
Bibliometric Analysis (2012-2022) of Research Hotspots and Trends on Technological Pedagogical and Content Knowledge in China

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ABSTRACT: *Technological Pedagogical and Content Knowledge (TPACK) has become a key impacting factor on the continuous advancement of higher education transformation in the digital age. In recent years, a significant development has been observed in the publication of TPACK study in China. However, very few researches have been conducted to investigate the overall literature of the TPACK research in China. This paper analyzes the bibliometric features of documents published from 2012 to 2022 on the TPACK study in China. The research literature is retrieved from CNKI and CiteSpace and it is used to visualize the network analysis of author co-occurrence analysis, institution co-occurrence analysis and keyword co-occurrence analysis. The research result shows that the publications of TPACK research in China have maintained a stable increment, but the close cooperation network between the authors and institutions hasn't been formed. The theme related to "integrated technology" and "information technology" constantly attracted the researchers' attention in the last decade, and the burst terms "vocational teachers", "college English", "PSTs" and "teaching and learning capability" were the strongest citation keywords in the 2022, which would represent the hotspots and trends of the TPACK research in China. This study contributes towards the better understanding of the existing literary landscape and the future research direction in the field of TPACK.*

KEYWORDS: TPACK, Hotspots and Trends, Bibliometric Analysis, China

INTRODUCTION

Over the past few decades, the framework of Technological Pedagogical and Content Knowledge (TPACK), which depicted the knowledge needed by teachers to incorporate the technology and pedagogy into specific teaching content (Koehler & Mishra, 2013), was brought into light by the bloom in innovative technologies and its utilization in the education area in many countries (Adipat, 2021). Since TPACK framework was systematically introduced into China at the beginning of the 21st century (Li, 2008), it has drawn the

attention of Chinese educators and researchers, as evidenced by the approximately 1700 publications across major disciplines currently indexed in the *China National Knowledge Infrastructure* (CNKI). Still, research has seldom been conducted to investigate the overall literature of the TPACK research in China over the past decade. More specifically, no review studies have been found that applied the visual analytic approach to seek the research hotspots and research trends in the field of Chinese TPACK study.

Given the gap in literature, it would be quite pertinent to conduct a comprehensive review covering the recent decade to look into the relevant publications. Based on the aforementioned reasons, a bibliometric analysis was carried out by evaluating and mapping the relevant literature in the field of TPACK in China. An extensive look into the existing publications on TPACK will be presented by addressing the following research questions:

- 1) What is the trend of publication of TPACK research in China?
- 2) Who are the main contributors in terms of institution and authors on TPACK in China? Does any research collaboration exist among these institutions and among these authors?
- 3) What are the most frequently discussed hotspots and evolving trends on the TPACK in China?

The findings of this paper are aimed at helping researchers and academicians to understand the fundamental structure, frontiers, and latest areas of research in the domain of Chinese TPACK, and provide meaningful and valuable reference for future studies in the field of TPACK.

LITERATURE REVIEW

The research on the TPACK in China started from the introduction of TPACK frameworks and schools, development paths, measurement methods and instrument (Zhang & Tang, 2021). Li (2008) systematically introduced Koehler & Mishra's (2005) framework into China, and this is considered as the first TPACK study in China. Then in 2010, some researchers provided an overview of TPACK and reviewed previous literature done within the framework outside China (Jiao & Zhong, 2010). Besides, some instruments were also introduced to China. For example, Zhan (2011) translated Schmidt's (2009) TPACK survey into Chinese and modified it to diachronically measure the TPACK in Chinese math PSTs. Chinese scholars also noticed the different trend of the TPACK term. In Yi's (2010) research, he systematically depicted the differences and similarities between Mishra & Koehler's (2005) TPACK, Angeli & Valanides' (2007) ICT-related PCK, and Niess's (2018) technology-enhanced PCK. During the process of introduction, Chinese scholar discovered some insufficiency of the oversea research and put forward some new notions. Ruan (2018) proposed the TSACK (Technological Strategy and Content Knowledge) and TMACK (Technological Methodology and Content knowledge), which used to emphasize the teacher and student's subjectivity. Chen et al. (2022) introduced

the TCPNet (Technological Content Pedagogical Knowledge Network), and tried to address the dispute between the integrated view and transformative view. Some researchers extended the TPACK into specific subject and proposed subject-related framework, such as TPASK (Technological Pedagogical Science Knowledge) (Liu et al., 2020), TPUMK (Technological Pedagogical Unit Music Knowledge) (Wang et al., 2022) and TPMK (Technological pedagogical mathematics knowledge) (Zheng & Zhang, 2021). To some extent, the proposal of these notions greatly improved, supplemented and broadened the research of TPACK. After a qualitative deep content analysis of journal papers retrieved from Journal Full Text Database of *China National Knowledge Infrastructure* (CNKI) and *Peking University Core Periodicals and Periodicals of Chinese Social Sciences Citation Index* (CSSCI), which are two kinds of core periodicals and can represent the highest quality and latest topics in China, Lu (2020) and Zhu & Feng (2022) proved that TPACK study has become a hot spot in the field of education research in China after more than twenty years of development.

