



Trends and hotspots in critical thinking research over the past two decades: Insights from a bibliometric analysis

Manxia Dong^a, Fuli Li^b, Huiming Chang^{c,*}

^a Professor of Language Assessment and English Education, Sichuan International Studies University, Chongqing, China

^b English Teacher, Longjin Middle School, Shenzhen, Guangdong, China

^c Sichuan International Studies University, Chongqing, China

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ABSTRACT

Critical thinking has received significant scholarly attention in education over the years. This study conducted a bibliometric analysis of critical thinking during the last two decades (2000–2021) to identify research trends and hotspots of critical thinking. After data processing, 2043 publications related to critical thinking were retrieved from the Web of Science (WOS). Our analysis covers the number of publications per year, most used keywords, most productive countries/regions, institutions and authors, and most cited publications. The results show that critical thinking received increasing interest throughout this period; the research topics of critical thinking were rich and constantly evolving; the publications in western countries/regions have a stronger impact and higher recognition than do those in non-western countries; and critical thinking instruction has become the most popular research topic. This study holds important implications and should serve as a reference for future research.

1. Introduction

Critical thinking is a high-order thinking activity for “deciding what to believe or do” [1]. It comprises skills of interpretation, analysis, evaluation, inference, explanation, self-regulation, inquisitiveness, self-confidence, open-mindedness, prudence, and the like [2]. Critical thinking was interpreted as seven definitional strands: judgment, skepticism, originality, sensitive readings, rationality, an active engagement with knowledge, and self-reflexivity [3]. People with excellent critical thinking skills are commonly thought to be purposeful, reasoning and goal-directed when solving problems, formulating inferences, calculating likelihoods, and making decisions [4]. Research on critical thinking is gaining momentum in various fields owing to its critical role in work, study, life, and scientific research. According to the Web of Science database (hereafter, WOS), critical thinking research has been conducted in 101 research areas from 2000 to 2021. Of all these areas, research on education accounted for the largest proportion (55.392%).

As Dewey advocated reflective thinking and its education practice, critical thinking has aroused strong interest on the part of researchers and educators in education [5]. With a more globalized economy and rapid developing technology in the 21st century, critical thinking has attracted greater attention worldwide and has even been identified as a highly desired skill or a “vital necessity” for the 21st century [6–8]. The Association of American Colleges and Universities identified critical thinking as an essential learning outcome of higher education [9]. Some scholars maintain that enhancing students’ critical thinking skills and abilities is critical as it is a highly prized educational objective [10,11]. International educational institutions have repeatedly recommended teaching critical

* Corresponding author.

E-mail address: Changhuimingsis@163.com (H. Chang).

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thinking [12]. Many countries have devoted efforts to improving their educational systems or enacting policies to prepare their students for the challenges of the twenty-first century [8,13]. For example, in the US, The No Child Left Behind Act of 2001 (NCLB) which entered in force in 2002, mentioned the development of students' critical thinking skills [14]. In the same year, the organization, "Partnership for 21st Century Skills (P21)" was established to explore skills that will help students succeed in the 21st century. Critical thinking was one of the most important skills listed, alongside communication, collaboration, and creativity, together summed up as the 4Cs [15]. Since 2009, the US has established the 4Cs as one of the prior educational goals for elementary and middle school [16]. In addition, some countries (e.g., Japan, Vietnam, and India) have introduced various courses, programs and activities across educational levels to foster critical thinking in schools [17]. For instance, in India, the National Curriculum Framework (NCF) and National Curriculum Framework for Teacher Education (NCFTE) enacted in 2005 and 2009, respectively, emphasized the importance of critical thinking.

Although critical thinking has received wide attention from authorities, organizations, institutions, and schools in education in the 21st century, the current state of research and development trend of critical thinking over this period remain unknown. Periodical content analysis of a discipline or field can provide some information to evaluate the development of professional literature or a given discipline, and bibliometric analysis conducting a quantitative assessment of various parameters (i.e., the number of publications or citations) is an effective way to achieve this [18]. Lei and Liu and Wang et al. [19,20] suggested that bibliometric analysis is a particularly effective way to identify internal structure and development trends of a particular research direction/field or a specified journal. Bibliometric analysis has two major forms: investigating a certain research field or research topic for a specific period through the analysis of all related journals, and conducting a mapping study for a single journal over a certain period [18]. This study attempted to adopt the former form of bibliometric analysis (focusing on the specific research area of critical thinking) to reveal research trends and hot topics of critical thinking in education over the last two decades. The findings of this bibliometric analysis are expected to help scholars to understand research on critical thinking over this period and identify the most popular research topics, thereby helping researchers find fruitful topics for future research.

