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To cite this article:

Orhan, A. (2023). Bibliometric analysis of the studies on critical thinking in educational research: An insight from the last four decades (1980-2022). *International Journal of Research in Education and Science (IJRES), 9*(2), 329-350. https://doi.org/10.46328/ijres.3128

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International Journal of Research in Education and Science
2023, Vol. 9, No. 2, 329-350 https://doi.org/10.46328/ijres.3128

Bibliometric Analysis of the Studies on Critical Thinking in Educational Research: An Insight from the Last Four Decades (1980-2022)

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Article Info

Article History

Received:
27 December 2022
Accepted:
30 March 2023

Keywords

Critical thinking
Education
Bibliometric analysis
Systematic review
Science mapping

Abstract

In this bibliometric analysis study, it was aimed to systematically review and analyze the existing CT literature and provide an overall outlook and current status of research on CT using the publication and citation data extracted from the WoS database. For this purpose, 5064 articles and reviews on CT published in journals indexed in the WoS database were included in the bibliometric analysis. It was found that research on CT is an emerging area of inquiry and the interest in CT has grown exponentially in the last two decades. Also, publications are mostly published in higher education journals and the journals related to psychology, sociology, and philosophy as well as education technology journals. The USA absolutely leads the production and dissemination of scientific research on CT with other predominantly English-speaking countries as well as some other countries in Asia. Besides, the authors who work on higher education, psychology, and educational technology come to the fore in productivity and number of citations. Although scientific collaboration exists among the institutions and countries in the field of CT, this scientific collaboration occurs mostly among the institutions or countries which are close to each other either geographically or culturally. Five major clusters emerged in the co-word analysis: higher education, 21st century literacy skills, educational psychology and assessment and evaluation, educational technology, the effect of student-centered teaching/learning strategies on the CT, and work life, civic responsibility and social life of individuals.

Introduction

Critical thinking (CT) can be defined, briefly, as a functional, reflective, and reasonable way of thinking that is used by individuals while deciding what to do or what to believe (Ennis, 1991). In other words, CT is a logical, reflective, reasonable, and rational way of dealing with ideas, arguments, and information (Ruggerio, 1990). Individuals question, examine, and evaluate the ideas, arguments, and information through CT before deciding to believe or support them (Lewis & Smith, 1993). Therefore, we can say that individuals wear CT as armor against today's world and they can acquire true, useful, and logical information about their environments thanks to CT (Epstein & Kernberger, 2012). After a Delphi project sponsored by APA in 1990, CT was defined as "purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation

of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based" (Facione, 1990, p.2). Therefore, we can say that CT is a complex thinking process (Halpern, 2003) and includes different cognitive skills like interpretation, analysis, evaluation, and inference (Facione et al., 2000). Also, in the same Delphi Report, an ideal critical thinker is defined as "habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fair-minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit" (Facione, 1990, p.2). Based on this definition, it can be said that CT does not only include some cognitive skills but also some dispositions. Individuals need to have high cognitive skills and strong dispositions towards using those skills to be an adequate critical thinker (Profetto-McGrath, 2003). Therefore, it can be said that any effort to improve CT should include the aim of enhancement of both CT skills and dispositions together.

In recent decades, the enhancement of CT is seen as one of the primary goals (Astin, 1993; Stedman & Adams, 2012) and important outcomes (Halpern, 1998) of education systems. This is mainly due to the acceptance of the idea that CT can advance the quality of education (Ren et al., 2020). Also, it is not only vital for academic achievement (Orhan, 2022) but also important for individuals' civic and social life because CT makes individuals both more academically successful students and more socially positive individuals in their daily life (Kökdemir, 2003). It also has a strong relationship with other 21st century skills like decision making and reflective thinking which are also important skills of this century (Wagner, 2010). Therefore, we can say that CT is needed to found a democratic and healthy society and individuals can liberate the force in their education life and strong resource in their daily life (Facione, 1990). Besides, CT is seen as one of the most desired skills to be needed in the world of employment in near future (Al-Zou'bi, 2021; Schleicher, 2016; World Economic Forum, 2020).

Therefore, it is broadly accepted that the enhancement of CT at all levels of 21st century education systems is vital today (Stassen et al., 2011; Trilling & Fadel, 2009). In this sense, CT has gained attention in education research and this attention has grown exponentially in recent decades. Indeed, CT finds a place for itself among the skills which are most frequently used in the national policy documents of 152 countries (Care et al., 2018). There is great literature on CT and this literature is still expanding. In parallel with this growing research on CT, some studies have been conducted to systematically synthesize the previous research and to provide a general outlook and structure of the literature on CT. These attempts include meta-analysis studies to reveal the best way to teach CT (e.g., Abrami et al., 2008; Huber & Kuncel, 2016; Çeviker Ay & Orhan, 2020). Also, there are previous meta-analysis studies to investigate the relationship between CT and academic achievement (e.g., Fong et al., 2017; Orhan, 2022). In addition to these, we can find other meta-analysis studies to examine the effectiveness of game-based learning (Mao et al., 2022), problem-based learning (Kong et al., 2014; Liu & Pasztor, 2022), and concept mapping (Yue et al., 2017) on the enhancement of CT.

There are also some systematic review studies aiming to reveal the outlook of the previous literature on CT in the field of nursing education (Chan, 2013; Andreou et al., 2014), teacher education (Lorencova et al., 2019), language teaching (Lu & Xie, 2022), and dental education (Anders et al., 2019; Woldt & Nenad, 2021). Besides, some other

systematic reviews on the effectiveness of instructional strategies to promote CT can be found (Puig et al., 2019; Yuan et al., 2022).

Therefore, it can be said that there are mostly meta-analysis studies combining the quantitative results of previous research on CT in the literature. In addition, there are systematic review studies combining the results of previous studies on CT in a qualitative way. However, most of these studies have focused on the different aspects of CT (e.g., enhancement of it, relationship of it with other thinking skills, etc.) and are limited to different fields (e.g., nursing education, dental education, teacher education, etc.). When the literature is examined, some bibliometric studies aiming to systematically review and analyze the previous research with a holistic approach can be seen. Aktoprak and Hursen (2022) conducted a bibliometric analysis with 386 publications extracted from the WoS database to analyze the literature on CT in primary education. Also, Jatmiko et al. (2021) conducted a bibliometric analysis study with 99 publications using the Scopus database to reveal the research trends of the literature on CT skills in physics learning during Covid-19. Besides, Nor and Sihes (2022) conducted a systematic literature review study using bibliometric analysis with 605 publications extracted from the Scopus database to analyze the existing literature on CT teaching. We can say that these bibliometric analysis studies are limited in terms of the discipline they have focused on and the number of publications they have included. While the study of Aktoprak and Hursen (2022) has focused on CT in primary education, the study of Jatmiko et al. (2021) has focused on CT in physics learning. Also, Nor and Sihes (2022) have only focused on CT teaching in their study. In short, we can say that there are not any studies aiming to analyze the CT literature as a whole using bibliometric analysis.