In order to comprehensively understand the trends and implication of international study related to the TPACK, some Chinese researchers, such as Zhu & Feng (2022), and Xue & Wei (2021), conducted the review study around the world based on the database of WOS. However, regarding the review studies on the TPACK in China, it has been seldom conducted, according to author's observation only two studies involved in the review study in the recent years. In 2019, Huang (2019) reviewed 495 TPACK related documents published on CNKI from 2008 to 2019, specifically investigating the research history and situation of China's TPACK research, however this review adopted the content analysis methods rather than the visual analytic methods that is applied in this study.

Zhou & Mo (2019) in the same year, statically analyzed the current situation and future trend of the TPACK research in China from the annual distribution, unit distribution, discipline distribution, research topic and research object, and found that in recent years, great progress has been made in the TPACK research in China, but there were still some shortcomings, such as the deficiency of the "localization" of the TPACK theory, as well as the lag of the development of suitable TPACK assessment tools. Zhou & Mo's (2019) put forward some suggestion based on the investigation, but their research samples were 154 masters' and doctors' thesis retrieved from "Chinese Master's Doctoral Dissertation Full-Text Database", which excluded the journal articles.

The results of the review studies may carry some important implications, which can indicate subsequent research directions during a period of time, but the existing review studies may need to be updated because all these studies were conducted at least three years ago. Moreover, none of the study adopted the visual analytic approach, which is a valuable literature analysis tool that is widely used in academic research to determine the development patterns of a research field effectively.

METHODOLOGY

This article utilized a bibliometric approach through intuitive visualizing analysis. Developed from the library and information sciences research field, the bibliometric approach can provide a quantitative analysis of the features of the literature, which includes scientific contributions, fundamental research structure, citation development, visualized knowledge structure and emerging trends in the research domain. The science mapping tool CiteSpace can take a set of inputs from a valuable bibliographic data resource and construct a structure of the necessary information and knowledge of the selected topic, which has been receiving increasing attention since the 2000 (Chen & Song, 2019).

Research design

The research design adopted in this study mainly involved identifying appropriate bibliographic data bases, developing search criteria, and selecting analysis software tools.

The data source for bibliometric analysis in this study was collected from the online database CNKI, which can export the structured data such as citation information (author name, document title, source title, publication year, and citation counts), bibliographical information (affiliations, document language, publishers, editors, abstract, keywords, and funding details), and other information. CNKI is recognized as the most authoritative and widely used databases for highest quality and latest scientific research in China (Huang, 2022).

Research criteria in this study were set according to the research objectives and research questions. The initial search was performed in the CNKI database with the boolean expressions (“technological pedagogical content knowledge or “TPACK” in English version and Chinese version) shown in titles, keywords and abstracts. Considering the source types of the publication, only peer-reviewed journal articles were included because peer review procedures were considered to produce more reliable results (Niñerola et al., 2019). The research field was chosen as the social science to ensure the relevance of retrieved articles; the retrieval date was 1st November 2021; the publication duration was “1st January 2012–1st November 2022”; the language was focused on Chinese.

CiteSpace tool was used in this paper to present a visualization of scientific knowledge based on the bibliometric analysis. CiteSpace is a Java-based application, which is a powerful tool to map and visualize network structure with bibliographic data from many databases, such as CNKI, WOS and Scopus (Chen, 2017).

Data collection:

Based on the research criteria set in the research design phase, the whole search strategy is summarized in Table 1.

Table 1 Search strategy

Type	Criteria
Database	CNKI
Search string	TITLE-ABS-KEY: (technological pedagogical content knowledge” or “TPACK”
Document type	Article
Source of the publications	Academic journals
Time span	January 2012 – November 2022
Language	Chinese
Retrieval time	11 November 2022
No of records	2701

A total of 2701 publication results were initially captured according to the search keywords. Of these, 1772 publications were excluded for violating the criteria for the research design, including the document type (545), the source type of the publication (18), time span (264) and language (945) at this stage. The remaining 932 publications were manually checked for eligibility by examining the title and abstract of each article, following which a total of 91 publications were excluded for irrelevance to the study.

In order to conduct bibliometric analysis, the authors collected the data with cited references for 841 studies, exported these data in CNKI through the extraction of a “refword” format, imported to CiteSpace, and converted the “refword” format into the “txt” format that can be executed by CiteSpace. After the elimination of duplicates data by CiteSpace, the final 838 samples were identified.