2. Review of bibliometric studies

The term "bibliometrics," coined by Pritchard (1969) [21], refers to the quantitative analysis of scientific publications [22]. White and McCain defined bibliometrics as "the quantitative study of literature as they are reflected in bibliographies" [23]. Early bibliometric studies primarily concerned the natural sciences and focused on the development of a discipline rather than the impact of research in the discipline [19]. Bibliometrics is also frequently used in library and information science and presently plays a significant role in measuring research performance [24].

With the development of modern technology, some databases (i.e., WOS, Scopus, Derwent, PubMed) provide a wealth of bibliometric information, including citations of publications, collaborative publications, authors, institutions, and countries. Such information facilitates the evaluation of the contribution of authors, institutions, and countries/regions to a field and the impacts of researchers, articles, and journals [25,26]. Such information is also useful for amateur researchers seeking to determine the impact of the last published articles and in choosing the best journal for a manuscript [27]. Therefore, most recent bibliometric studies have included bibliometric information.

Although a wealth of bibliometric studies has been conducted on certain disciplines in the natural and social sciences over the past decades, only a few have concerned critical thinking in education [28–30]. For instance, Sommers's bibliometric analysis focused on nursing education [28]; Aktoprak and Hursen's bibliometric and content analysis of critical thinking examined research in primary education [29]; and Yang and Ren conducted a bibliometric analysis of the literature sources of critical thinking research within a specific country [30]. These bibliometric studies focus on either a sub-field of education, a certain phase of education, or a specific country/region, which cannot reveal the research trends of critical thinking research throughout the entire field or phases of education or provide a panoramic view of the international development of critical thinking research. Therefore, it is necessary to conduct a comprehensive and deep overview of critical thinking during the last two decades to afford scholars a better and fuller understanding of the development of critical thinking in the entire field of education throughout the world and advance ideas suggested by our analysis.

To this end, we aimed to review the publications related to critical thinking based on bibliometric information published from 2020 to 2021 by using VOSviewer and CiteSpace (two visualization tools). VOSviewer and CiteSpace specialize in exhibiting the co-citation network and display a research field's structure [31]. The review included the number of publications per year, keywords analysis, most productive countries/region, institutions and authors, and most cited publication. Correspondingly, four research questions were addressed as follows:

- 1) How many publications on critical thinking have been produced over the past two decades?
- 2) What keywords have been used most frequently?
- 3) Which countries/regions, institutes and authors were the most productive in terms of critical thinking publications?
- 4) Which publications have been cited the most?

The work makes the following contributions:

- 1) Analyses of the number of publications per year and the most prolific countries/region, institutions and authors to display the current status of critical thinking and predict the general development trends from multiple aspects.

- 2) The keywords analysis using VOSviewer and CiteSpace can help scholars to grasp the prominent topics of critical thinking and obtain new ideas.
- 3) In light of the aforementioned analysis, some implications and future directions of critical thinking are discussed.

3. Method

The research process is outlined in Fig. 1. The details of the data sources, search criteria, and methods of analysis will be presented in the following parts of this section.

3.1. Data source

Databases (e.g., WOS, Scopus, PubMed) are the typical data sources of a bibliometric overview. Each database has particular strengths or characteristics. For example, Scopus indexes a larger number of journals than the other databases, and its citation analysis is faster; WOS provides citation analyses with better graphics and more detailed information in the citation analysis; and PubMed focuses on medicine and the biomedical sciences without providing citation analysis [32]. WOS, one of the most widely used databases in academics, provides detailed information about publications worldwide in a number of leading journals. Data can be collected on this platform for such indexes as the Social Science Citation Index (SSCI), Science Citation Index-Expanded (SCI-E), Arts and Humanities Citation Index (A & HCI), and Conference Proceedings Citation Index Science (CPCI-S) [20]. Furthermore, Aoife et al. suggested that WOS was the most appropriate online database for conducting a bibliometric analysis [12]. Considering the scope, discipline, and research aim, we chose WOS as the data source for our investigation.