Therefore, this bibliometric analysis study aims to fill in this gap in the literature by systematically reviewing and analyzing the existing CT literature as a whole and providing an overall outlook and current status of research on CT using the publication and citation data extracted from the WoS database. Thanks to this study, the gaps in the previous literature on CT can be clearly identified, the most productive and influential journals, countries, authors, institutions, and documents can be uncovered, and the scientific collaboration network among the institutions, authors, and countries can be seen. Also, the most frequently used concepts can be revealed. The questions sought to be answered in this study are:

1. How is the year and journal distribution of the studies?
2. How is the citation ranking of the journals, countries, authors, institutions, and documents?
3. What pattern of co-citation author network has emerged?
4. What pattern of scientific cooperation among institutions and countries, and co-word network has emerged?

Method

Procedure

In order to prepare the dataset for bibliometric analysis, firstly, the studies in which the word "critical thinking" was mentioned in its title, abstract, or author keywords were searched in the WoS database. Then, Education Educational Research category was filtered and 7621 studies were found. No restrictions were determined for the publication year and language of the studies. After that, the articles and reviews as a document type were filtered

and the other studies (e.g., conference proceedings and book chapters) were removed from the data set (n = 2557). As a result, 5064 studies on CT were included in the bibliometric analysis. The final search was conducted on October 03, 2022. Flow diagram for the literature review can be seen in Figure 1.

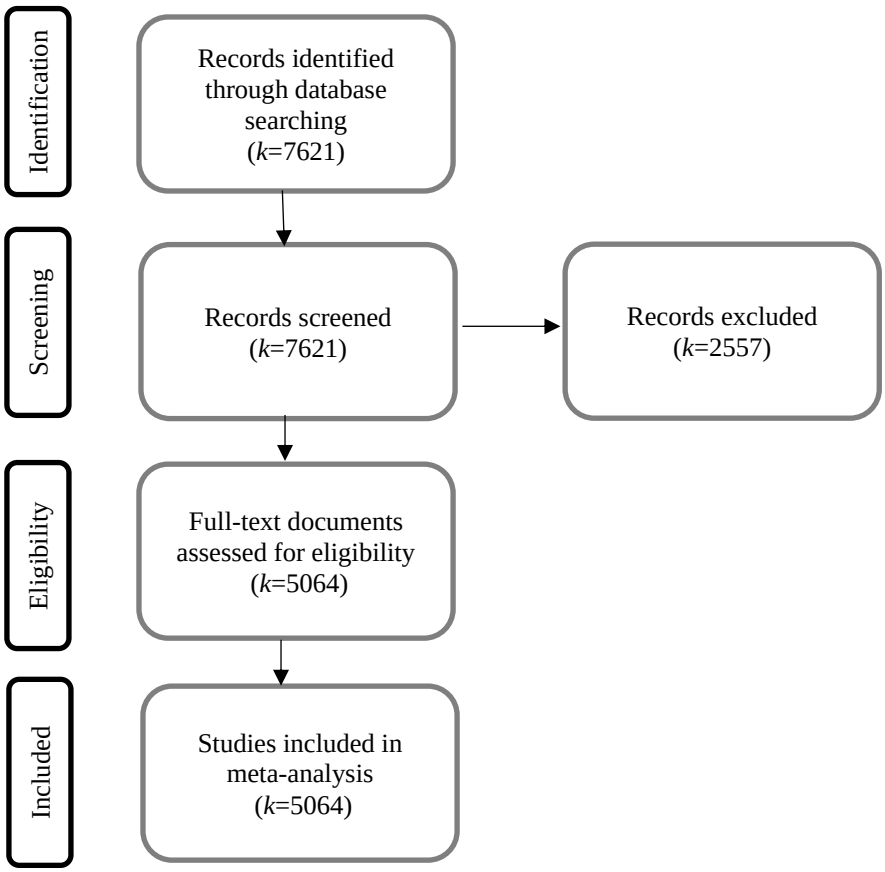

Figure 1. Flow Diagram

Analysis of the Data

The data were firstly analyzed descriptively using WoS's own system. For bibliometric analysis, data of 5064 publications were uploaded to the VOSviewer program, and citation (journal, country, author, institution, and document), co-author (institution and country), co-citation (author), and co-word analyses were carried out. Number of publications and citations were used to reveal the most productive and influential authors, institutions, countries, journals, and publications in the CT research. Also, co-author analyses were carried out to uncover the scientific collaboration network among the different institutions and countries. Lastly, co-citation and co-word analyses were conducted to reveal the authors who are cited a lot together and the most frequently used keywords (in other words concepts) in the field of CT. The data were examined in a detailed way and if necessary, data cleaning procedures (e.g., combining the words 'student' and 'students') were done by creating a "thesaurus file" before each analysis.

Results

Descriptive Findings

Distribution of Publications by Years

As it can be seen in Figure 2, the first study was published in 1980 and the number of the studies increased slowly until 2006. However, since 2006, the number of publications has increased with a significant acceleration indicating that interest in CT has increased exponentially since that year. Indeed, while the number of publications was 78 in 2006, 573 studies were published in 2021.

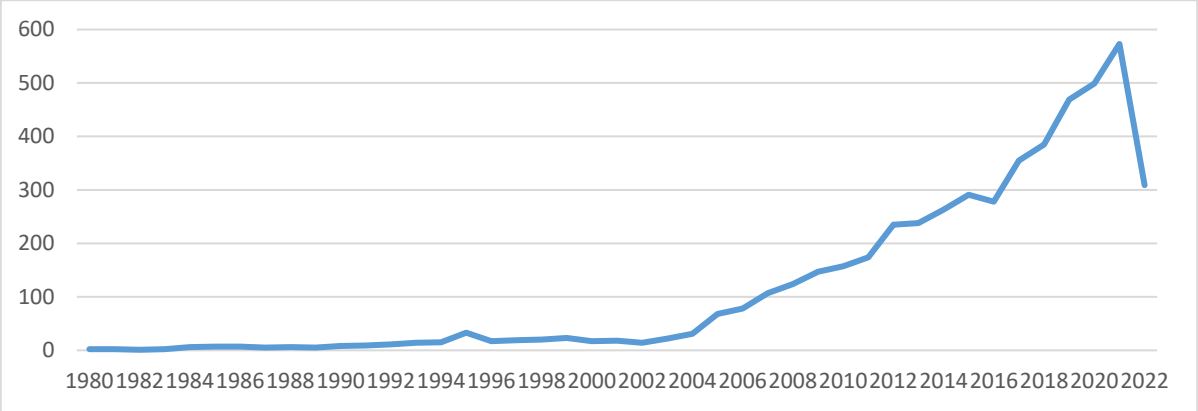

Figure 2. Distribution of the Publications by Year.