Data Analysis

In this study, CiteSpace was applied to visualize three kinds of bibliometric analysis networks: institution co-occurrence analysis, author co-occurrence analysis, and keyword co-occurrence analysis. Institution collaboration network identified the main contributors in terms of institutions and the scientific collaboration among various institutions; author co-occurrence analysis revealed the main authors in the TPACK research and the scientific collaboration among these authors; keyword co-occurrence analysis identified the research frontiers, hotspots, and emerging trends. Fig. 1 described the process of the methodology using CiteSpace tools. During the execution of CiteSpace, the parameters such as time slice, node type, links, selection criteria, and pruning method should be decided to fulfill the research objectives

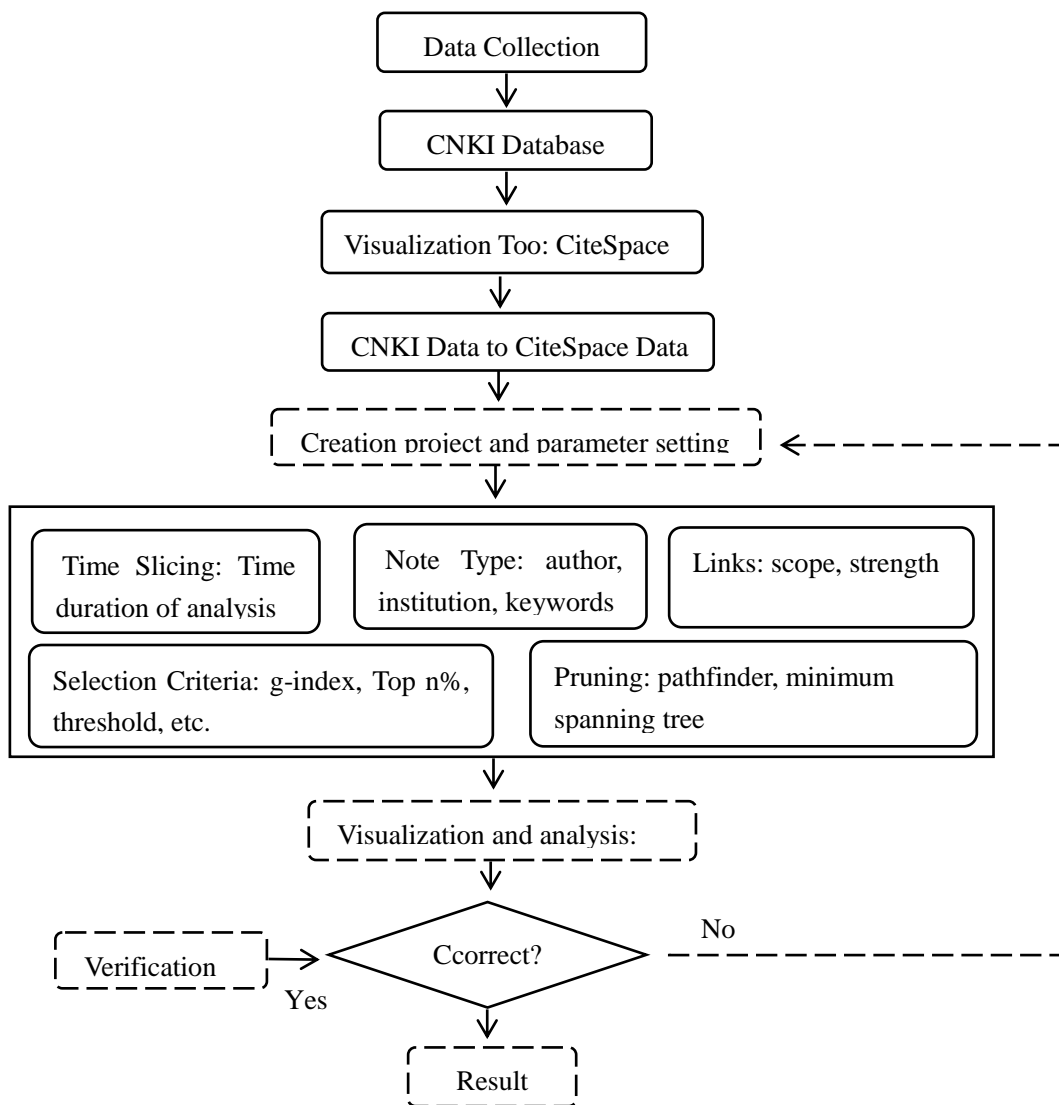


Fig. 1 Visualization and the analysis process of CiteSpace

The parameter setting for the three-co-occurrence analysis in this study was shown in Table 2.

Table 2 Parameter setting of CiteSpace

Author co-occurrence analysis	Institutions co-occurrence analysis	Keyword co-occurrence analysis
Time slicing: 1st January 2012–1st November 2022	Time slicing: 1st January 2012–1st November 2022	Time slicing: 1st January 2012–1st November 2022
Node type: author	Node type: institution	Node type: keywords
Selection criteria: g-index with scale factor K=25	Selection criteria: g-index with scale factor K=25	Selection criteria: g-index with scale factor K=25
The rest setting remained set as default	The rest setting remained set as default	The rest setting remained set as default

VISUAL ANALYSIS

Publication trends

According to the quantitative analysis results, a total of 838 articles related to this study were published in China during the last ten years (from 2012 to 2022). As showed in Fig. 2, the overall trend of publication has maintained a stable increment during this period of time. More sacrificially, the developmental trend of publications could be divided into three stage. In the first stage (2012-2019), the research on TPACK in China witnessed a continuously development, and the publications were increased from only 17 in 2012 to its peak in 2019 with 125 publications; in the second stage (2019-2021), the publication saw a slight declining trend in 2020 and 2021, with 115 and 100 publications, respectively; in the third stage (2021-2022), research on TPACK showed revival development with more than 117 publications before November of the 2022.