3.2. Search criteria

We searched for publications on WOS that met the following four criteria: 1) the theme was related to “critical thinking”; 2) the keywords included “critical thinking”; 3) the research areas were limited to education; 4) the publication year spanned from January 1, 2000, to December 31, 2021. The searching query was as follows: $(TS = (“critical\ thinking”)) AND AK = (“critical\ thinking”)) AND SU =$

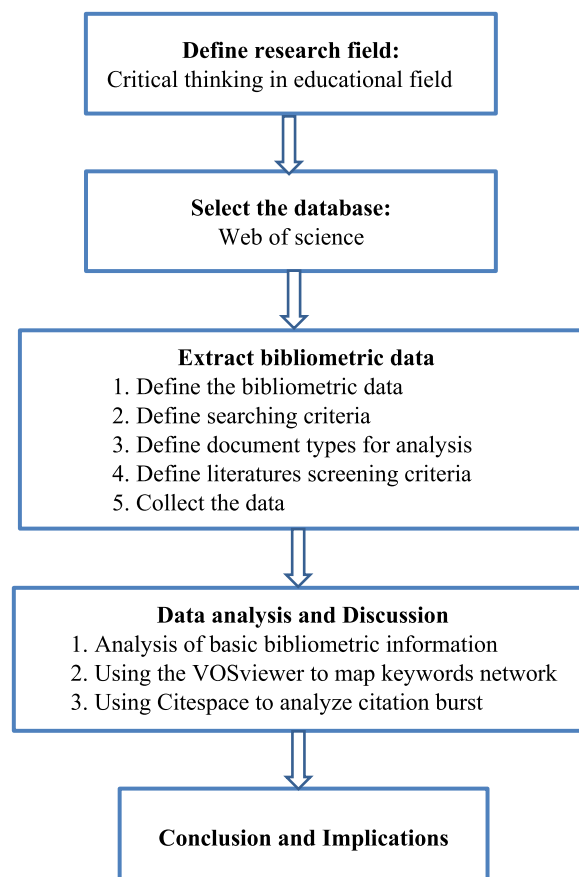


Fig. 1. Flow chart of the research process.

(*Education & Educational Research*) AND PY= (2000–2021). According to the criteria, 2432 records on critical thinking in WOS were identified.

A preliminary analysis of the original data showed that the documents included articles, proceeding papers, review articles, editorial material, meeting abstracts, letters and retracted publications. Articles ($N = 1498$, 61.595%), proceeding papers ($N = 878$, 36.102%), and review articles ($N = 56$, 2.303%) were the three main document types, accounting for 99.219% of the total publications and were included in the final analysis. As the other document types (i.e., editorial materials, meeting abstracts, and letters) were minimal and could not reflect the development trends and hot topics of critical thinking, they were excluded from analysis.

To obtain representative and relevant literature in the dataset, we conducted manual screening of the retrieved data according to the screening criteria. Two researchers conducted a joint analysis of each publication's title, abstract, and keywords and assessed whether the publication was related to critical thinking. Disagreements in the analysis were addressed to achieve agreement through discussion. Finally, 2043 valid publications were included in analysis.

3.3. Data analysis

In the present study, some basic bibliometric information, including publication numbers, the most productive countries/regions, institutions, and authors, and the most highly cited publications, was directly drawn from WOS databases using its functions “create citation report” and “analyze search results.” VOSviewer was used to generate the network maps of keyword co-occurrence, while CiteSpace (version 5.7.2) was used to process keywords with the strongest citations, which can reflect the structure and characteristics of the research field [33].

4. Results and discussion

4.1. Number of publications per year

Fig. 2 presents the numbers of publications from 2000 to 2021, which was used to uncover the diachronic development of critical thinking research in education. No results were returned in 2000 and 2001, and the number of publications from 2002 to 2021 steadily increased. Further observation found very low production, with less than 10 publications, for the period from 2002 to 2006. From 2007 to 2016, the number of publications steadily increased, ranging from 25 to 108. In 2017, a drastic increase was found, and the number of publications increased from 108 in 2016 to 242 in 2017. From 2017 to 2021, the number of publications increased considerably, reflecting researchers' increasing interest in critical thinking. The considerable increase in number can be attributed to the importance placed by some countries/regions' governments and education authorities on critical thinking ability and skills. There was a slight decline in 2020 and 2021, probably because of the impact of the COVID-19 pandemic.