Distribution of Publications by Journals

As it can be seen in Table 1, "Thinking Skills and Creativity", "Teaching of Psychology", and "Nursing Education Perspectives" are the most three popular journals and they are followed by "International Journal of Instruction" with 88 articles and "Teaching Sociology" with 61 articles. Also, "BMC Medical Education", "Education Sciences", and "Computers & Education" are the journals with over 50 articles. We can group these journals with the most articles into three categories. First group includes journals which focus on thinking skills, psychology, and philosophy like "Thinking Skills and Creativity" and "Teaching of Psychology". Second group comprises the journals related to higher education like "Teaching in Higher Education" and "Studies in Higher Education". Third group includes the journals specializing on educational technology like "Computers & Education" and "Interactive Learning Environments". Also, it can be said that five of the journals with the most publications are specialized in higher education. Besides, while five of these journals are related to psychology, sociology, and philosophy, three of them are on technology and education.

Table 1. Journal Distribution of Publications

No	Journal name	Number of articles	Number of citations	Link strength	Number of citations per research
1	Thinking Skills and Creativity	141	1922	799	13.63
2	Teaching of Psychology	99	1061	174	10.71

No	Journal name	Number of articles	Number of citations	Link strength	Number of citations per research
3	Nursing Education Perspectives	93	1349	33	14.50
4	International Journal of Instruction	88	476	194	5.40
5	Teaching Sociology	61	846	43	13.86
6	BMC Medical Education	55	641	15	11.65
7	Education Sciences	52	164	49	3.15
8	Computers & Education	51	2748	233	53.8
9	Educational Philosophy and Theory	37	342	94	9.24
10	Higher Education Research & Development	37	667	206	18.02
11	Teaching in Higher Education	36	394	46	10.94
12	Studies in Higher Education	34	914	200	26.88
13	Eurasian Journal of Education Research	33	179	87	5.42
14	International Journal of Emerging Technologies in Learning	33	159	42	4.81
15	Journal of Education for Business	33	249	86	7.54
16	Interactive Learning Environments	32	376	90	11.75
17	Modern Journal of Language Teaching Methods	32	23	28	0.71
18	Childhood and Philosophy	31	20	9	0.64
19	Higher Education	30	1132	115	37.73
20	Journal of Geography in Higher Education	30	260	15	8.66

Distribution of Publications by Countries

The distribution of publications by countries is shown in Table 2.

Table 2. Distribution of Publications by Countries

No	Countries	Number of articles	Number of citations	Link strength
1	The United States of America	1496	20596	1809
2	Australia	308	4849	843
3	England	293	3637	559
4	Canada	233	2768	710
5	Taiwan	147	2716	555
6	China	222	2165	828

No	Countries	Number of articles	Number of citations	Link strength
7	Spain	332	1710	327
8	Türkiye	229	1569	552
9	Norway	45	907	97
10	Netherlands	62	899	234
11	Israel	52	868	133
12	Scotland	41	835	233
13	Ireland	54	778	241
14	Singapore	63	731	205
15	New Zealand	62	709	58
16	Indonesia	107	543	324
17	Sweden	58	519	105
18	France	35	506	74
19	Germany	58	499	110
20	South Africa	118	486	105

As it can be seen in Table 2, the country with the most publications is the United States of America (USA) (n = 1496). It is followed by Spain with 332 publications, Australia with 308 publications, England with 293 publications, and Canada with 233 publications. In addition, Türkiye (n = 229) and China (n = 222) are listed as the countries with over 200 publications. Besides, Taiwan (n = 147), Colombia (n = 118), South Africa (n = 118), and Indonesia (n = 107) have publications over 100.

Bibliometric Findings

Citation Analysis (Journal, Country, Author, Institution, and Document)

The 5064 articles included in the dataset have been published by 10574 authors working in 3334 institutions from 118 different countries in the world. The results of citation analysis of the first twenty journals with the most citations are shown in Table 3.

Table 3. Citation Rankings of the Journals

No	Journal name	Number of articles	Number of citations	Link strength	Number of citations per research
1	Computers & Education	51	2748	233	53.88
2	Research in Higher Education	22	1928	170	87.63
3	Thinking Skills and Creativity	141	1922	799	13.63
4	Nursing Education Perspectives	93	1349	33	14.50
5	Higher Education	30	1132	115	37.73
6	Teaching of Psychology	99	1061	174	10.71

No	Journal name	Number of articles	Number of citations	Link strength	Number of citations per research
7	Internet and Higher Education	11	979	33	89
8	Studies in Higher Education	34	914	200	26.88
9	Teaching Sociology	61	846	43	13.86
10	Journal of Research in Science Teaching	14	823	27	58.78
11	Journal of Computer Assisted Learning	16	796	40	49.75
12	Journal of Higher Education	10	732	101	73.2
13	Higher Education Research & Development	37	667	206	18.02
14	BMC Medical Education	55	641	15	11.65
15	Educational Leadership	18	602	157	33.44
16	Instructional Science	15	602	85	40.13
17	Educational Technology Research and Development	28	587	149	20.96
18	Learning and Instruction	12	585	150	48.75
19	Comunicar	28	567	9	20.25
20	International Journal of Instruction	88	476	194	5.40

When Table 3 is examined, it can be seen that some journals stand out. It is interesting that “Computers & Education” journal ranks in the middle of the list prepared according to the number of publications although it is the journal with the highest citations. In a similar way, although “Research in Higher Education” cannot find a place for itself in the list in terms of number of publications, it is the journal which received the second highest number of citations. These two journals are followed by “Thinking Skills and Creativity” with 1922 citations, “Nursing Education Perspectives” with 1349 citations, “Higher Education” with 1132 citations, and “Teaching of Psychology” with 1061 citations.

Also, it can be said that the articles in “Internet and Higher Education” receive high number of citations because it has 89 citations per research. It is followed by “Research in Higher Education”, “Journal of Higher Education”, “Journal of Research in Science Teaching”, and “Computers & Education” in terms of citation rankings per article. “Thinking Skills and Creativity” is the journal which has the highest link strength which means its co-citation power with other journals is really high. This journal is followed by “Computers & Education”, “Higher Education Research & Development”, and “Studies in Higher Education”. Besides, although “Internet and Higher Education” is the journal with the most citations per article, its link strength is really low indicating the co-citation power of it with other journals is low.