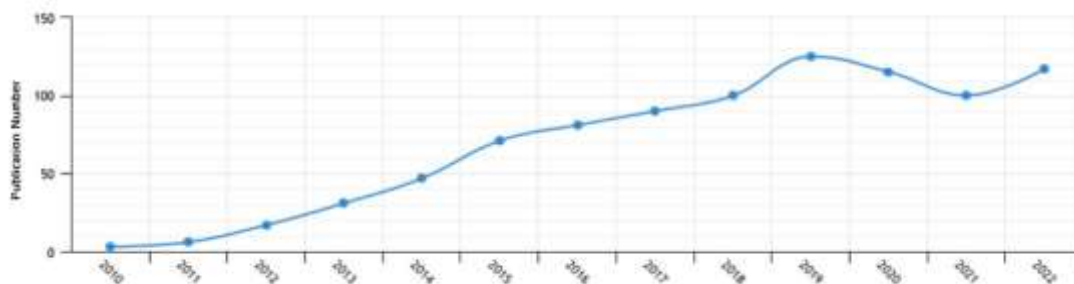


Fig. 2 Publication trends of TPACK study in China (2012-2022)

Author Co-occurrence Analysis

Research on authors with high academic productivity will enable researchers to grasp the development trend of the certain research field and obtain a broader perspective (Xue & He 2021). In this study, the node type of author co-occurrence analysis was set as “Author” (Top N=50) in Citespace, and the researcher selected “Minimum Spanning Tree” to optimize the co-occurrence network. The results (Nodes=329, E=136, Density=0.0025) showed that there were 329 authors in the field of TPACK research in China, with a total of 136 collaborations among them between 2012-2022 (as shown in F 3) . Based on Price’s Law (de

Solla Price, 1965), $M \approx 0.749 \times \sqrt{N_{max}}$ (M = the number of papers, N_{max} = the number of papers from the authors with the most published papers). If the number of articles published by an author is more than M, the author is defined as one of the main authors. When the total number of papers published by main authors reaches 50%, it indicates that a

core group of authors had been formed in this field. Calculated based on N_{max} (15) in this study, the authors who have published more than 2 articles belong to the high publishing ability group in this field. From 2012 to 2022, 109 scholars published over 2 papers (n=276), accounting for 83.9.% of the selected literature (n=329), which indicated that the core author group of TPACK research had been formed. The top 20 core author were showed in Table 3.

The author co-occurrence graph, which is also named the author collaboration graph, can identify the core academic group of TPACK research. Fig. 3 showed that the author co-occurrence graph generates a total of 329 nodes. Each node represents an author, and the size of the node represents the number of articles published by the author. The label size represents the centrality. The connection between the nodes indicates the existence of a cooperative relationship between the authors, and the thickness of the connection represents the cooperative relationship between the authors. As shown in Table 3 and Figure 3, the overall graph was very loose, and the network density of the knowledge graph was only 0.0025, which means, although several research teams with relatively fruitful results have been formed (for example, several teams headed by Professor Wang Yining, Professor Zhang Hai, Professor He Kekang and Professor Zhao Leilei), the close cooperation network between the authors didn't form, and the existing scale of cooperation was mainly limited to 2-3 persons. What's more, according to the observation, the most collaboration researches were conducted in the same institution or instructed by the same mentor, and there is basically no cross-regional cooperation in terms of geography.

Table 4 Top 20 core author in CNKI (2012-2022)

N.	Count	Year	Author	N.	count	Year	Author
1	15	2012	Wang Yining	11	4	2012	He KeKang
2	10	2012	Zhang Hai	12	3	2013	Liu Yanhua
3	6	2013	Zhang jing	13	3	2019	Wang Qiong
4	6	2014	Zhao Leilei	14	3	2018	Wu Di
5	5	2012	Wu Huanqin	15	3	2015	Dong Yan
6	5	2015	Zhang Zhe	16	3	2015	Yan Zhiming
7	4	2016	Ma Yan	17	3	2014	Zhao Keyun
8	4	2015	Fu Pingjun	18	3	2021	Hu Xiaotian
9	4	2012	Xu Zhanghuan	19	3	2015	Duan Yanmei
10	4	2020	Liu Qingtang	20	3	2013	Cao Yiming

schools of the Northeast Normal University (School of Media Science, School of Information and Technology as well as School of Teaching) were obviously close than the collaboration they hold with other institutions. The institutions in Beijing conducted more collaborative research in Beijing area than the collaborative research with another region. The evidence provided an insight into the needs of collaborative research contexts and more open resources for further research institutions.

