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The Evolution of Critical Thinking in the Classroom: A Bibliometric Analysis

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Abstract

Education systems have recognized the importance of strengthening students' critical thinking skills in order to develop critical thinkers. However, teachers must better integrate critical thinking into their curricula in order to achieve this. Therefore, this study aims to provide a review of past literatures related to "critical thinking in teaching education". The data from Scorpus was used to conduct a bibliometric analysis in this study**.** The papers in this database were checked without a time limit in all categories, restricted to the keywords of "critical thinking" and "teaching." For further analysis, 605 publications published between 1944 and 2019 were retrieved. Microsoft Excel was used for frequency analysis, VOSviewer was used for data visualization, and Harzing's Publish or Perish was used for citation metrics and analysis. Standard bibliometric indicators such as research productivity, document types and sources, document language, subject area, keywords analysis, country productivity, authorship, and citation analysis are used to report the findings in this study. Since 2014, the rate of growth of critical thinking has increased, according to the findings. Meanwhile, 362 documents (59.83%) were multi-authored, with an average collaboration index of 2.87 authors per article. According to analysis by country, the United States of America (USA) is ranked first productive, with 205 (33.88%) published documents. In terms of citation frequency, D.F. Halpern (1998)'s article is the most cited, with an average of 23.91 % citations per year. Overall, the rise in the number of works on critical thinking in education reflects a growing awareness of its importance and specific requirements in 21st-century education.

Keywords: critical thinking, teaching, bibliometric analysis.

1 Introduction

When the term ‘Critical Thinking’ is searched, it is understood in the frame of philosophy and psychology sciences but it does not have a clear definition in the general sense. Helping students develop critical thinking skills has become a global issue in education in recent decades due to the importance of critical thinking in education. Some scholars, such as Paul et al., (1997), argue that because of the complexity and intellectual history of critical thinking, it is not wise to attempt a single definition that encompasses all of the meanings, qualities, and skills it entails. As a result, they assert that any proposed definition would be limited. Researchers, on the other hand, argue that it plays a critical role in all fields and domains of knowledge, as well as in all life settings where humans develop, such as work, education, family, friends, and community (Moseley et al., 2005; Butler, 2012).

Education is now widely regarded as critical to the development of competent societies in the 21st century. One of the most important goals in 21st-century education is to empower critical thinking skills. It is said that students require not only intellectual mastery but also a competence that leads to critical thinking and life skills in order to survive (Glaze, 2018; Lindsey et al., 2014). Therefore, educational development should be able to accommodate the enhancement of students' critical thinking abilities (Strauss, 2016). The development is indistinguishable from a number of studies that

have sparked extensive debate about how to maintain quality improvement in the teaching process (Fauzi & Pradipta, 2018; Spencer-Rodgers & Cortijo-Ocaña, 2015).

In addition, certain trends of thinking abilities such as metacognitive (Perry et al., 2019), creative (Mumford & McIntosh, 2017), and critical thinking (Strauss, 2016), have also been said to be the most valuable resource for graduates in the 21st century to excel in the tight competition. Among all the listed competencies, critical thinking is frequently included in the list of must-acquire skill competence for the 21st century education. Correspondingly, critical thinking skills belong to 10 key competencies identified in the Assessment and Teaching of 21st Century Skills (ACT21S) (Binkley et al., 2014).

Despite the growing interest in critical thinking in education research, attempts to report the trend of literature, particularly those that used a bibliometric approach are limited. Indeed, bibliometrics is the application of quantitative analysis and statistics to journals, such as journal articles and their corresponding quotes (Thomson-Reuters, 2008). Therefore, this article will summarize the current state of critical thinking research and assess its future prospects. The goal of this paper is to report the trends of a previous studies on critical thinking in the classroom and compare them to the field's global development.

2 Methodology

Bibliometric analysis methods are used to examine and evaluate the trend and evolution of critical thinking research in education. In this paper, the results are analysed using network visualization and bibliometric indicators.