Second, citation analysis of countries which have the most publications was carried out to reveal the leading

countries in the field of CT (see Table 2). It is seen that the country with the most citations is the USA (n = 20596) and it is followed by Australia (n = 4849), England (n = 3637), Canada (n = 2768), Taiwan (n = 2716), and China (n = 2165). In addition, Spain (n = 1710) and Türkiye (n = 1569) are the countries with more than 1000 citations. The USA is the absolute leading country of CT research with 27% of the publications and 37% of the total citations in the database. Also, its number of publications and citations is five times higher than Australia which has got second place in the list. The mentioned countries including the USA have 59% of the publications and 72% of the citations indicating that these countries have produced most of the publications and received most of the citations in the CT research. Also, we can say that the countries which have the most publications also have the most citations. Besides, the country with the highest link strength is the USA and it is followed by Australia, China, and Canada. Therefore, we can say that co-citation power of these countries with other countries is really strong.

Table 4. Author Rankings (who have at least three publications)

Rank	Author	Number of documents	Number of citations	Link strength
1	Ernest T. Pascarella	23	1186	145
2	Ya-Ting Carolyn Yang	12	697	46
3	Amaury Nora	9	665	71
4	Gow-Jen Hwang	33	615	70
5	Philip C. Abrami	3	569	149
6	Robert M. Bernard	3	569	149
7	Patrick T. Terenzini	5	444	31
8	Robert Soden	3	341	51
9	Peter Shea	3	324	0
10	Kelly Y. L. Ku	5	320	66
11	Michael J. Hogan	7	305	117
12	Christopher P. Dwyer	7	304	124
13	Martin Davies	4	304	57
14	Lisa Tsui	3	260	46
15	Nel Noddings	5	242	0
16	Anna Jones	4	234	26
17	Ian Stewart	3	224	75
18	E. Michael Nussbaum	5	208	5
19	Diane F. Halpern	5	207	49
20	Shao-Chen Chang	8	202	23

Third, citation analysis of the authors was carried out based on the WoS citation data to reveal the leading authors in the field of CT. Table 4 shows the first 20 authors who have at least three publications. As it can be seen in Table 4, four authors stand out in terms of number of articles and citations. Gow-Jen Hwang, Ernest T. Pascarella, Ya-Ting Carolyn Yang, and Amaury Nora are the most productive and influential authors in CT research. Also, when the number of articles of all authors was examined, it is seen that 92.5% of the authors included in the dataset produced only one publication while only 0.38% of them have more than five publications. This result

indicates that expertise in CT research is definitely concentrated around an exceptionally small group of authors which can be seen as a threat for the sustainability of the research on CT if the number of the group of scholars does not increase in the future.

Fourth, Indiana University is the institution which has the highest citations and it is followed by National Taiwan University of Science and Technology with 813 citations, The University of Melbourne with 812 citations, and The University of Iowa with 810 citations (see Table 5). We can say that the universities from the USA and Asian countries like China and Taiwan host the authors with the most citations. Also, when the link strength of the universities is examined, it can be said that the Asian universities (e.g., Nanyang Technological University, Hong Kong Institute of Education, The University of Hong Kong, and National Taiwan University) have higher link strength than American universities which means that Asian universities have stronger co-citation power.

Table 5. Citation Ranking of Institutions (which have at least 15 publications)

No	Institutions	Number of articles	Number of citations	Link strength
1	Indiana University	23	1004	15
2	National Taiwan University of Science and Technology	38	813	61
3	The University of Melbourne	25	812	39
4	The University of Iowa	29	810	30
5	Nanyang Technological University	38	569	47
6	The Chinese University of Hong Kong	19	544	30
7	Purdue University	21	513	22
8	Hong Kong Institute of Education	15	454	44
9	The University of Hong Kong	33	453	38
10	The Penn State University	24	443	16
11	University of Missouri	16	416	15
12	Monash University	37	367	25
13	Stanford University	19	366	1
14	The University of North Carolina	18	344	7
15	University of Florida	19	330	19
16	National Taiwan University	29	324	38
17	Florida State University	20	317	9
18	University of Illinois	20	306	7
19	Macquarie University	18	258	19
20	Queensland University of Technology	17	258	4

According to Table 6 showing the 15 most cited documents, most of these documents were published in higher education journals. Also, most of these publications are systematic review articles on CT.

Table 6. Most Cited Publications

No	Article	Journal	Number of citations
1	Carini, R. M., Kuh, G. D., & Klein, S. P. (2006). Student engagement and student learning: Testing the linkages.	Research in Higher Education	661
2	Broadbent, J., Poon, W. L. (2015). Self-regulated learning strategies & academic achievement in online higher education learning environments: A systematic review.	The Internet and Higher Education	495
3	Abrami, P. C., Bernard, R. M., Borokhovski, E., Wade, A., Surkes, M. A., Tamim, R., & Zhang, D. (2008). Instructional interventions affecting critical thinking skills and dispositions: A stage 1 meta-analysis.	Review of Educational Research	323
4	Lee, A. (2008). How are doctoral students supervised? Concepts of doctoral research supervision.	Studies in Higher Education	292
5	Pithers, R. T. & Soden, R. (2000). Critical thinking in education: A review.	Educational Research	268
6	Ennis, R. H. (1985). A logical basis for measuring critical thinking skills.	Educational Leadership	246
8	Ferres, J. & Piscitelli, A. (2012). Media competence: Articulated proposal of dimensions and indicators.	Comunicar	244
9	Yang, Y. T. C. & Wu, W. C. I. (2012). Digital storytelling for enhancing student academic achievement, critical thinking, and learning motivation: A year-long experimental study.	Computers & Education	225
10	Davies, M. (2011). Concept mapping, mind mapping and argument mapping: What are the differences and do they matter?	Higher Education	223
11	Abrami, P. C., Bernard, R. M., Borokhovski, E., Waddington, D. I., Wade, C. A., & Persson, T. (2015). Strategies for teaching students to think critically: A meta-analysis.	Review of Educational Research	215
12	Atkinson, D. (1997). A critical approach to critical thinking in TESOL.	TESOL Quarterly	196
13	Kong, S. C. (2014). Developing information literacy and critical thinking skills through domain knowledge learning in digital classrooms: An experience of practicing flipped classroom strategy.	Computers & Education	195
14	Cavagnetto, A. R. (2010). Argument to foster scientific literacy: A review of argument interventions in K-12 science contexts.	Review of Educational Research	191
15	Ten Dam, G., Volman, M. (2004). Critical thinking as a citizenship competence: Teaching strategies.	Learning and Instruction	188

Co-author Analysis (Institution)

Figure 3 presents the collaborative networks between 41 institutions with at least 15 publications. It can be said that there are some scientific collaboration networks among institutions in CT research (i.e., clusters).

