

An Overview of the Literature on Design Thinking in Education and Educational Research

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Abstract: This paper provides a bibliometric analysis of Design Thinking in education and educational research based on the Web of Science (WoS) database from 2002 to 2022. It is a guiding procedure aligning the Preferred Reporting Items for Systematic reviews and Meta-analyses (PRISMA) guidelines into the bibliometric standard workflow and adopting VOSviewer as the visualization tool. With the built-in WoS analysis tools, the annual publication trends and contributions and the most prolific countries are explored. VOSviewer is employed to exploit the research themes. The co-occurrence analysis of keywords distinguishes nine research themes, namely creativity, design education, motivation, instructional design, problem-based learning, engineering design, methodology, pedagogy and teacher education.

Keywords: Web of Science; Design Thinking; A bibliometric analysis; International core journals.

1. Introduction

In the past twenty years, a growing body of literature on design-thinking has emerged. Research about Design Thinking grew significantly and the number of published papers found in the Web of Knowledge database concerning the theme increasing to over 180 papers (Fleury, 2016). Design Thinking, as an educational priority, is originally grounded in the work of engineers and designers (Hynes, 2012, Koh and Chai, 2016, Blundell, 2022). Now, design thinking is more widely used because it is a human-centered approach, involving understanding the needs and perspectives of users to create innovative solutions to complex problems in the world (Razzouk and Shute 2012, Fleury et al., 2016, Yurkoff et al. 2020, Blundell, 2022).

Design thinking, for teachers, is positioned as an approach (Henriksen, Richardson, and Mehta, 2017, Kyza and Nicolaidou, 2017, Noh and Karim, 2021) for their continuous improvement (Deluca, C., et al., 2015, Koh, Chai and Lim, 2017, Lor 2018, Arrington, and Willox. 2021, Chai, 2018; 2021, Chiu, et al. 2021, Blundell, 2022). It 'suggests that through close observations, empathy interviews, brainstorming and prototyping, fresh new ideas will be generated that meet the needs of the context and the moment' (AKsela, M. 2019, Andino, C.I., 2017, Yurkoff et al. 2020, Blundell, 2022). A series of models and variation of design thinking (McFadden and Roehrig, 2017, Kelly, N., et al., 2019, English, Adams and King, 2020, Spoon, et al., 2020, Yeh, Chan, and Hsu, 2021, Kim, 2021) are involved in education and educational research (Georgiev, 2012). It is claimed that because design thinking uses teacher's experience of the dynamic and relational nature of education to frame problems and seek solutions, it allows teachers to continuously improve themselves (Chai 2018, Stevenson et al., 2019, Yeh et al., 2021, Tualalelei and Halse, 2021, Noh and karim, 2021, Blundell, 2022). However, design thinking as a pedagogy has not been well conceptualized (Spoon, 2020).

This paper aims to collect the literature on design thinking from the WoS database and conduct a comprehensive overview of this field by translating the sparse literature into

the visualized analysis. A bibliometric study of this field integrating PRIMA guidelines (Moher et al., 2009) and VOSviewer visualizations is developed to collect and compiling the literature on the key topics, influential research literature, research themes and co-occurrences of keywords. The network visualizations are conducive for researchers to identify and recognize the gaps in the literature. It turns out that PRISMA guidelines are exceedingly helpful to explicate the existing evidence and improve the meta-analysis.

2. Research Design

2.1. Methodology

The PRISMA guidelines are recognized as a valid and transparent approach to examine the systematic literature review. Recent studies have focused on incorporate software programs and visualization tools to conduct the reviewed literature (Alsolami and Embi, 2018, Almasri, 2021; Kalibatiene & Miliauskaite, 2021; Petersen et al., 2015; Zupic & Cater, 2015). Based on PRISMA developed by (Moher et al. 2009), Almasri et al. (2021) developed a novel procedure combining the PRISMA guideline with bibliometric standard workflow and applying VOS viewer, Bibilioshy, and NVIVO software to enhance the extraction, visualization and analysis of data. The proposed procedures comprise four stages, as shown in Figure 1. This study resumes the line of analysis by aligning the PRISMA guidelines with bibliometrics using VOSviewer software.