2.1 Bibliometric Analysis

A bibliometric analysis is becoming more popular as a method of revealing study trends. It can be used to assess the quantity and quality of published materials, as well as to track trends or patterns in a particular research field (Sweileh et al., 2017). The bibliometric analysis gives insights into research areas by revealing detailed information about the collection of publications from specific databases such as publication type, location of publication, h-index, authors, keywords frequency and the number of citations (Ahmi & Mohd Nasir, 2019).Therefore, bibliometric analyses have become the most popular scientific discovery and research results can be read and cited by other researchers.

2.2 Source and Data Collection

Since Scopus is the largest scholarly works database, the study employed this database as a basis to extract prior works on critical thinking. This study examined the data obtained from the Scopus database on 24 September 2020. It represents the relevant topic that is significant with the research area and the aim of the study. The search of critical thinking studies was conducted based on the keywords to further specify relevant scholarly works on the research keywords. To find the most recent trend in critical thinking research, the search included publications from the year 1944 to 2019. To avoid double or false counting of documents, erratum and retracted document types were excluded. As such, the following query was specified in the search process; TITLE("criticalthinking"AND "teach*") AN D (EXCLUDE (PUBYEAR , 2021) OR EX CLUDE (PUBYEAR , 2020)) AND (EXC LUDE (DOCTYPE , "er")). Chen (2010) highlighted that the title of an article should incorporate information that can be potentially used to attract readers' attention, as it is the element that readers first observe.

The database supplies publication details that include access type, year, author name, subject area, document type, source title, keyword, affiliation, country, source type and language. This query yielded a total of 605 documents to be used to conduct the bibliometric analysis. Therefore, this research focused on all documents that are related to critical thinking based on the title of the document. Some tools are available to examine the data in bibliometric analysis. For this paper, we used: (1) Microsoft Excel to calculate the frequencies of the published materials and to design the relevant chart and graph; (2) VOSviewer (www.vosviewer.com) to construct and visualise the bibliometric networks; and (3) Harzing's Publish and Perish software to calculate the citations metrics and some of the other frequencies.

3 Results and Findings

Based on the data obtained, the bibliometric attributes such as research productivity, document types and source types, the language of the document, subject area, keywords analysis, country productivity, authorship, and

citation analysis were analysed. Most of the findings are presented as frequency and percentage. The co-occurrence of the author's keywords is mapped using VOSviewer, and citation analysis is reported as citation metrics and the top 10 most cited articles in critical thinking are disclosed.

3.1 Research Productivity

Research productivity is examined in this review based on the number of documents produced per year. Ahmi & Mohamad (2019) stated that examination of the documents based on year of publication helps the researcher to observe the pattern of the chosen area. The first publication on critical thinking was published by Debreceny and Gray (1944). Since then, the growth of publication was a little bit slow until 1991. The numbers increased year by year, and the highest number of publications on critical thinking was in 2019 with 81 papers published. Table 1 and Figure 1 summarise the details statistic of annual publications on critical thinking from 1944 to 2019 representing a total of 605 publications. It is expected that the number will increase in 2020 as the topic is related to industrial revolution 4.0, is widely debated and has a significant impact on the teaching education currricula.

Table 1: Document by Year

Year	Number of Published Articles	Percentage (N=605)	Cumulative Percent
1944	1	0.16	0.16
1945	1	0.16	0.33
1954	1	0.16	0.49
1958	1	0.16	0.66
1963	2	0.33	0.99
1964	1	0.16	115
1967	1	0.16	1.32
1968	1	0.16	1.48
1972	1	0.16	1.65
1982	1	0.16	1.81
1984	4	0.66	2.47
1985	1	0.16	2.64
1986	4	0.66	3.30
1987	1	0.16	3.47
1988	2	0.33	3.80
1989	3	0.49	4.29
1990	2	0.33	4.62
1991	9	1.48	6.11
1992	7	1.15	7.27
1993	2	0.33	7.60
1994	5	0.82	8.42
1995	7	1.15	9.58
1996	14	2.31	11.90
1997	13	2.14	14.04
1998	8	1.32	15.37
1999	10	1.65	17.02
2000	7	1.15	18.18
2001	10	1.65	19.83
2002	7	1.15	20.99
2003	10	1.65	22.64
2004	15	2.47	25.12
2005	11	1.81	26.94
2006	8	1.32	28.26
2007	10	1.65	29.91