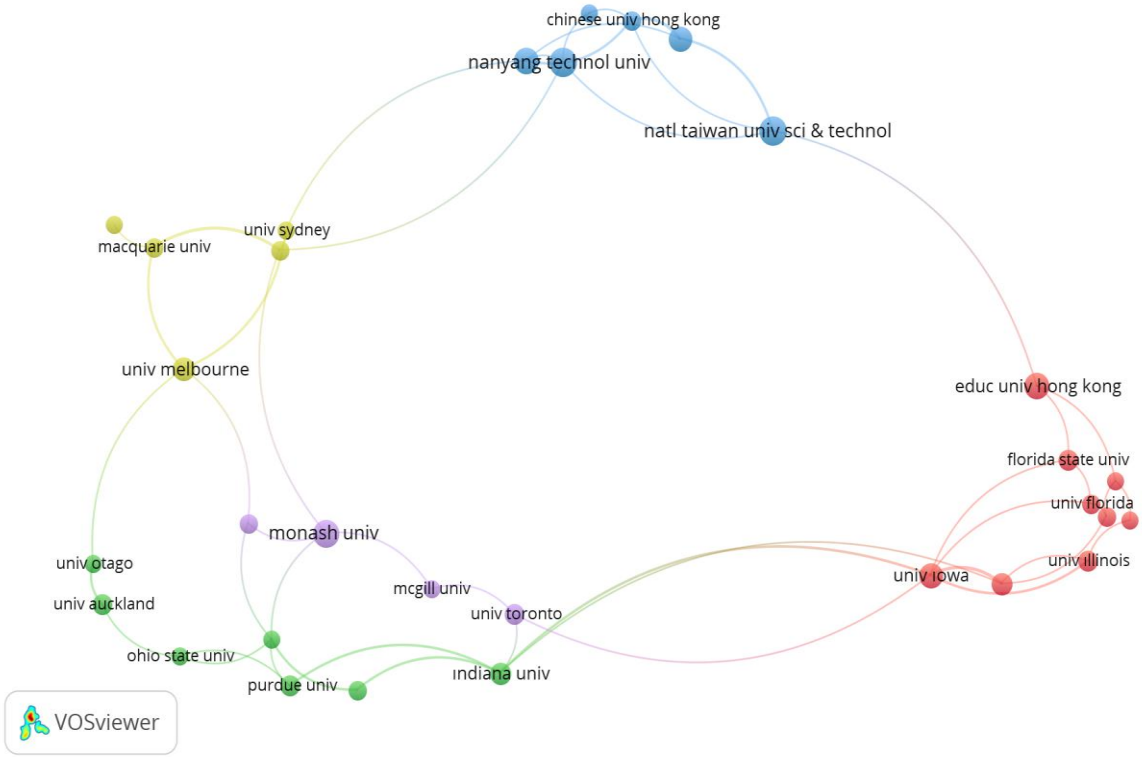

Figure 3. Institutional Collaborative Network

When the map is investigated, we can see that there are five clusters. In the first cluster (blue one), there are universities from Asian countries or territories. The second (yellow one) cluster includes two Canadian universities, namely, Macquarie University and The University of Sydney and one university from Australia (The University of Melbourne). Similarly, the third (purple one) cluster includes two universities from Canada (University of Toronto and McGill University) and one from Australia (Monash University). Therefore, we can say that the universities from Canada and Australia have strong co-author network.

The fourth cluster (red one) includes American universities like University of Florida and The University of Iowa. However, this cluster also includes The Education University of Hong Kong which means that this university has stronger networks of scientific collaboration with American universities than Asian universities. There are universities from the USA (e.g., Purdue University and The Ohio State University) and New Zealand (e.g., University of Otago and The University of Auckland) in the fifth cluster (green one). Therefore, we can say that the universities from the USA and New Zealand have strong co-author network. In addition to these, we can say that although the universities in the same clusters have strong collaborative networks among themselves, there are very few ties among the different clusters.

Co-author Analysis (Country)

Collaborative networks among 44 countries with at least 20 publications can be seen in Figure 4. It can be seen that the USA is at the center of CT research and it has strong networks of scientific collaboration with other countries. The green cluster includes the countries from Asia and China is at the center of this cluster. Also, England is the leading country of the red cluster and it has strong collaborative networks with other European countries. Besides, the blue cluster includes the Spanish-speaking countries like Colombia and Mexico. Türkiye is at the center of the last cluster (yellow one) and it has strong collaborative networks with Cyprus, Ukraine, and South Africa.

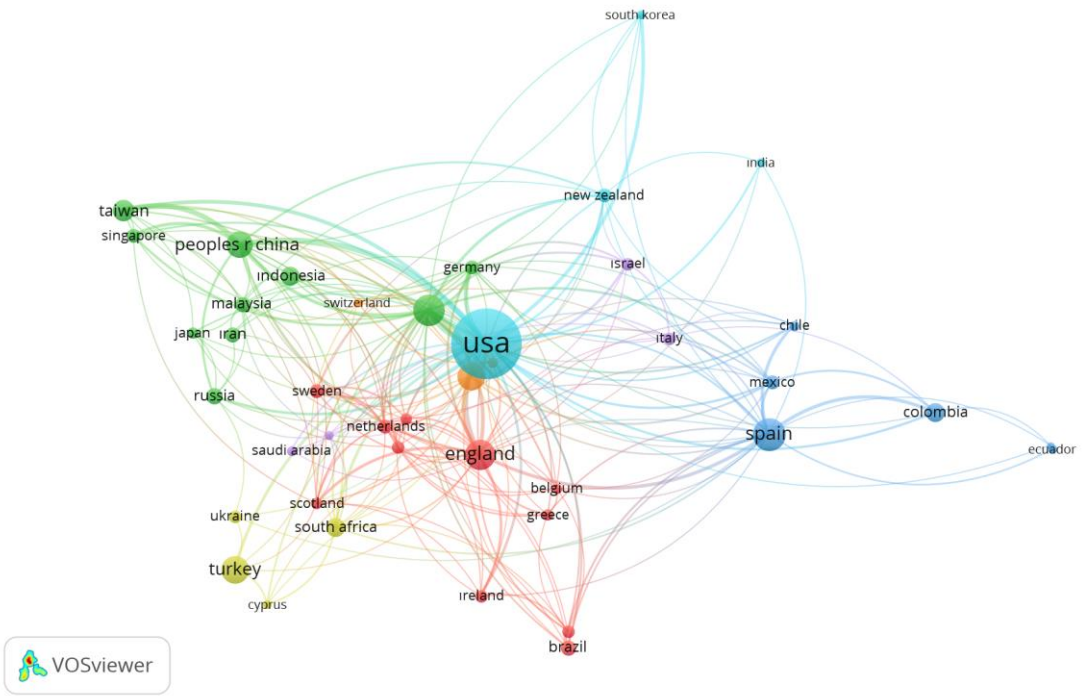

Figure 4. Scientific Collaborative Network Among Countries

Co-citation Analysis (Author)

Figure 5 shows the map formed based on co-citation analysis conducted based on the authors with at least 75 citations (n = 99). There are four clusters on the map. While three of these clusters (red, blue, and green ones) are large, the yellow one is small.