4.2. The most frequently used keywords

Keywords are used to highlight the contents of a publication, and high frequency keywords reflect the hotspot areas of science [18]. Analysis of keywords is an essential tool for investigating trending topics [34]. There were 5355 keywords with one occurrence found by VOSviewer. The top 20 most used keywords are presented in Table 1. “Critical thinking” ranked first (1594 occurrences), “skills” ranked second (239 occurrences), and “education” ranked third (237 occurrences). The results indicate that critical thinking, skills, and education have been popular areas of research over the last two decades.

To obtain a clearer and deeper understanding of trends in critical thinking, we set the minimum number of occurrences of a keyword as 20, and obtaining the 59 most used keywords from the WOS to generate a keyword co-occurrence map using VOSviewer (see Fig. 3). Co-occurrence refers to the frequency of keywords occurring simultaneously in all papers [18]. The co-occurrence map reflects the frequency and proximity of keywords, which gives insight into the field's knowledge structure [35]. A keyword

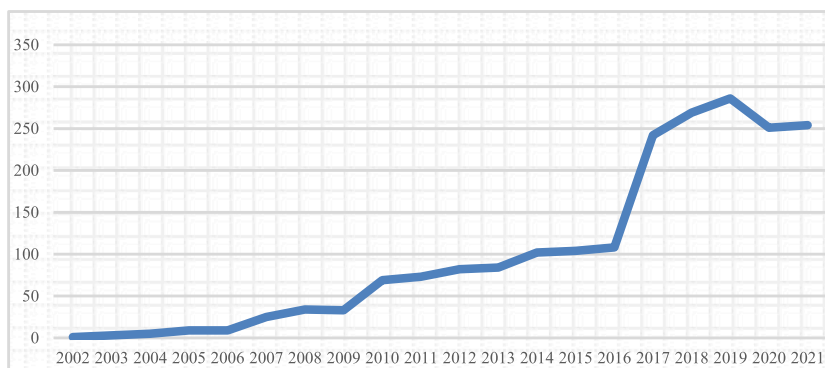


Fig. 2. WOS publications on critical thinking in education during 2000–2021.

the keywords of “education,” “nursing education,” “online,” “simulation,” and “technology.” Online teaching has also been frequently discussed beyond the classroom environment in schools. Moreover, nursing education frequently explores teaching strategies combined with technologies like simulation. The bright blue cluster is related to critical learning, which the keywords such as “students,” “learning,” “pedagogy,” and “collaborative learning” bear out. The green cluster is related to the skills, disposition of critical thinking, and to language pedagogy in higher education, represented by words such as “skills,” “disposition,” and “higher education.” The pink cluster is related to the validation of the critical thinking ability and model.

Overall, the findings for these clusters showed that critical thinking education was interdisciplinary with, for instance, science education. The focus of teaching broadened from dispositions such as self-efficacy and motivations to the framework, model, and validity. Moreover, the teaching space has expanded from physical classrooms to cyberspace. Thus, teaching strategies assisted by technology have become trendy.

To better understand the trend of hot topics of critical thinking, we use CiteSpace to analyze the strongest citation bursts of these keywords. Citation burst detection displays explosive growths in data, indicating the topics that attracted scholars’ attention in a certain period [37]. Hence, it can reveal the dynamic changes of publications related to critical thinking. Fig. 4 displays the top 20 most used keywords with the strongest citation bursts, representing the research frontiers in critical thinking in different periods. In Fig. 4, “Year” indicates the year in which the keyword first appeared and, “Begin” and “End” stand for the first and the last year of the citation burst for the respective keyword. “Strength” represents the degree to which received attention from scholars within that period.

The graph shows some shifts in the research interests and development of critical thinking research over the past two decades. Specifically, “nursing education,” “thinking skills” and “online discussion” had the strongest citation bursts from 2009 to 2012, suggesting that these topics gained tremendous popularity. From 2013 to 2015, “online learning,” “cognitive ability,” and “ability” were the most popular areas. A closer analysis found that two keywords were related to online environments, “online discussion” and “online learning,” indicating that online environments to develop critical thinking have received increasing attention primarily because the progress of technology made it possible to conduct online teaching and learning. Among the keywords, “impact” had the maximum strength (5.84), indicating that it has received the highest attention since 2019. The keywords “students learning” and “academic writing” had the longest citation burst durations, with six years, suggesting that these two areas were the prevalent topics for that period. Note that the strongest citations of six keywords have continued until now, including “STEM education,” “judgment,” “challenge,” “children,” “pre-service teachers,” and “paranormal belief,” suggesting that these topics have been gaining traction in recent years.