Table 4 Top 10 core research institution of TPACK in CNKI (2012-2022)

Number	Count	Year	Institutions
1	16	2012	School of Media Science, Northeast Normal University
2	11	2014	School of Educational Technology, Beijing Normal University
3	11	2014	School of Educational Information Technology, Central China Normal University
4	10	2012	School of Computer Science and Information Technology, Northeast Normal University
5	8	2014	Communication College of Qufu Normal University
6	7	2015	Northeast Normal University
7	7	2013	School of Mathematics and Statistics, Central China Normal University
8	6	2018	School of Information Science and Technology, Northeast Normal University
9	5	2013	Communication College of Jiangxi Normal University
10	5	2012	Institute of Modern Educational Technology, Beijing Normal University

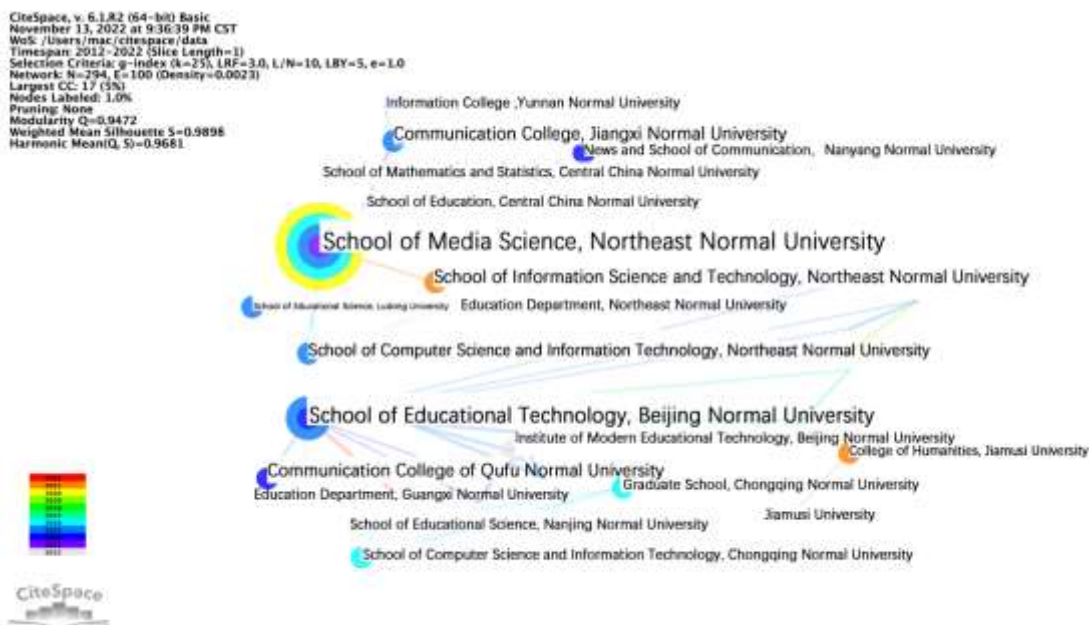


Fig. 4 The co-occurrence institutions research of TPACK in CNKI (2012-2022).

Keyword Co-occurrence Analysis

Keywords are taken as an elevated summarization and refinement of the scientific publication (Xie et al., 2020). A co-occurrence analysis of keywords is an efficient way to illustrate the structure of scientific knowledge, and explore hotspots as well as research frontiers in a specific domain (Su et al., 2019). By mapping and clustering the terms extracted from keywords, research themes can be determined concisely (Xie et al., 2020).

Table 5 listed the top 10 most frequent keywords with the number of occurrences and centrality equal to or greater than 8 and 0.02, respectively. It was observed that the research field of TPACK was connected to the research areas such as information technology, teaching design, PSTs, university and college teacher, teacher education and vocational teachers.

Table 5 Top 10 Keyword of TPACK in CNKI (2012-2022)

N.	Count	Centrality	Year	Keyword
1	52	0.39	2013	Information technology
2	31	0.05	2012	Teaching design
3	30	0.04	2012	Normal student
4	23	0.1	2014	University and college teacher
5	22	0.03	2012	Teacher education
6	21	0.02	2018	Vocational teacher
7	21	0.06	2014	PSTs
8	17	0.09	2012	Teaching technology
9	17	0.02	2012	English teacher
10	17	0.07	2015	Flipping classroom

Keyword clustering analysis is one primary function of Citespace. It reflects the structural features among clusters, emphasizing important nodes and critical connections. To better understand the research hotspots and the highlight research topic, further cluster analysis of the co-occurrence of the keywords of TPACK was carried out in this research.

In this study, keywords and log-likelihood ratio (LLR) weighing algorithms are used to identify cluster labels. The LLR algorithm determines the label of the cluster that presents the main topics of each cluster in the network. Modularity and mean silhouette values represent the precision of the clustering boundary and clustering scale, respectively. As can be seen from Fig. 5, 10 clusters were identified with a modularity value of 0.7119 and a mean silhouette value of 0.9054, which is higher than the standard value of Modularity (0.3) and mean silhouette values (0.7), indicating the clustering was convincing. These 10 clusters were sorted according to the number of keywords contained, where a smaller sequence number indicates a larger category. CiteSpace uses algorithms to cluster closely related keywords, and

then gives each keyword a value. In a cluster, the keyword with the largest value becomes the representative of the cluster. Table 6 listed the summary of the clusters with an attribute Cluster ID, Cluster size, Silhouette value, label LLR, and mean citation year.

