] Brookfield, S.D. (1987). Developing critical thinkers: Challenging adults to explore alternative ways of thinking and acting. San Fransisco: Jossey Bass.

[11] Shermer, M. (2002). Why do people believe weird things? New York, NY: Henry Holt and Company.

[12] Arum, R., & Ruska, J. (2011). Academically adrift: Limited learning on college campuses. Chicago, IL: The University of Chicago Press.

[13] United States Department of Education. (2006). A test of leadership: Charting the future of U.S. higher education. ED Pubs: Washington, D.C. Downloaded 02/08/2016 from https://www2.ed.gov/about/bdscomm/list/hiedfuture/reports/final-report.pdf

[14] Shermer, M. (2002). Why do people believe weird things? New York, NY: Henry Holt and Company.

[15] Facione, P. (1990). The Delphi report. Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction. Executive summary. Millbrae, California: The California Academic Press. Facione, N. & Fa cione, P. (1996). Externalizing critical thinking in knowledge development and clinical judgment. Nursing Outlook, 44, 129-136.

[16] Barseghyan, L. (2022). ON THE IMPORTANCE OF TEACHING CRITICAL THINKING. Foreign Languages in Higher Education, 25(1(30)), 118–130. Retrieved from https://doi.org/10.46991/flhe/2021.25.1.118

[17] R Mishra, Ketan Kotecha. "Thinkers in my classrooms: Teaching critical thinking deductively", 2015 5th Nirma University International Conference on Engineering (NUiCONE), 2015

[18] NaveenDonthua et al, How to conduct a bibliometric analysis: An overview and guidelines, Journal of Business Research, Volume 133, September 2021, Pages 285-296

[19] Ellegaard and Wallin, 2015, O. Ellegaard, J.A. Wallin, The bibliometric analysis of scholarly production: How great is the impact? Scientometrics, 105 (3) (2015), pp. 1809-1831

[20] ŠNÍDL, V.: Šíril sa hoax, ako migranti vlakom dorazili do Prahy. Ľudia si nevšimli, že zdieľajú video z Anglicka. [online]. [2018-10-24].Available at: <https://dennikn.sk/1168189/siril-sa-hoax-ako-migranti-vlakom-dorazili-do-prahy-ludia-si-nevsimli-ze-zdielaju-video-zanglicka/>.

[21] R Mishra, Are We Doing Enough? A Bibliometric Analysis of Hate Speech Research in the Selected Database of Scopus, Library Philosophy and Practice (e-journal), ISSN 1522-0222, 2021

[22] Baumgartner, H., & Pieters, R. (2003). The structural influence of marketing journals: A citation analysis of the discipline and its subareas over time.Journal of Marketing,67(2),123-139.

[23] Eisenhardt, K. M. (1989). Agency theory. An assessment and review.Academy of Management Review,14(1), 57-74.

[24] Morrison, E. W., & Bies, R. J. (1991). Impression management in the feedback-seeking process: A literature review and research agenda.Academy of Management Review,16(3),522-541

[25] R Mishra, Are We Doing Enough? A Bibliometric Analysis of Hate Speech Research in the Selected Database of Scopus, Library Philosophy and Practice (e-journal), ISSN 1522-0222, 2021

[26] R Mishra, K Kotecha, Are we there yet? Inclusion of higher-order thinking skills (HOTs) in assessment, Journal of Engineering Education Transformations, 2016

Richa Mishra is I/c Head, Department of Humanities and Social Sciences, Nirma University. She has received her PhD on Gender Studies and Comparative Literature from Rani Durgawati Vishwavidyala, Jabalpur in 2008. Dr Mishra has authored more than 20 publications in indexed journals and 5 books.

Dr Mishra is member of ISTE, Association for Computers and the Humanities, and The Alliance of Digital Humanities Organizations (ADHO). She has won runner up award during DHOx, Oxford University in 2022 for her research work on Gender and Language. She is recipient of research grant from ICSSR.