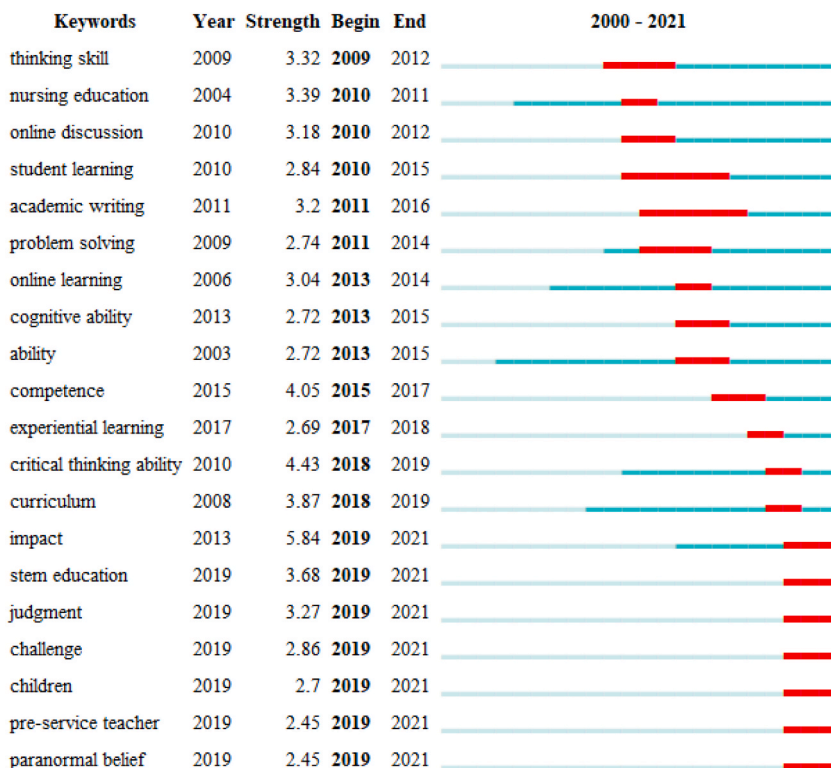


Fig. 4. Key words with strongest citation bursts from 2020 to 2021.

4.3. The most productive countries/regions, institutions and authors

1) The most productive countries/regions

The top 20 most productive countries according to the data from WOS are presented in Table 2. It may be noted that Taiwan as a part of China, has been classified as a region in this paper. The total number of publications (TP) can present the general situation of the most productive countries/regions. However, the average number of citations per publication (TC/TP) can reflect the recognition or impact of a publication, which has been used to assess the productive countries/regions [18,20,38]. Therefore, our analysis included TP and TC/TP, and the country rank is based on TC/TP.

As shown in Table 2, the top 20 countries/regions produced 1699 publications, accounting for 83.16% of the total. We found that the top 20 contributing countries/region covered countries/regions from six continents, indicating that critical thinking has gained wide attention from researchers worldwide.

Of the top 20, 8 come from Asia, 6 from Europe, and 3 from North America, indicating that Asian, European, and North American countries/regions perform well in critical thinking research. Compared with Europe (358 publications) and North America (461 publications), Asia (730 publications) has played a leading role in research production, indicating that Asian countries/regions have attached greater importance to critical thinking over the past two decades. This is reflected in an array of policies and programs introduced in some Asia countries. For instance, in China, the New Curriculum Standards for Compulsory Education (2003 experimental version) and Outline of the National Medium- and Long-Term Program for Educational Reform and Development issued in 2010 both attach importance to the development of students' critical thinking skills and ability.

