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Analysis of the Research Progress of Teachers' Digital Competence in China based on Bibliometrics

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Abstract

With the rapid development of information technology, teachers' digital competence has become the focus of attention in the education field. China is deeply implementing the "Internet +" action plan and the National Education Informatization 2.0 strategy, and the study of Chinese teachers' digital competence is particularly important. Research on Chinese teachers' digital competence shows a diversified trend. Although existing research has provided valuable insights and data, there is still a lack of systematic understanding of Chinese teachers' digital competence. Systematic research on the digital competence of teachers in China is essential for informing policy, improving educational quality, enhancing global competitiveness, mitigating the digital divide, supporting professional development, and advancing research and innovation in the field of educational technology. This study uses VOSviewer as a tool to research and analyze 366 articles related to teachers' digital competence in China included in the Web of Science database and CNKI database. This study uses quantitative research methods and bibliometric to sort out the current research status of Chinese teachers' digital competence and explore the shortcomings and development direction. The study found that the number of articles published in the field of teachers' digital competence in China is generally increasing, with China publishing the largest number of articles, followed by Spain, the United States, etc. The authors of the article have less cross-team collaboration, insufficient communication, insufficient research depth, and no sustained research. A total of 47 keywords that appeared 5 times were analyzed, and 9 clusters were formed, which were further divided into three themes: digital transformation, digital competence, and teachers. "Digital literacy of teacher", "rural teacher", "education digitalization", "digital teaching", etc. are hot topics in recent research. It can be inferred that the next research will focus on the practical application of teachers' digital competence in teaching.

Keywords: Teachers' Digital Competence, China, Bibliometrics, Research Progress, VOSviewer

Introduction

Given the speed at which information technology is developing in the twenty-first century, digital transformation is becoming a major factor in pushing the boundaries of educational

innovation and raising standards of instruction. The success of educational informatization is directly correlated with teachers' digital competence, as they constitute the core of educational activity. These studies not only involve new concepts and the integration of new technologies in the field of educational technology, but also include multiple issues such as teacher professional growth, teaching method reform, and balanced allocation of educational resources. In an increasingly digitalized environment, the conventional classroom setting, where teachers convey knowledge, has given place to a more flexible position. Since technology has been ingrained in educational institutions, teachers are now required to possess a wide variety of digital competencies to navigate the digital terrain and engage students in meaningful learning experiences. The educational standards now heavily depend on teachers' digital competency. In the rapidly evolving field of education, the integration of digital technologies has emerged as a revolutionary force, revolutionizing teaching, and learning methodologies across the globe. This advancement highlights the significance of understanding and evaluating teachers' digital abilities, a field of educational research that has garnered a lot of attention. In China, where educational reform is a major focus, raising the bar for quality and efficacy in education requires instructors to become more proficient in digital technology. The COVID-19 pandemic's disruption of traditional modalities of instruction in China has contributed to the increased prevalence of digital technology integration into instructional practices in today's educational landscape. This shift has highlighted how crucial it is for educators to be digitally competent to successfully navigate mixed and online learning environments. China is still reforming education to bring teaching techniques up to date, but comprehensive research on teachers' digital competence is lacking.

Literature Review

China's educational informatization has always been in a stage of rapid development. Research results on teachers' digital competence are of great significance for guiding educational practice. In recent years, research on teachers' digital competence in China has shown a diversified trend. The analysis of the 309 academic papers reveals several key findings regarding the research status of Chinese teachers' digital competence.

Connotation analysis Xiaochun (2021); Yuanbin (2023), technology application Dan (2023); Dong (2021); Liu Jinfang (2021); Yanyu (2023), curricular integration (Yang Yaping, 2009), policy orientation Hu Xiaoyong (2023); Wu Jiaxia (2023); Wu Qijun (2021); Ye (2023) of teachers' digital teaching competency, and implementation consequences are the research areas. Prior research has mostly examined the variables affecting educators' acceptance and utilization of digital tools in the classroom (Liu Yuping, 2021; You Jiaxin, 2014). Researchers have looked into how teachers' digital activities are shaped by things including institutional support networks, pedagogical views, and technology infrastructure (Guo et al., 2016; Luo Jianghua, 2023; Ma Xiaoxu, 2024; Weimin, 2017; Yan, 2011). The significance of digital pedagogy and its effect on student learning outcomes have been underlined by research (Shen et al., 2015). Research has looked at how well different digital tools and instructional techniques can improve the quality of instruction and help students develop 21st-century abilities(Cerveró-Carrascosa, 2022). The amount of research on professional development's contribution to teacher digitalization is increasing. To help educators develop and hone their digital competence, researchers have suggested creative training courses, cooperative learning groups, and mentoring programs (Fu Weidong, 2024). Scholars have examined teachers' perceptions Shen et al (2015), professional development needs Thurm et al (2024),