Firstly, it seems that Robert H. Ennis, Peter A. Facione, Richard Paul, Linda Elder, and Watson Goodwin are located at a relatively central place and they have associations with all of the clusters which shows that these authors were cited in various publications and contributed to the scientific knowledge production in the field of CT. Also, these researchers have developed the widely-used instruments to measure CT skills and dispositions of individuals (e.g., Watson-Glaser Critical Thinking Appraisal, Cornell Critical Thinking Tests, etc.). Therefore,

this can be shown as the possible reason why these researchers were cited a lot in many different studies.

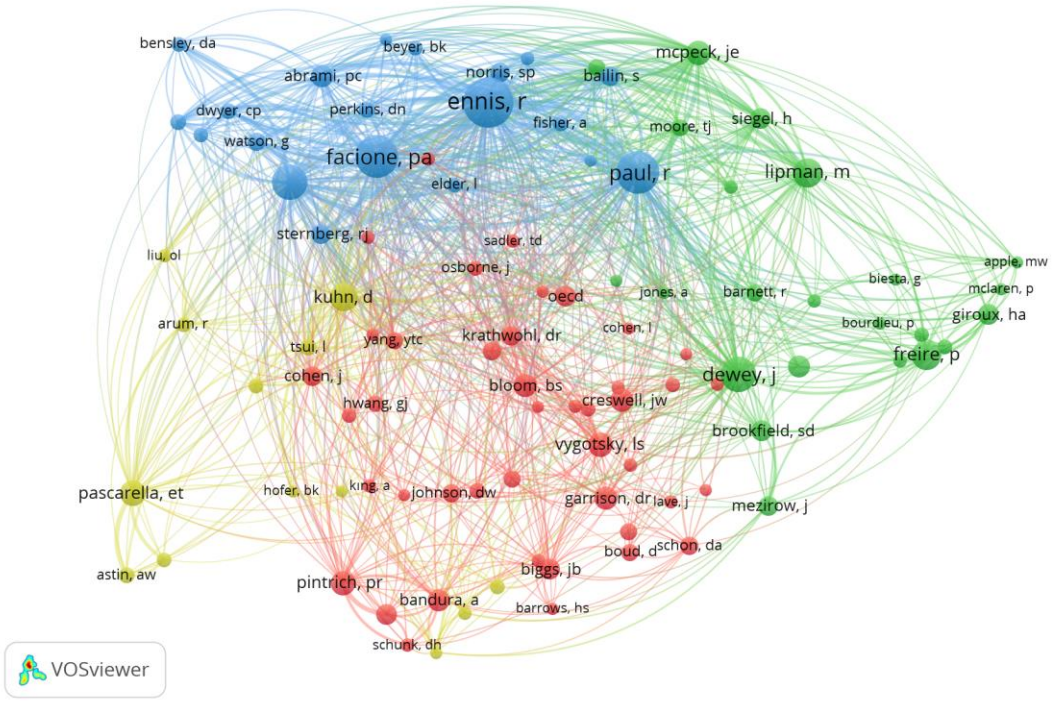

Figure 5. Co-citation (Author) Network

The blue cluster, one of the most intense clusters, includes authors who are the pioneers of CT research (e.g., Robert H. Ennis, Peter A. Facione, Linda Elder, Watson Goodwin, Richard Paul, etc.). Also, this cluster includes the researchers who are interested in psychology of education like Christopher P. Dwyer, Robert J. Sternberg, Philip C. Abrami, etc. These researchers have mainly discussed about the best way to enhance CT in their studies.

The red cluster, one of the biggest clusters, includes the researchers who have contributed to the taxonomy of educational objectives (e.g., Benjamin S. Bloom, David Krathwohl, John B. Biggs, etc.). These researchers are also associated with other clusters although they do not have strong connections. Therefore, we can say that the researchers from different disciplines refer to taxonomy of educational objectives in their studies. Also, this cluster consists of the researchers working in research methods, measurement and evaluation, and statistics (e.g., Louis Cohen, Jacob Cohen, John W. Creswell, Robert K. Yin, etc.). Besides, there are the researchers who are interested in learning theories, self-efficacy, self-regulation, self-directed learning, and metacognition (e.g., Dale H. Schunk, Albert Bandura, Lev S. Vygotsky, Paul R. Pintrich, Barry J. Zimmerman, etc.). In addition, the researchers who are specialized in educational technology, distance learning, and blended learning (e.g., Ya-Ting Carolyn Yang, Donn R. Garrison, etc.) are included in this cluster. Therefore, we can say that the researchers who work on topics like learning theories, self-efficacy, self-regulation, educational technology, distance learning, etc., are generally influenced by the names like Louis Cohen, Jacob Cohen, and John W. Creswell and they mostly carried out quantitative studies and used advanced statistical analysis.

The green cluster mostly consists of the researchers specialized in philosophy and sociology like John Dewey,

Pierre Bourdieu, Michel Foucault, Paulo Freire, Jack Mezirow, and Matthew Lipman. Also, there are the researchers who are interested in teaching of CT in the green cluster (e.g., John E. McPeck, Stephen D. Brookfield, and Matthew Lipman). These researchers support the usage of philosophy in the effort of enhancing CT. Indeed, Matthew Lipman is known as the founder of Philosophy for Children. Therefore, we can say that the researchers who support the usage of philosophy to enhance higher-order thinking skills, especially CT, are generally influenced by the ideas of the researchers who specialized in philosophy and sociology.

In the yellow cluster, there are the researchers who have focused their research and writing on higher education like Ernest T. Pascarella, Alexander W. Astin, Lisa Tsui, and Ou L. Liu. Also, this cluster includes the researchers who are interested in epistemology like Barbara K. Hofer and Deanna Kuhn. Therefore, we can say that this cluster is mainly about the relationship between epistemology and CT in higher education.

Co-word Analysis

As a result of co-word analysis, it was found that 9622 different keywords are used in the publications. 104 frequently used keywords were found after determining at least 20 occurrences as a cut-off point. As it can be seen in Figure 6, the map of frequently used keywords consists of six main clusters (red, purple, turquoise, green, yellow, and blue). It is not surprising that the keyword of CT is at the center of the map and has strong ties with other keywords.

First, in the yellow cluster, there are keywords related to 21st century literacy skills (e.g., information and communication literacy, media literacy, etc.). Therefore, we can say that this cluster mainly focuses on literacy skills which are important in 21st century. There are also other keywords like teacher education, language learning, early childhood education, art education, and science education in this cluster. Therefore, we can say that these 21st century literacy skills are studied in the context of different disciplines.