2008	19	3.14	33.05
2009	25	4.13	37.19
2010	27	4.46	41.65
2011	22	3.63	45.28
2012	20	3.30	48.59
2013	17	2.80	51.40
2014	25	4.13	55.53
2015	39	6.44	61.98
2016	46	7.60	69.58
2017	45	7.43	77.02
2018	58	9.58	86.61
2019	81	13.38	100
Total	**605**		

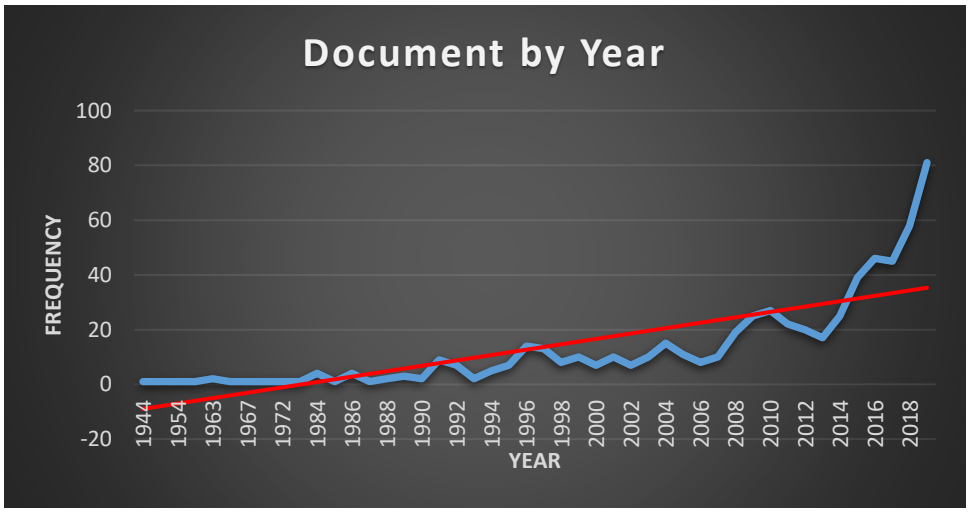

Figure 1. Document by Year

3.2 Document Type and Source Type

Further analysis was done to analyse the type of documents and source types in which the research on critical thinking was published. The document type can be journal article, conference paper, review, article, book, book chapter, or editorial. Results of document type as presented in Figure 2, show that journal articles represent more than half (419, 69%) of the articles published on critical thinking followed by conference paper (91, 15%) and book chapter (41.7) and review paper (37.6). Other types of documents represented less than 5% of the total publication respectively.