Table 6 Summary of Keyword cluster of TPACK in CNKI (2012-2022)

Cluster ID	Size	Silhouette	Lable(LLR)	Mean(Year)
0	22	0.903	integrated technology	2016
1	18	0.886	information technology	2016
2	18	0.842	pre-sevice teacher	2015
3	16	0.91	teaching and learning capability	2016
4	14	0.894	teaching design	2017
5	13	0.954	instructional technology	2015
6	13	0.883	flipping class model	2015
7	12	0.986	math teacher	2013
8	10	0.858	teacher’s knowledge	2016
9	10	0.914	teacher training	2016

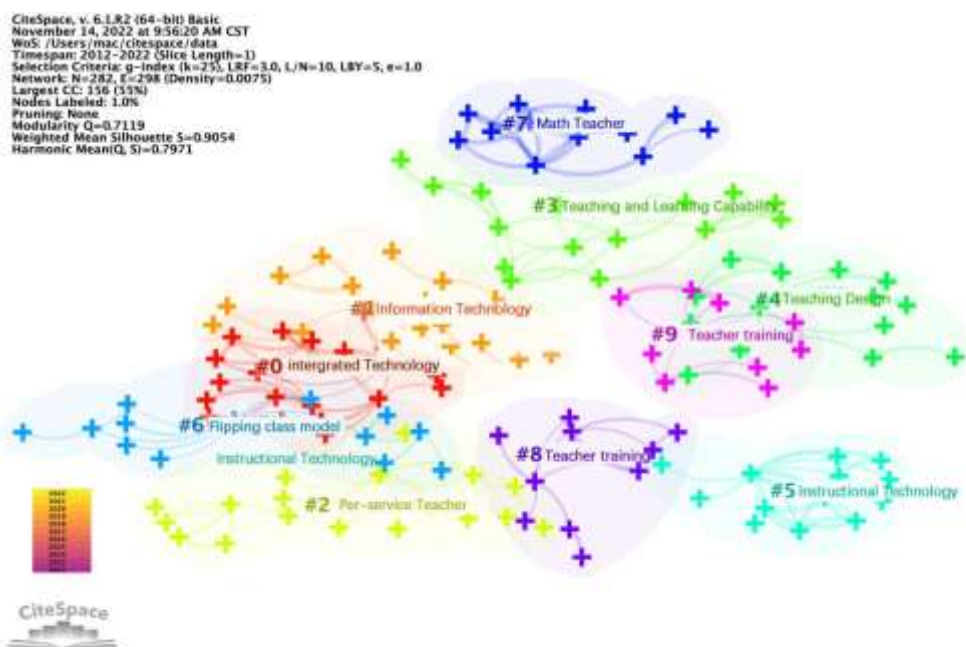


Fig. 5 The Keywords clustering network of TPACK research in CNKI (2012-2022)

As shown in Figure 5 and Table 6, cluster #0 consisted of a grouping of keywords that included “integrated technology”, “university and college teacher”, “normal university student”, “English”, and “variation analysis”. This cluster represented the latest research

theme was focused on the university and college teachers and students' development of TPACK and particularly shed light on the normal university and college in China.

Cluster #1 consisted of a grouping of keywords that included “information technology”, “influential factors”, “strategy”, “innovation”, and “chemistry education”. This cluster indicated Chinese researches attempted to illuminate the function of information technology in the TPACK integration and seek the influential factors in the process of integration of TPACK.

Cluster #2 consisted of a grouping of keywords that included “pre-service teacher”, “micro-lecture”, “professional developing”, “curricula construction”, and “English teacher”. This theme was focused on the pre-service teacher's TPACK cultivation.

Cluster #3 consisted of a grouping of keywords that included “teaching and learning capability”; “vocational teacher”; “informatization”, “promoting strategy”, and “information literacy”. This theme showed that the informatization teaching and learning capability inspired the researchers to conduct the studies.

Cluster #4 consisted of a grouping of keywords that included “teaching design”, “college English”, “comprehensive practice”, “application and innovation”, and “learning contextual”. This theme was focused on the interaction between the learning and practice.

Cluster #5 consisted of a grouping of keywords that included “instructional technology”, “integration”, “learning strategy”, “learning evaluation”, and “investigation”. This theme paid attention to the utilization of technology in the teaching and learning.

Cluster #6 consisted of a grouping of keywords that included “flipping class model”, “teaching model”, “IT”, “teacher's education”, and “investigation”. This cluster was concentrated on building model for the teaching.

Cluster #7 consisted of a grouping of keywords that included “math teacher”, “mathematics content”, “information technology teacher”, “countermeasure”, and “questionnaire for teacher”. This theme indicated that the TPACH study in China marched into the more specific domain— mathematics.

Cluster #8 consisted of a grouping of keywords that included “teacher's knowledge”, “cultivating path”, “developing mechanism”, and “integration of education and production”. This theme was focused on the formation of teacher's knowledge.

Cluster #9 consisted of a grouping of keywords that included “teacher training”, “teacher”,

“curricular standard”, “system” , and “strategy study”. In this theme, TPACK researchers focused on the role of teachers’ training in the process of promoting TPACK.