According to the total number of publications, the US is the most productive country with 385 publications, followed by Indonesia (198), China (164), Turkey (137) and Spain (125). Regarding the average number of citation per publication, the US ranked second (15.77) with the greatest number of scientific publications, indicating that the US has played leading roles in research production and influence. It may be noted that some countries were at the top of TC/TP list despite their small number of publications. For instance, Canada was ranked first in the list (21.86) with 51 publications, Australia ranked third (15.33) with 96 publications, Netherlands ranked fourth (10.79) with 24 publications and Portugal fifth (10.56) with 27 publications. The results indicate that these countries' publications were highly recognized. Furthermore, we found that the publications from Western countries (i.e., European and North American countries/regions) had stronger influence and higher recognition in the critical thinking circle due to their higher TC/TP.

2) The most productive institutions

As in the analysis of the most productive countries/regions, two indicators were used to assess the institutions producing publications. The top 20 most productive institutions out of the 1727 institutions are displayed in Table 3.

Among the 20 institutions, 6 are from Indonesia, 4 from the US, 2 each from Singapore, China, and Russia, and 1 each from Iran, Malaysia, Turkey, and Italy. Indonesia has the most highly productive institutions in terms of the total number of publications, indicating that institutions in Indonesia have displayed a keen interest in critical thinking. For instance, Universitas Negeri Yogyakarta was ranked first with 38 publications, followed by Sebelas Maret University (Indonesia; 26). This can be attributed to the fact that many studies examined the lower critical thinking skills of Indonesian students [39–41], leading the Indonesian government to devote great efforts to improving education, such as implementing a new curriculum (namely, the 2013 curriculum) and, conducting

Table 2
Top 20 most productive countries.

Country rank	Country /region	publication	Citations	Citations/publication
1	Canada	51	1115	21.86
2	US	385	6070	15.77
3	Australia	96	1472	15.33
4	Netherlands	24	259	10.79
5	Portugal	27	285	10.56
6	Iran	58	593	10.22
7	England	88	894	10.16
8	Taiwan	54	547	10.13
9	Singapore	28	270	9.64
10	China	164	1328	8.1
11	Turkey	137	905	6.61
12	South Africa	28	184	6.57
13	Spain	125	789	6.31
14	Japan	24	95	3.96
15	Malaysia	67	237	3.54
16	Indonesia	198	494	2.49
17	Russia	64	138	2.16
18	Romania	31	63	2.03
19	Columbia	26	40	1.54
20	Mexico	24	26	1.08

Table 3
Top 20 most productive institutions.

rank	Institution	Country/region	Publications	Citations	Citations/publication
1	University of Hongkong	China	13	280	21.54
2	University of North Carolina	USA	13	229	17.62
3	University of IOWA	USA	13	187	14.38
4	National Institute of Education	Singapore	16	212	13.25
5	Nanyang Technological university	Singapore	17	218	12.82
6	State University System of Florida	USA	15	153	10.2
7	Education University of Hongkong	China	16	155	9.69
8	Islamic Azad University	Iran	22	195	8.86
9	Universitas Negeri Malang	Indonesia	22	161	7.32
10	University System of Georgia	USA	14	58	4.14
11	HSE University	Russia	12	47	3.92
12	University Technology Malaysia	Malaysia	16	49	3.06
13	Roma Tre University	Italy	13	37	2.85
14	Universitas Negeri Yogyakarta	Indonesia	38	97	2.55
15	Universitas Negeri Surabaya	Indonesia	12	30	2.5
16	Sebelas Maret University	Indonesia	26	58	2.23
17	Hacettepe University	Turkey	13	25	1.92
18	Kazan Federal University	Russia	13	25	1.92
19	Universitas Pendidikan	Indonesia	15	18	1.2
20	Universitas Negeri Padang	Indonesia	12	8	0.67

in-service training for teachers [41]. The importance placed by the Indonesian government on critical thinking skills raised great concern among researchers about critical thinking.

Regarding TC/TP, the University of Hong Kong (China) ranked first (21.54), followed by the University of North Carolina (US; 17.62) and the University of Iowa (US; 14.38) despite their lower ranking by total number of publications, indicating that these institutions have wide recognition and in-depth research in critical thinking. Note that Indonesia had the most productive institutions in terms of the number of publications. However, the average citation per publication is lower primarily due to a lack of high recognition (the value of TC/TP ranges from 0.67 to 7.32).