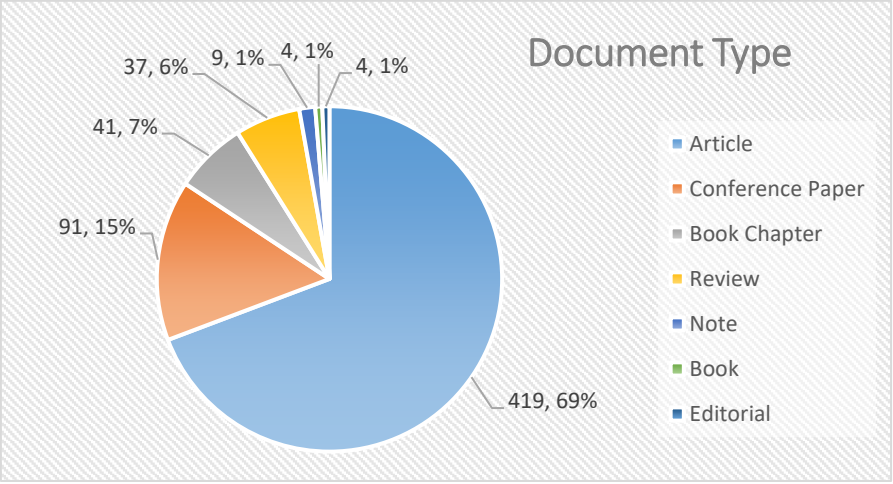

Figure 2. Document Type of the Published Articles

While there are various document types for the published articles on critical thinking, there are also different categories of source type identified in this study. Table 2 shows that most of the articles are published in journals compared to conference proceedings and books.

Table 2. Source Type

Source Type	Total Publications (TP)	Percentage (%)
Journal	471	77.85
Conference Proceeding	78	12.89
Book	43	7.11
Book Series	11	1.82
Trade Journal	1	0.17
Undefined	1	0.17
Total	**605**	**100.00**

3.3 Source Title

The studies on critical thinking were also published in various journals, proceedings, and books. Table 3 below tabulates the top source titles where critical thinking articles have been published, based on a minimum of 5 publications produced by each source title. It can be seen from the table that Journal of Physics Conference Series hosts the most number of papers on critical thinking.

Table 3: Most Active Source Title

Source Title	TP	% (N=605)
Journal of Physics Conference Series	30	4.95
Nurse Educator	13	2.14
Palgrave Handbook of Critical Thinking in Higher Education	12	1.98
Teaching of Psychology	10	1.65
Journal of Nursing Education	9	1.48
Teaching Philosophy	9	1.48
Eurasian Journal of Educational Research	7	1.15
Thinking Skills and Creativity	7	1.15
Procedia Social and Behavioral Sciences	6	0.99
Radiologic Technology	6	0.99

Notes: TP=total number of publications

3.4 Languages of Documents

According to Table 4, English-language papers related to critical thinking research that are indexed in Scopus account for 577 (93.67 percent) of the total publications. Spanish (16, 2.60 %), Turkish (11, 1.79 %), and other languages with a total of less than 1%, such as Portuguese, Croatian, Arabic, Finnish, Italian, Japanese, Persian, and Slovenian, are among the most commonly used languages.

Table 4: Languages Used for Publications

Language	Number of Published Articles *	% (N=616)
English	577	93.67
Spanish	16	2.60
Turkish	11	1.79
Portuguese	4	0.65

Croatian	2	0.32
Arabic	1	0.16
Finnish	1	0.16
Italian	1	0.16
Japanese	1	0.16
Persian	1	0.16
Slovenian	1	0.16
Total	616	**100.00**

*one document has been prepared in dual languages

3.5 Subject Area

Table 5 shows the total number of subjects that are as published under the article title 'critical thinking'. It was found that most of the critical thinking research are from the area of social sciences which represents (499, 48.18 %) of the total publications. Arts and humanities, psychology, nursing, medicine, engineering, physics, and astronomy, among other subject areas, accounted for less than 10% of total publications.

Table 5: Subject Area

Subject Area	Number of Published Articles *	%
Social Sciences	449	48.18
Arts and Humanities	81	8.69
Psychology	57	6.12
Nursing	54	5.79
Medicine	44	4.72
Engineering	43	4.61
Physics and Astronomy	38	4.08
Computer Science	36	3.86
Business, Management and Accounting	23	2.47
Economics, Econometrics and Finance	18	1.93
Mathematics	16	1.72
Health Professions	15	1.61
Environmental Science	8	0.86
Chemistry	7	0.75
Agricultural and Biological Sciences	7	0.75
Earth and Planetary Sciences	6	0.64
Biochemistry, Genetics and Molecular Biology	5	0.54
Decision Sciences	5	0.54
Energy	5	0.54
Pharmacology, Toxicology and Pharmaceutics	4	0.43
Dentistry	4	0.43
Materials Science	3	0.32
Neuroscience	2	0.21
Multidisciplinary	1	0.11
Chemical Engineering	1	0.11