2.2. Research Questions

The first step for designing the study is to formulate the research questions. Thanks to the previous study, this article offers a comprehensive overview of the scientific landscape of design thinking based on a bibliometric analysis of data available in WoS database. The research questions are identified as follows:

RQ1: What are the most powerful countries to the field of design thinking between 2002-2022?

RQ2: What are the most influential sources?

RQ3: What are the research themes?

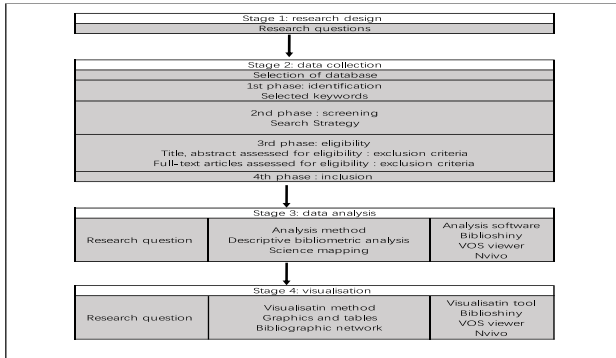
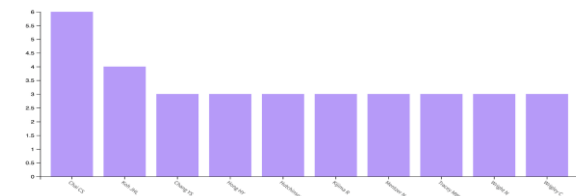


Figure 1. The procedure aligning with the PRISMA guides and analysis tools

2.3. Data collection

The second stage is the collection of data. Figure 2 is the revised PRISMA flowchart offering the descriptive records included in the study. In selecting the publications, PRISMA guidelines were adopted, including four main phrases: identification, screening, eligibility, and inclusion.

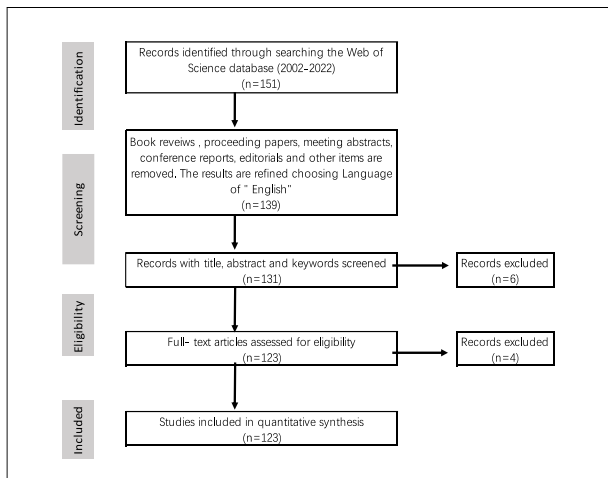


Figure 2. A Revised PRISMA flow for Publication Selection

In the first phase (Identification), a literature search was performed in the Web of Science database, updated until 2023. The database was chosen because all the journal included are evaluated by Journal Citation Report (JCR). Based on the research questions and research design, the criteria are set to specify the inclusion and exclusion of the most related research articles. The inclusion criteria are as follows: (1) All journals indexed by the WoS Core Collection are selected, (2) The keywords with various terms, such as “design thinking” or “design-think” are searched. (3) The publication must be journal articles.

In the identification phase, all articles were collected from WoS Core Collection, namely, SSCI, SCI-expanded, A&HCI, CPCI-SSH, CPCI-S. In light of data collection, the search strings were “design think*” Or “design-think*” AND education. A total of 151 records are identified in this phase.

In the Screening phase, the search result was filtered

considering only “article” in the parameter “document types”. The review was simply refined by articles published in English. The initial search resulted in papers, covering the period between 2002 and 2022. After applying the criteria, 20 items were excluded.

In the Eligibility phrase, the left 123 items were then scoped for eligibility. The articles without “design thinking” or “design-think” as research objectives are not included.

In the Inclusion phase, 123 data records were included.