Second, the green cluster includes the keywords like distance learning, blended learning, and online learning indicating that it is about the field of educational technology. Also, there are some keywords like metacognition, self-regulation, self-efficacy, autonomous learning, and cognitive skills in this cluster. Therefore, we can say that these concepts are heavily studied in terms of educational technologies in the studies of this cluster.

Third, the turquoise cluster consists of the keywords like validity, assessment, evaluation, academic achievement, and learning outcomes indicating that this cluster is about the field of educational psychology and assessment and evaluation. Therefore, we can say that most of the studies referring to this cluster have mainly focused on scale development and learning outcomes, especially academic achievement. This cluster also includes the keywords like problem solving and decision-making indicating this cluster is related to the other higher order thinking skills.

Fourth, the frequently used keywords of the purple cluster are project-based learning, problem-based learning, constructivism, active learning, and student engagement indicating that this cluster mainly focuses on the effect of student-centered teaching/learning strategies on the CT. Fifth, the keyword of higher education is at the center

of the red cluster indicating that most of the research in this cluster focuses on higher education. Also, there are the keywords like employability skills, professional development, and adult education. This shows us that this cluster also focuses on work life and CT. Besides, this cluster includes the keywords like education for sustainable development, social work education, environmental education, and service learning which means that the research related to this cluster is about the civic responsibility and social life of individuals. In short, we can say that this cluster focuses on the social life, work life, and civic responsibility of university students or adults.

Lastly, the blue cluster consists of the keywords like teachers, students, thinking skills, and CT skills. Therefore, it can be said that most of the studies in this cluster focus on assessing the CT skills of the teachers and students. Also, in this cluster, there are the keywords like education, curriculum, elementary education, primary education, history education, and social studies education indicating that this cluster may focus on whether the curriculums of different disciplines are well designed to enhance CT of students, especially at the primary and secondary education levels. Besides, philosophy for children, critical pedagogy, and social justice are some of the frequently used keywords in this cluster which shows us that there are also studies examining CT in the context of philosophy and sociology in this cluster.

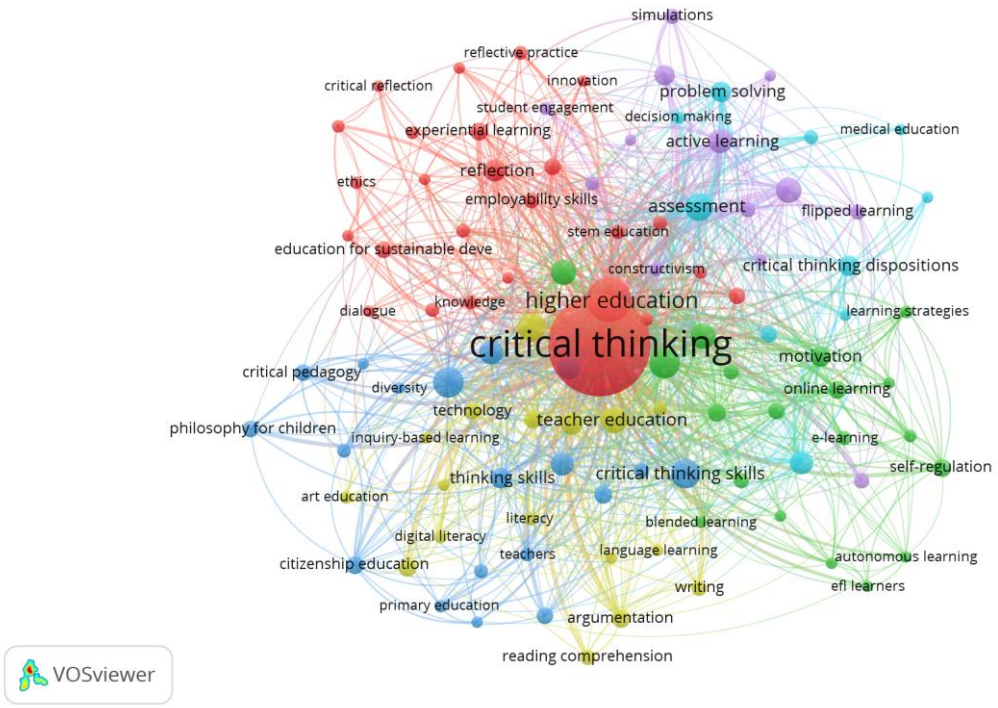

Figure 6. Analysis of Keywords

Discussion and Conclusion

The aim of this study was to investigate the literature on CT through descriptive and bibliometric analysis based on the data extracted from the WoS database to provide an overview of the evolution and current status of CT research. The first study on CT was published in 1980 and the number of studies increased slowly until 2006.

However, since 2006, the number of publications has increased with a significant acceleration indicating that the interest in CT has increased exponentially in the last two decades. In their study aiming to systematically review and analyze the CT literature in primary education using bibliometric analysis, Aktoprak and Hursen (2022) concluded that the number of studies started to increase after 2009. Typically, the developmental pattern of a discipline has four stages (Keathley-Herring et al., 2016). Firstly, a small group of researchers begins to produce studies on new ideas and theoretical frameworks. After that, based on these first studies and theoretical frameworks, an exponential increase is seen in publications by a high number of scholars. Then, a field maturation is seen and the number of publications stabilizes. Lastly, the number of studies declines because of the diminishing interest in the field. Therefore, we can say that CT research in education is in the exponential growth stage currently indicating that the number of the CT studies will probably go on increasing in the future.

It can be said that the most three popular journals are "Thinking Skills and Creativity", "Teaching of Psychology", and "Nursing Education Perspectives". Also, the most popular journals list includes five higher education journals, five journals which are related to psychology, sociology, and philosophy, and three journals on technology and education. This result shows us that CT is largely studied in the context of higher education. However, citation analysis by journals revealed that "Computers & Education", "Research in Higher Education", and "Thinking Skills and Creativity" have the first three places. In parallel to the results of this study, Aktoprak and Hursen (2002) concluded that "Thinking Skills and Creativity" is the journal with the highest citations in the literature on CT in primary education. Even though "Computers & Education" is in the middle of the most popular journals list and "Research in Higher Education" cannot find a place for itself in the same list, these two journals rank first and second in terms of the number of citations indicating that the articles in these journals receive a lot of citations. Also, the journals with the most citations list includes five higher education journals, four journals on technology and education, and three journals which are related to psychology and sociology. Besides, "Thinking Skills and Creativity" is the journal with the highest link strength. This result tells us that this journal has the highest co-citation power with other journals indicating that it is the core journal of CT research.