*Some documents are categorized in more than one subject area

3.6 Keywords Analysis

VOSviewer was utilised to perform the author's keyword analysis. Author's keywords were mapped using VOSviewer, a software tool for constructing and visualising bibliometric networks. Figure 3 presents a network visualisation of the author's keywords produced by VOSviewer in which color, circle size, font size, and thickness of connecting lines indicate strength of the relationship between the keywords. The analysis indicates that there are five (5) clusters in critical thinking research

which have been developed based on the author's keywords. Related keywords as indicated by the same color are commonly listed together. For example, the first cluster is related to critical thinking, knowledge, education, teaching, thinking skill and others colored in red are closely related and usually co-occur together.

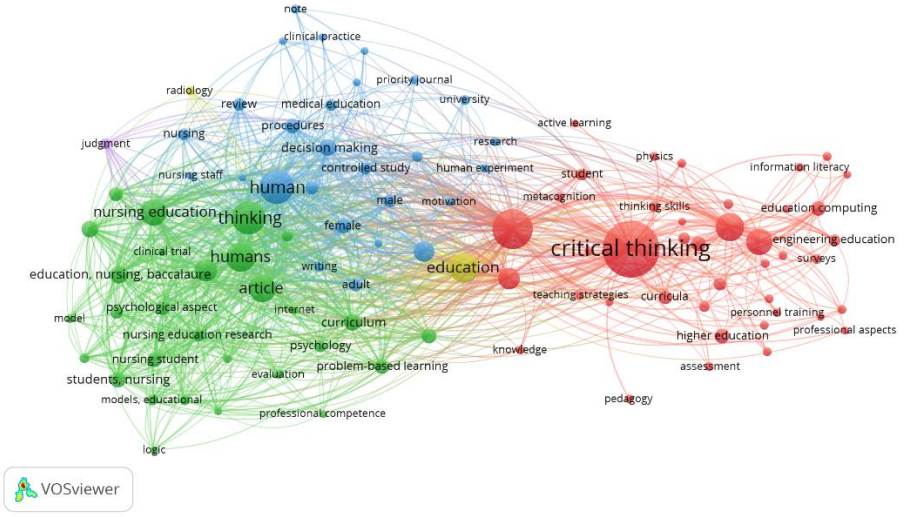

Figure 3. Network visualisation map of all keywords

Meanwhile, keywords such as critical thinking and teaching, human, thinking, and education are found as the most widely used keywords in the analysis of the critical thinking based on the number of occurrences. Table 6 shows the top 20 keywords used related to critical thinking.

Table 6. Keywords

Author Keywords	Total Publications (TP)	Percentage (%)
Critical Thinking	249	23.36
Teaching	122	10.46
Human	89	7.63
Thinking	86	7.38
Education	68	5.83
Humans	67	5.75
Students	64	5.49
Article	57	4.89
Critical Thinking Skills	53	4.55
Nursing Education	53	4.55
Methodology	40	3.43
Problem Solving	37	3.17
Learning	33	2.83
Education, Nursing, Baccalaureate	26	2.23
Curriculum	23	1.97
Decision Making	23	1.97
Clinical Competence	21	1.80
Students, Nursing	19	1.63
Education Computing	18	1.54
Higher Education	18	1.54

3.7 Geographical Distribution of Publications - Most Influential Countries

The distribution of the top 20 countries based on an amount of publication in the critical thinking is illustrated in Figure 4. The United States of America is ranked 1st with a total of 205 documents, followed by Turkey (51), and Indonesia (117), while Chile and Colombia were ranked the lowest with a total of four (4) publications each.