3) The most productive authors

The top 20 most productive authors are displayed in Table 4. In top 20 most productive authors in critical thinking, 8 authors were from Indonesia, 3 from Italy, 2 each from the US, China, and Ireland, and 1 each from Canada, Finland, and Taiwan. In terms of the number of publications, Wilujeng, I. from Indonesia was the most productive with 12 records, followed by Kuswanto, H (Indonesia; 11) and Poce, A (Italy; 10), and Zubaidah, S (Indonesia: 9). The rest had a slight disparity in their publication numbers, varying from five to seven.

In terms of TC/TP ratio, Ku, KYL (China) ranked first with an average of 67.2 citations per publication, followed by Hogan, M.J

Table 4
Top 20 most productive authors.

rank	Author	Country /region	Number of Publications	Citations	Citations/publication
1	Ku, KYL	China	5	336	67.2
2	Hogan, M.J	Ireland	6	304	50.67
3	Dwyer, C.P	Ireland	7	315	45
4	Pascarella, E.T	USA	6	124	20.67
5	Fung, D	China	6	108	18
6	Hwang, G.J	Taiwan	5	88	17.6
7	Mahanal, S	Indonesia	6	85	14.17
8	Liu, OL	USA	5	64	12.8
9	Zubaidah, S	Indonesia	9	89	9.89
10	Hyytinen, H	Finland	5	31	6.2
11	Sajidan	Indonesia	6	14	2.33
12	Sarwanto	Indonesia	6	9	1.5
13	Poce, A	Italy	10	10	1
14	Wilujeng, I	Indonesia	12	10	0.83
15	Balcaen, P	Canada	6	5	0.83
16	Jumadi	Indonesia	6	5	0.83
17	Kuswanto, H	Indonesia	11	8	0.73
18	Masykuri, M	Indonesia	5	3	0.6
19	Re, M.R	Italy	7	4	0.57
20	Amenduni, F	Italy	5	2	0.4

(Ireland) with an average 50.67 citations per publication. This result indicates that their publications had a stronger impact and wider recognition despite them not having the most publications (five and six publications, respectively).

4.4. The most highly cited publications

An analysis of the most highly cited publications helps identify the most popular publications and research areas [42], and can boost the acceptability and visibility of these publications, especially among the young researchers [18]. The top 20 highly cited publications are displayed in Table 5 in descending order based on the citation counts.

The results suggest that most of the highly cited publications were related to exploring the possibility and efficacy of critical thinking instruction. These studies offered evidence of the possibility of teaching students critical thinking skills or helping learners develop critical dispositions. Their results rebutted the argument that critical thinking as a cultural practice could not be easily taught [43]. For instance, Carini, et al.'s article "Student Engagement and Student Learning: Testing the Linkages" is the most highly cited publication, with 679 citations, suggesting that it has been highly recognized since it was published [44]. The publication reported an empirical study on how student engagement was related to academic performance, which corroborated a significant positive relationship that had been reported between student engagement and such student learning outcomes as critical thinking and grades [44]. The second most highly cited publication 332 is "Instructional Interventions Affecting Critical Thinking Skills and Dispositions: A Stage 1 Meta-Analysis" by Abrami et al. [45], which presented ways to effectively practice critical thinking instructions. The sixth publication indicated that the development of critical thinking was possible if teachers kept practiced higher-order thinking strategies on purpose [46]. Some important elements for fostering critical thinking were also emphasized in some publications on the list, such as dialogues and expressive capacity [47–49], diversity or authenticity in experiences [50], media competency [48], and strategies and methods promoting critical thinking [51–54]. Another research concern of the most cited publication is the clarification of definitions of critical thinking and framework construction [3,55].

5. Conclusions

This study conducted a bibliometric analysis of the critical thinking publications in the WOS in the education field from 2000 to 2021 to present a comprehensive overview of the research trends and hotspots of critical thinking. Two bibliometric tools, VOSviewer and CiteSpace were used to analyze the development trends and current status. The results show that the research on critical thinking exhibited a steady increase on the whole. Keyword analysis revealed that the research topics of critical thinking were rich and some novel areas are evolving. In terms of TC/TP, Canada and the US are the most productive countries and the University of Hong Kong is the most productive institution. Although Indonesia has the most productive institutions in terms of the total number of publications, the average citation of per publication is relatively low due to a lack of high recognition and strong impact. Wilujeng, I (Indonesia) is the most productive author and Ku KYL (China) has the highest number of citations per paper. The data on the most cited publications revealed that critical thinking instruction had become a popular research topic. This paper provides an overall bibliometric analysis from a global view of critical thinking development in education over the past two decades that should help scholars to deeply understand the development and status of research on critical thinking.