2.4. Data analysis

After retrieving the data, a general bibliometric analysis of design thinking in education and educational research in international journals was performed via WoS’s built-in tool. We, then, loaded the data into VOSViewer(Van Eck & Waltman, 2009) to conduct a co-occurrence analysis of keywords. The annual publication trends and the most influential countries are presented with the automatic visualization of the WoS Core Collection. To answer the second RQ, the citation analysis of sources using the citation function in VOSviewer. The citation analysis of documents is used to evaluate their academic impact on a certain field of study.

2.5. Results and Discussion

2.5.1. General Bibliometric Analysis

Figure 3 shows that the first paper on design thinking in education and educational research was published in 2005 in the retrieved data. From 2002 to 2022, the number of articles grew gradually, implying that research scholars emphasized this topic. In 2017, more than 7 papers were published, and the number of articles reached the highest in 2022, with 28 journal papers published.

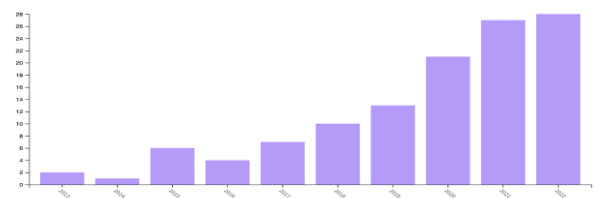


Figure 3. Annual research output

Table 1 shows the ten most prolific countries. papers are listed in the second column, followed by the number of papers in the third column. The fourth column are the percentage of published articles in the fourth column, and the citations received by the countries in the fifth column. Authors from the United States contributed the most papers over the past two decades, with 27.64% of the 123 papers respectively, followed by Taiwan area, Australia, South Korea, Canada, the People’s Republic of China, Singapore, Brazil, Japan and Turkey with contributions of 14.634%, 12.195%, 7.317%, 6.504%, 4.065%, 3.252% respectively. Authors from other countries contributed less than 5 papers. The United States ranked at the top, indicating that American academics have high productivity.

A total of 123 articles were published in 25 journals. The number of articles is listed in the second column in Table 2. According to the number of articles, International Journal of Technology, a worldwide Journal from the Netherlands, ranks top when it come to the number of publications related to design-thinking in education and educational research. Thinking Skills and Creativity ranks the second, International Journal of Art Design Education the third, and ETR&D-

Educational Technology Research and Development the fourth. To determine the influence of a journal, both the citations and the number of articles need to be taken into account. The most mentioned article is Razzouk and Shute's (2012) "What Is Design thinking and Why Is It Important" with 348 citations in Review of Educational Research. The second mentioned articles are both Henriksen and Richaedson and Mehta's (2017) "Design Thinking: A Creative approach to educational problems of practice" and Christiaans & Venselaar's (2005) "Creativity in design engineering and the role of Knowledge: Modelling the expert", each with 73 citations, published in Thinking Skills and Creativity and International Journal of Technology and Design Education respectively. The third mentioned article is Koh, Chai and Hong's (2015) "Technological Pedagogical Content Knowledge (TPACK) and Design Thinking: A Framework to Support ICT Lesson Design for 21st Century Learning" with 69 citations published in Asia-Pacific Education Researcher.

Table 1. Top Ten Prolific countries and territories

No.	Countries/territories	Documents	% of 123
1	USA	34	27.64%
2	TAIWAN	18	14.63%
3	AUSTRILIAN	15	12.20%
4	SOUTH KOREA	9	7.32%
5	CANADA	8	6.50%
6	PEOPLE R CHINA	8	6.50%
7	SINGAPORE	5	4.07%
8	BRAZIL	4	3.25%
9	JAPAN	4	3.25%
10	TURKEY	4	3.25%

Table 2. Top Ten Sources

No.	Journal titles	No. of articles	% of 123	Citation
1	International Journal of Technology and Design Education	21	17.073	73
2	Thinking Skills and Creativity	20	16.263	73
3	International Journal of Technology and Design Education	14	11.382	13
4	ETR&D-Educational Technology Research and Development	7	5.691	39
5	Computers Education	4	3.252	46
6	Education and Information Technologies	4	3.252	7
7	Asia Pacific Journal of Education	3	2.439	69
8	Higher Educational Researcher	3	2.439	14
9	Australian Educational Researcher	2	1.626	4
10	Education and Training	2	1.626	44