The keywords timeline view of TPACK was showed in Figure 6, which demonstrated the development of keywords contained in each cluster. From the timeline graph, it can infer the development of TPACK during 2012–2022. Cluster #0 (integrated technology), cluster #2 (PSTs), cluster #3 (teaching and learning capability), cluster #4 (teaching design), cluster #5 (instructional technology), cluster #6 (flipping class model), cluster #7 (math teacher), and cluster #8 “teacher’s knowledge ” are the beginning clusters with mean citation year 2012; cluster #1 (information technology) and cluster #9 (teacher training) are the second group of cluster with mean citation year 2013; cluster#0 (integrated technology), cluster#2 (PSTs), cluster#3 (teaching and learning capability) were developed continuously and steadily in the research area of TPACK in China; research theme related to cluster #5 (instructional technology), cluster #6 (flipping class model), cluster #7 (math teacher), cluster #8 (teacher’s knowledge), and cluster #9 (teacher training) declined in the recent three years; some new hotspots emerged from 2020, including “empirical research”, “variation analysis” and “application situation”, and they may represent the future research area in this field.

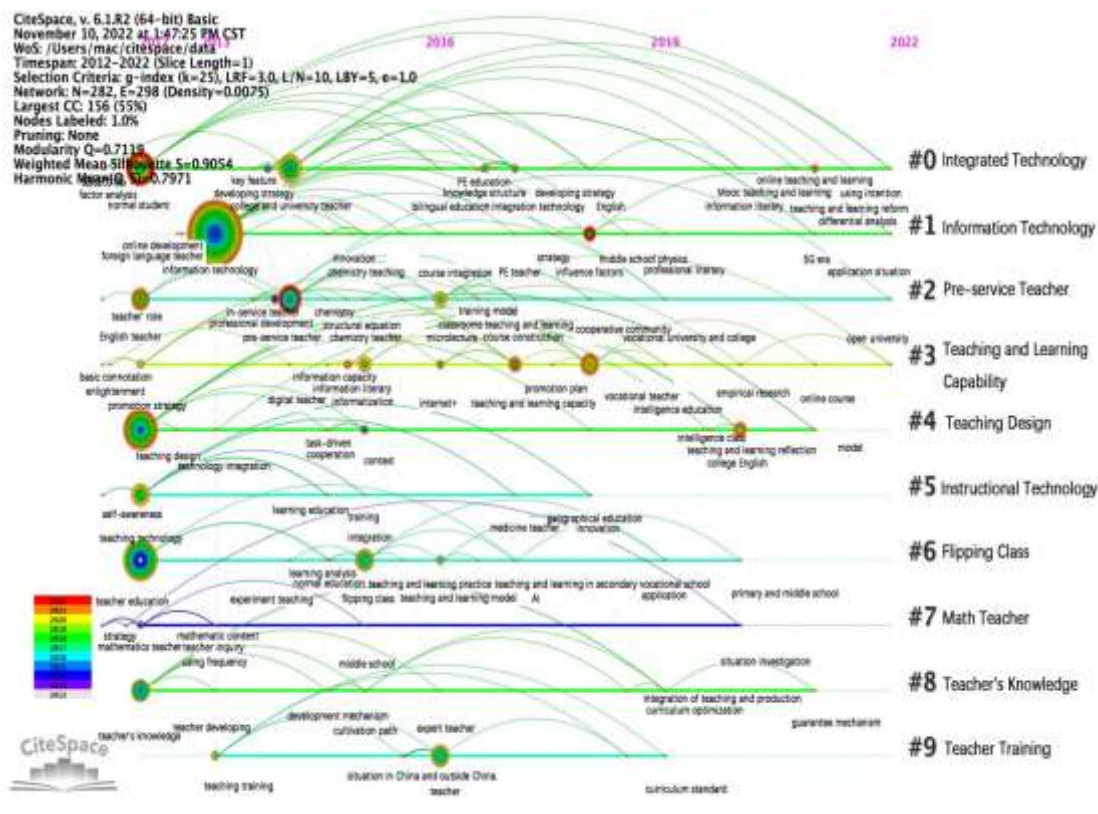


Fig. 6 Timeline graph of TPACK research in CNKI (2012-2022)

Bursts refer to the words which are cited frequently in a short time in the citespace. Based on the burst detection algorithm, the citespace can provide the keywords with the strongest citation bursts which can indicate words with a sudden increase in citation frequency and are used to reveal the frontier trends in certain research field. Therefore, to perceive the research development trend of the TPACK in China, the burstness analysis was carried out in this study. Fig. 7 shows the keywords of TPACK with the strongest citation bursts.

As shown in the Fig. 7, the burst term “vocational teachers” and “college English” approximately emerged from 2018 and lasted to the 2020; the burst term “PSTs” and “teaching and learning capability” are roughly raised in 2019 and sustained to the 2022. According to Citesapce, it can be concluded that the research frontier trends were focused on the field of “vocational teachers”, “college English”, “PSTs” and “teaching and learning capability”. Meanwhile, these frontiers will probably represent the research trend of the TPACK in China.