The findings of this study hold major implications for researchers, educators, institutions and countries/regions. The publications on critical thinking have steadily increased over the past two decades, indicating that issues of critical thinking are gaining popularity. Therefore, we suggest that researchers continue to focus on issues of critical thinking in the future. Through the analysis of the most explored research topics and most highly cited publications, we found that some topics received wider attention from researchers worldwide, such as critical thinking skills, online teaching and learning, and the teachability and effectiveness of critical thinking instruction. In future research on critical thinking, researchers should focus on the most explored research topics, and educators should follow the research trends, learn about the most recent research findings on critical thinking and adjust their teaching concepts and methods to improve the effectiveness of critical thinking instruction. Furthermore, this study found that the publications in Western countries had a stronger impact and higher recognition than those in non-Western countries. Thus, we suggest that researchers in non-Western countries/regions attach importance to exchange and cooperation across institutions and countries/regions to improve the quality and impact of their research.

This study has a few limitations. Only the publications within WOS were retrieved and analyzed, thereby excluding other publications on critical thinking in other databases (i.e., Scopus). Although WOS contains a large number of leading journals available and detailed information, data sources limited to WOS cannot collect all publications related to critical thinking [21], possibly leading to an incomplete picture of critical thinking research in education. In future, we hope to integrate Scopus and WOS, making good use of the strengths of each database to perform a more comprehensive bibliometric study. Also, although keywords are related to the research topics, any publication has several keywords. Hence, it remains unsettled whether a keyword exactly represents or reflects the topic of the research. A clustering analysis of all the publications using CiteSpace may be time-saving and ensure high reliability in identifying research topics or themes. However, it did not provide exact or meaningful research topic descriptions. In a future study, we will combine the keyword analysis using CiteSpace and VOSviewer with a manual analysis of the titles and abstracts of the publications to enhance the validity of the identification of research topics.

Table 5
Top 20 most highly cited publications.

Rank	Title	Author(s)	Year	Citations
1	Student engagement and student learning: Testing the linkages	Carini, et al.	2006	679
2	Instructional Interventions Affecting Critical Thinking Skills and Dispositions: A Stage 1 Meta-Analysis	Abrami et al.	2008	332
3	Media Competence. Articulated Proposal of Dimensions and Indicators	Ferres,J. Piscitelli, A	2012	250
4	The caring relation in teaching	Noddings, N	2012	225
5	Strategies for Teaching Students to Think Critically: A Meta-Analysis	Abrami et al.	2015	222
6	Purposely teaching for the promotion of higher-order thinking skills: A case of critical thinking	Miri, B et al.	2007	185
7	An integrated critical thinking framework for the 21st century	Dwyer, CP et al.	2014	157
8	Promoting argument-counterargument integration in students' writing	Nussbaum, EM; Schraw, G	2007	149
9	Assessing students' critical thinking performance: Urging for measurements using multi-response format	Ku, KYL	2009	148
10	College students' experiences with diversity and their effects on academic self-confidence, social agency, and disposition toward critical thinking	Nelson Laird, TFN	2005	144
11	Promotion of critical thinking by using case studies as teaching method	Popil, I	2011	143
12	Dealing with uncertainty: challenges and possibilities for the early childhood profession	Urban, M	2008	143
13	Pedagogy for developing critical thinking in adolescents: Explicit instruction produces greatest gains	Marin, LM; Halpern, DF	2011	135
14	Metacognitive strategies that enhance critical thinking	Ku, KYL; Ho, IT	2010	121
15	Critical thinking: seven definitions in search of a concept	Moore, T	2013	107
16	Team-Based Learning in Pharmacy Education	Ofstad,W; Brunner, LJ	2013	107
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19	Investigating students' level of critical thinking across instructional strategies in online discussions	Richardson, JC; Ice, P	2010	92
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Production notes

Author contribution statement

Manxia Dong: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Fili Li: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Huiming Chang: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Data availability statement

Data will be made available on request.

Additional information

No additional information is available for this paper.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Dong Manxia reports financial support and administrative support were provided by Chongqing Education Commission. Dong Manxia reports a relationship with Sichuan International Studies University that includes: employment and non-financial support.

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