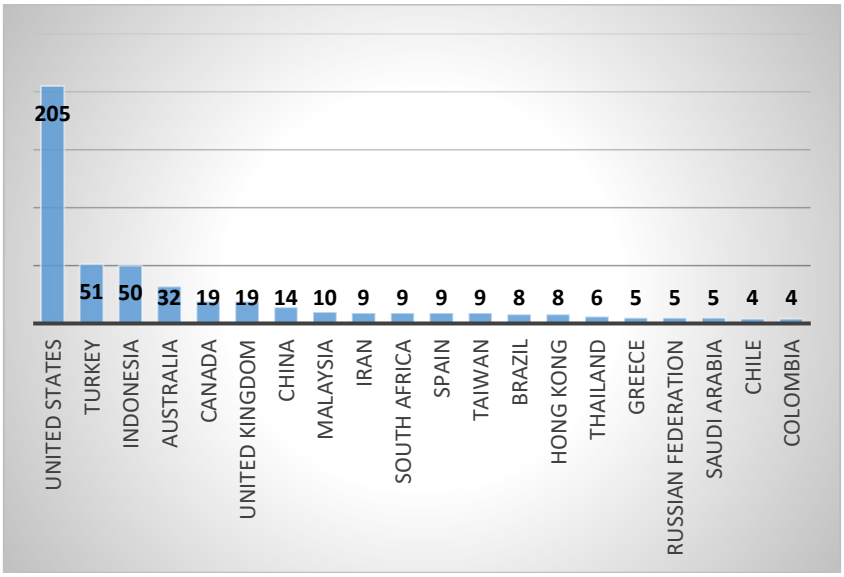

Figure 4. Countries contributed to the publications

3.8 Authorship

The number of authors per publication is presented in Table 7. The analysis shows that (240; 39.67%) documents are single authored, the remaining documents (362; 59.83%) are reported as multi-authored publications with the number of authors ranging between 2 and 9, while there are (3; 0.50%) documents where the author's name was not available and cannot be obtained from the Scopus database.

Table 7: Number of Author (s) per document

Author Count	Total Publications (TP)	Percentage (%)
0	3	0.50%
1	240	39.67%
2	163	26.94%
3	109	18.02%
4	54	8.93%
5	23	3.80%
6	5	0.83%
7	6	0.99%
9	2	0.33%
Total	605	**100.00**

*Conference review document. No of author is listed.

3.9 Citation Analysis

The citation metrics data from 1944 – 2029 generated using Harzing's Publish and Perish software are summarized in Table 8. The summary includes the total number of citations with their citations per year, citations per paper, and citations per author. Altogether, there are 605 papers with 6325 citations averaging at 83 citations per year related to critical thinking and teaching publications. Each paper is cited 10.45 times, and the total h-index and the g-index are at 34 and 61 respectively for all the publications.

Table 8: Citations Metrics

Metrics	Data
Publication years	**1944-2019**
Citation years	**76 (1944-2019)**
Papers	**605**
Citations	**6325**
Citations/year	**83.22**
Citations/paper	**10.45**
Citations/author	**4309.94**
Papers/author	**377.83**
h-index	**34**
g-index	**61**

Furthermore, the top 10 most cited articles and productive authors in the field of critical thinking are presented in Table 9. The document entitled "Teaching Critical Thinking for Transfer Across Domains: Dispositions, Skills, Structure Training, and Metacognitive Monitoring" by D.F. Halpern, (1998) received the highest number of citations (562 citations or an average of 23.91 citations per year) from a total of 6325 citations based on the SCOPUS database.