Top 9 Keywords with the Strongest Citation Bursts



Fig. 7 Keywords with the strongest citation in CNKI (2012-2022)

DISCUSSION

China’s TPACK research showed a steady rising trend in CNKI in years from 2012 to 2022. 838 articles related to TPACK research were published in China in the last decade. The annual published articles have been increased from 17 publications in 2012 to the peak in 2019 with 125 publications. Although experienced a slight decline in 2020 and 2021, with 115 and 100 publications, respectively, the research on TPACK saw revival development with

more than 117 publications in 2022. This means Chinese education academia has realized the vital role of integrating the new emerging technology into the teaching and learning to promote the sustainable development and reform of the education under the framework of TPACK, and the TPACK research development may still keep increasing in the future, despite the periodical shrinkage of the publication in the 2020 and 2021(may be caused by Covid-19 pandemic).

The analysis based on the institution found most of TPACH researches in China was conducted by the normal universities. The top 10 core research institutions were all normal universities, such as Northeast Normal University, Beijing Normal University, Central China Normal University, which means the Normal universities had become the main force in the study of TPACK in China. Moreover, according to the publication date, this study found that the research on the TPACK in China had been expanded from the Normal universities belonging to the Ministry of Education of China to the provincial and local colleges and universities, which implied that TPACH framework was widespread and the stage of introduction of TPACK theory from abroad into China was roughly finished. The research had stepped into the phrase to utilize the TPACK framework to study the local and specific application. Meanwhile, in terms of the density, the value of the institution-based algorithm is 0.0023. It indicated that there was a lack of long-lasting collaboration between institutions let alone TPACK researchers collaborating with those in other research fields. Active collaboration between institutions possessed the opportunity to become the point of penetration and breakthroughs in Chinese TPACK study in the future.

The analysis based on the keywords found that due to the impact of the continuous development of information and communication technology, the exploration on the integrated technology (cluster#0) and the information technology (cluster#1) constantly attracted the researchers' attention throughout the last decade. Chinese research conducted a large number of researches to verify the framework, explore the path and test the application of the fusion of new-emerging technology into the TPACK such as Zhang et al. (2022), Hou (2022) and Li (2022). As the technology developing, it had every reason to believe that the research on the "T" (technology) would be a trend in the Chinese TPACH research in the future.

Research on PSTs' TPACK (cluster# 3) also was one of the main branches of study about TPACK in China in the last ten years, since some researcher have proved that the quality and professional ability of PSTs' are closely related to the construction of Chinese teachers' capabilities (Wang et al., 2022), and developing PSTs' application ability of information technology in practice plays a critical role in cultivating qualified teachers of primary and secondary schools in the information age (Zheng & Zhang, 2020). Chinese researchers have conducted many investigations on the present level and development paths of PSTs' TPACK and found the present TPACK level of PSTs' is not high (Yan et al., 2022; Dong et al., 2019).

In order to promote PSTs' TPACK effectively, researchers dedicated to put forward various development strategies such as Zheng & Zhang (2021), Huang (2020), Ma & Baek (2020) and Nie (2022), and it is foreseeable that this theme would be another research hotspot in the future. In the meanwhile, the burstness analysis found the burst term “vocational teachers”, “college English”, “PSTs” and “teaching and learning capability” were the strongest citation keywords in the 2022, which means these frontiers will probably represent the research trend of the TPACK in China.

CONCLUSION

This paper discussed the Chinese TPACK research based on bibliometric analysis from 2012 to 2022. In this study, 838 published papers on TPACK were chosen as the research samples from the CNKI database between 2012 to 2022. This study used CiteSpace software to analyze the public trend, authors, research institutions, and keywords of the literature visually. Finally, according to visual analysis results, research hotspots and trends of TPACK are concluded. Although they experienced a slight decline in 2020 and 2021, the growth of publications related to TPACK has been increased in recent years. TPACK research in China was conducted mainly by the normal universities, but also with the sign that TPACK research in China has been expanded from the normal universities belonging to the Ministry of Education of China to the provincial and local colleges and universities, but active collaboration still lacked. With the development of technology, the theme related to “integrated technology” and “information technology” constantly attracted the researchers' attention in the last decade, and it would be continually studied in the future. Chinese PSTs' TPACK was also one of the main branches of study on TPACK in China in the last ten years. In order to promote PSTs' TPACK effectively, researchers dedicated to explore the development strategies, especially the local oriented and specific domain-oriented application. The burstness analysis found the burst term “vocational teachers”, “college English”, “PSTs” and “teaching and learning capability” were the strongest citation keywords in the 2022, which means these frontiers will probably represent the research trend of the TPACK in China.

This paper will be helpful to researchers and academicians in the field of TPACK for the future research. However, there are still some limitations in this research. The Citespace software can't process the document occurrence analysis based on the CNKI because of the format restriction for example, so it inevitably caused some deviations in the prediction of development trends, hoping that the future research can refine relevant limitations.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

Data Availability Statement

Data in the summarized and analyzed forms are available in the article tables and figures. The complete data that support the findings of this study are available from the corresponding author upon reasonable request

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