2.5.2. Keywords network analysis

After the revision of the articles, a data analysis was conducted with the application of VoSviewer network analysis. The keywords network analysis was conducted based on the 123 papers. 420 keywords were obtained from a total of 123 references and nine clusters were identified: creativity, design education, motivation, instructional design, problem-based learning, engineering design, methodology, pedagogy and teacher education. The top 20 keywords, "Design thinking", "Creativity", "Design education", "Design", "Problem-solving", "Empathy", "Instructional

design", "Reflection", "Stem", "Tpack", "creative thinking", "Divergent thinking", "Education", "Education design", "Engineering education", "Higher education", "management", "Middle school", "Motivation", "Teacher education", are listed in Table 3. The ties in Figure 4 demonstrates the keywords that have been mentioned in the table 3, and the strength of the ties corresponds to the intensity of such relationship. The main linkage between clusters emerges between Design education and creativity. This highlights the significance of design thinking as an educational method that is exceedingly relevant for inspiring the creativity among students.

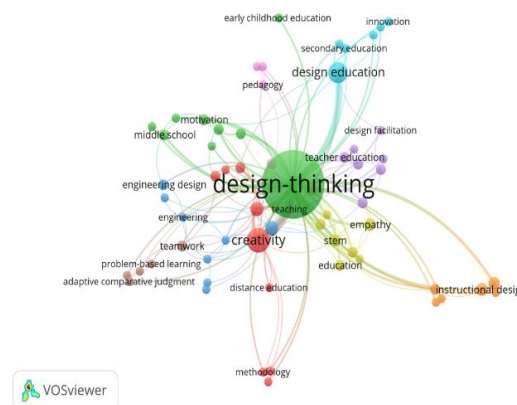


Figure 4. Keyword network

Table 3. Top Twenty Keywords List

No	Keywords	Occurrence
1	Design thinking	110
2	Creativity	15
3	Design education	11
4	Design	5
5	Problem-solving	5
6	Empathy	4
7	Instructional design	4
8	Reflection	4
9	Stem	4
10	Tpack	4
11	creative thinking	3
12	Divergent thinking	3
13	Education	3
14	Education design	3
15	Engineering education	3
16	Higher education	3
17	management	3
18	Middle school	3
19	Motivation	3
20	Teacher education	3

3. Conclusion

In this paper relevant articles concerning Design Thinking in education and educational research are analyzed. This literature evidenced a lack of systemized review on Design thinking in education and educational research. Aiming to fill some of these gaps and to characterize this research area, the articles identified influential countries and territories, sources, research themes of Design Thinking, the author uses the automatic visualization tools provided by the WoS database, the network analysis of co-occurrence of keywords. It has generated several significant findings.

First, it appears that the USA and China's Taiwan province contribute the most to the field. The international journals of

Design Thinking are causing attention to Design Thinking. One possible reason could be that USA is the birthplace of Design Thinking and it brought about the growing awareness of the importance to educational research. It also appears that such countries as Australia, South Korea, Canada, the People's Republic of China, Singapore, Brazil, Japan and Turkey contribute in international academia. This might be a research trend in other disciplines.

Second, the analysis of sources shows that the top three influential ones are International Journal of Technology, Thinking Skills and Creativity, International Journal of Art Design Education. Based on the number of articles, ETR&D-Educational Technology Research and Development also stand out the rest. Although Review of Educational Research contributes less to this field, it receives the highest record of citation.

Aligning the PRISMA and VOSviewer visualizations, this study will shed light on the trends and contributions of Design Thinking in education and educational research. First, the combined method for this study offers guidelines that show the literature in a staged procedure and improve the analytical clarity and transparency. Second, it helps the researchers to capture the most productive countries and areas, the influential sources and scholars. third, it helps scholars enhance their awareness of the key topics and research trends in the field of Design Thinking.

Finally, there are some limitations of this research, resulting from other databases such as Scopus, books and other types of documents excluded from the research. Thus, it sketches the limited view of the field. Second, the co-cited authors, cited authors and co-citation density were not performed. Third, documents in other languages are not included. Despite these limitations, it should be meaningful for researchers to identify the research themes and trends.

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