Table 9. Top 10 Cited Articles

No.	Authors	Title	Year	Cites	Cites per Year
1	D.F. Halpern	Teaching Critical Thinking for Transfer Across Domains: Dispositions, Skills, Structure Training, and Metacognitive Monitoring	1998	526	**23.91**
2	G. ten Dam, M. Volman	Critical thinking as a citizenship competence: Teaching strategies	2004	169	**10.56**
3	T.V. Gelder	Teaching Critical Thinking: Some Lessons from Cognitive Science	2005	162	**10.8**
4	B. Miri, B.-C. David, Z. Uri	Purposely teaching for the promotion of higher-order thinking skills: A case of critical thinking	2007	159	**12.23**
5	D.F. Halpern	Teaching for critical thinking: Helping college students develop the skills and dispositions of a critical thinker	1999	140	**6.67**
6	D.T. Willingham	Critical Thinking: Why Is It So Hard to Teach?	2008	126	**10.5**
7	I. Popil	Promotion of critical thinking by using case studies as teaching method	2011	124	**13.78**
8	B.J. Daley, C.R. Shaw, T. Balistrieri, K. Glasenapp, L. Piacentine	Concept maps: A strategy to teach and evaluate critical thinking	1999	117	**5.57**
9	C. Garside	Look who's talking: A comparison of lecture and group discussion teaching strategies in developing critical thinking skills	1996	116	**4.83**

10	A. King	Designing the Instructional Process to Enhance Critical Thinking across the Curriculum: Inquiring Minds Really Do Want to Know: Using Questioning to Teach Critical Thinking	1995	111	**4.44**

4 Conclusion

This paper describes a bibliometric analysis to gain vivid insight into the critical thinking literature's historical review, trends, and contributions. Scopus database is used in the title of the paper to access all the research that has the word "critical thinking". Overall, bibliometric details of 605 documents were extracted from the Scopus database. The results indicated that the topic on critical thinking has emerged since 1944 and grew with the greatest number of publications in 2019. Most of the articles were published in the journals, and English is the primary language. Moreover, 39.67% of the documents are single authored. The data also shows an increasing trend in the number of authorships per document over time. According to the geographic distribution of the literature, the United States has the biggest number of publications compared to other progressive nations. Aside from Indonesia, there are also sizable contributions of scholarly works on this research domain from other Asian countries. Therefore, this study suggests that the research on critical thinking should be conducted in other developing countries such as Malaysia, due to its significant global impact.

Issues pertaining to critical thinking mainly originate from social sciences, arts and humanities, psychology, nursing, medicine, and engineering. However, about half of the examined articles are classified under social sciences. Along with the increase in the frequency of publications per year, this study also indicates a higher average number of authors per document over the year. This trend, to some extent, shows greater collaboration among authors in this field. The findings suggest that critical thinking is an important subject that needs further investigation and more importantly, collaboration in many other different contexts. The publication impact can be evaluated based on the citation metric, as displayed in Table 8. Based on the 76 years of publications (1944 – 2019), 605 papers have been produced by researchers around the world with a total of 6325 citations. On average, the topic generated 83 citations and each paper is cited 10.45 times.

Despite the insightful results gathered through this bibliometric analysis, readers should consider several limitations. Firstly, this study conducted specific query/keywords to locate initial list of scholar works indexed by Scopus. Nevertheless, this practice has been a commonplace for earlier bibliometrics related studies. The use of more keywords related to critical thinking can contribute to more comprehensive results and improve the quality of the findings. Furthermore, no search query is 100% perfect for capturing all the scholar works in this area. Thus, false positive and false negative results are always expected. Secondly, although Scopus is the most extensive database in many scholarly works, but it does not completely cover all available sources (Sweileh et al., 2017;Ahmi & Mohamad, 2019). Other databases can be included in the search query to contribute to in-depth analysis and more valuable results. Despite these limitations, however, this study is the pioneer in presenting the bird's eyes view of the current trend of critical thinking in teaching education research globally. This study also contributes to the extension of the body of knowledge in critical thinking in education literature through the bibliometric approach.

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