According to another result obtained in the study, the country with the most publications is the USA and it is followed by Spain, Australia, England, Canada, Türkiye, China, and Taiwan. Also, the USA, Australia, England, and Canada are the first four countries with the most citations. They are followed by Taiwan and China. Spain and Türkiye rank seventh and eighth in the list prepared in terms of the number of citations. Previous bibliometric analysis also concluded similar results (Aktoprak & Hursen, 2022; Nor & Sihes, 2022). The USA is the absolute leading country of CT research with 27% of the articles and 37% of the total citations in the database. The mentioned countries including the USA have 59% of the publications and 72% of the citations indicating that these countries produced the most of the publications and received the most of the citations in the CT research. In short, we can say that the USA absolutely leads the production and dissemination of CT research with other mostly English-speaking countries (e.g., Spain, Australia, England, and Canada) as well as with some Asian countries. This can be explained by some possible reasons: firstly, modern CT research has derived from the USA and the early times of CT research can be related to the contributions of the researchers working in American universities like Robert H. Ennis, Peter A. Facione, Linda Elder, Watson Goodwin, and Richard Paul, etc.; secondly, the researchers in these countries have better access to funding and they are provided with better resources and

infrastructure for research.

According to another result of the study, the authors who work on higher education, psychology, and educational technology are the most productive and influential authors in CT research. Similarly, these authors also receive the highest citations. This result coincides with the fact that the journals related to higher education, educational technology, and psychology are the most productive and influential journals in the CT literature. Also, the leading institutions of CT research are mostly from the USA and Asian countries like China and Taiwan.

The co-author analysis revealed five clusters in terms of networks of scientific collaboration among institutions. The first cluster includes universities from Asian countries or territories while the second and third clusters include universities from Canada and Australia. Also, the fourth and fifth cluster consists of universities from the USA and New Zealand. This result shows us that the universities which are close to each other either geographically or culturally tend to work together. Collaborative networks among these universities are strong. However, scientific collaboration networks among different clusters are weak indicating that the authors from different universities in countries from different regions of the world are not in a strong scientific collaboration.

According to another result of this study, there are five clusters in terms of networks of scientific collaboration among countries. China leads the cluster consisting of Asian countries while England is the leading country of another cluster including European countries. The third cluster consists of the Spanish-speaking countries and Spain leads this cluster. Lastly, Türkiye is at the center of the last cluster and it has strong collaborative networks with Cyprus, Ukraine, and South Africa. It can be said that similar to the results of co-author analysis among institutions, the countries which are close to each other either geographically or culturally have strong co-authorship network. The countries like China, England, Spain, and Türkiye can be seen as the leading countries of their territories in terms of scientific knowledge production and dissemination on CT and have strong ties with the nearby countries.

Research collaboration is seen as an important indicator of quality in a research area (Freshwater et al., 2006; Kim, 2006) and it contributes to the quality of the research outputs and research productivity (Barrett et al., 2011; Kato & Ando, 2013; Lee & Bozeman, 2005) because researchers share knowledge, resources, and experiences during this scientific collaboration (Freshwater et al., 2006; Kim, 2006). This study shows that scientific collaboration exists among institutions and countries in the field of CT. However, it can be said that this scientific collaboration occurs mostly among the institutions or countries which are close to each other either geographically or culturally. Limited transnational scientific collaborations on CT may be seen as a problem for the future of CT research because a constant exchange and contrast of ideas are required for a field to evolve (Barrett et al., 2011; Freshwater et al., 2006).

Co-citation analysis conducted based on the authors revealed that the authors who can be named as the pioneers of CT research are located at a relatively central place and they have associations with all of the clusters which show that these authors were cited in various publications and contributed to the scientific knowledge production in the field of CT. Also, in one of the most intense clusters, there are authors who work in research methods and

statistics as well as educational technology. Also, this cluster includes the authors who have contributed to the taxonomy of educational objectives, learning theories, self-efficacy, self-regulation, self-directed learning, and metacognition. The last cluster, which is relatively small, includes the researchers who have focused their research and writing on higher education and epistemology. Therefore, we can say that the researchers working in these disciplines or on these topics stand out in the field of CT.

As a result of co-word analysis which can show us the common recurrent concepts in the field of CT, it was found that higher education is at the relatively center of the map and have strong ties with other keywords. This tells us that CT is studied a lot in the higher education context. Indeed, this study shows that higher education journals and the authors working in the fields of higher education are the most influential and productive journals and authors. Also, previous systematic review studies concluded that most of the studies on CT were conducted with university students (Polat, 2015; Kaplan, 2017; Chou et al., 2019) confirming the results of this study.

One of the clusters includes the keywords of 21st century literacy skills as well as teacher education, language learning, early childhood education, etc. This result reveals that 21st century literacy skills are studied in the context of different disciplines. Another cluster includes the keywords related to educational technology as well as metacognition, self-regulation, self-efficacy, and autonomous learning. This can tell us that CT is widely studied in the context of educational technology. Also, the concepts like metacognition, self-regulation, self-efficacy, and autonomous learning are the other concepts that are frequently studied in CT literature. The third cluster consists of the keywords related to the field of educational psychology and assessment and evaluation. Therefore, we can say that most of the studies referring to this cluster have mainly focused on scale development and learning outcomes, especially academic achievement. Besides, the fourth cluster focuses on the effect of student-centered teaching/learning strategies on the CT while the fifth one focuses on the work life, civic responsibility, and social life of individuals. The last cluster focuses on whether the curriculums of different disciplines are well designed to enhance the CT of students, especially at the primary and secondary education levels.

In short, this study is important and contributes to the CT literature by providing a comprehensive review of the previous research on CT as a whole. Also, this study can be seen as the pioneer in presenting the bird's eyes view of the CT literature globally because a couple of previous bibliometric analysis studies on CT are limited in terms of the discipline they have focused on and the number of publications they have included. This study reveals the general outlook of the CT literature, the development of it, and its current status as well as the most productive and influential journals, countries, authors, institutions, and documents, the scientific collaboration network among the institutions, authors, and countries, and the most frequently used keywords.

Limitations and Recommendations for Further Research

This study has several limitations. First, this bibliometric analysis study included the publications extracted from the WoS database and this can be seen as a limitation. Although the WoS database is one of the most extensive and comprehensive databases for scholarly works, it may not cover all available publications. Therefore, other

bibliometric analysis studies can be conducted with the publications extracted from other databases like Scopus. Second, the publications included in the bibliometric analysis are limited to Education Educational Research category of the WoS database. Also, only articles and reviews as a document type were included in the analysis. This may be shown as another limitation of the study. Future bibliometric analysis studies may include other WoS categories and additional types of publications like book chapters, conference proceedings, etc. to expand the findings of this study.

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