and the impact of digital resources on language education (Huang et al., 2021). Furthermore, investigations into the integration of digital technologies into curriculum design Zhao & Zhao (2021) and the exploration of innovative pedagogical approaches You (2022) contribute to our understanding of how Chinese educators are adapting to the digital age.

It is particularly worth noting that there are obvious differences in the development level of teachers' digital competence in various regions in China. Specifically, rural teachers had significantly lower levels of ICT attitude, ICT abilities, data literacy, and digital teaching competency compared to their urban counterparts (Lin et al., 2023). One of the main challenges to teaching and research at schools located in impoverished areas is the lack of adequate hardware facilities (Li Yizheng, 2017). Teachers in booming cities in eastern China, where technology is widespread, are often at the forefront of digital innovation, deftly integrating technological tools into their teaching methods. However, in more remote rural areas, such as central and western regions, insufficient resources and infrastructure have seriously hindered teachers' development of digital literacy. This disparity highlights the importance of implementing targeted interventions and support networks to ensure that all Chinese educators have equitable access to digital learning opportunities (Lei, 2019; Lei, 2024). Innovative methods, such as partnerships with tech businesses and community-based training programs, are aimed at closing the digital gap through strategies. Research on minority educators also seeks to improve digital literacy and access to education by creating culturally sensitive pedagogical practices and individualized course materials.

In China, there are also differences in the level of digital competence possessed by teachers across different subjects. Teachers with a high degree of expertise in disciplines like computer science and information technology frequently use their specific knowledge to successfully incorporate digital tools into their lessons (Lintao, 2024). On the other hand, teachers may find it more difficult to keep up with technology changes in topics like literature or history, where digital literacy may not be as important. Teaching digital skills in specific disciplines such as choreography and dance does not require much (You, 2022). This variation highlights the necessity of focused professional development programs catered to the needs of various academic fields so that teachers in all subject areas may fully utilize digital resources in their instructional strategies (Wenxin, 2024; Yingyao, 2023).

There is a lack of studies on the framework for teachers' digital competence even after China's Ministry of Education released the "Teacher Digital Literacy" industry standard at the end of 2022 (Chenyang, 2024). Strengthen teachers' understanding and recognition of digital capabilities (Yan, 2024). Research on the elements influencing teachers' digital competence is also dispersed. This gap highlights the necessity of thorough studies into the elements and applications of this framework. A further major difficulty is the lack of guidelines on how to assess and educate teachers' digital competence within the framework (Chen Fengdan, 2023). To fill this gap, methodical ways are needed that not only describe the abilities and information required but also offer workable plans for execution and evaluation. Educators and legislators can guarantee that teachers have the competencies required to succeed in the current digital era by carrying out thorough research and creating tangible approaches for digital competence assessment and training (Hao, 2024).

There is a lack of research that fully examines how digital competence interact with topic knowledge, classroom management, and assessment strategies, all of which are important components of a professional educator (Hu Weiwei, 2024). To get a full picture of how effective teachers are in the digital age, we must investigate this intersectionality (Tingting, 2024). The fields of educational psychology, sociology, and studies of technology should work

together in an interdisciplinary study. In the middle of digital integration, such teamwork can produce all-encompassing frameworks that improve teacher effectiveness. Researchers can inform methods to increase teacher professionalism in the digital era by overcoming disciplinary boundaries and advancing our understanding of how digital competencies intersect with larger characteristics of teaching.

Although existing research has provided us with valuable insights and data, there is still a lack of systematic understanding of Chinese teachers' digital capabilities. Because of this, the purpose of this study is to conduct a comprehensive review and visual analysis of existing research through bibliometric methods to reveal the research progress and existing problems of Chinese teachers' digital capabilities. This has important theoretical and practical significance for guiding future research directions, optimizing the teacher training system, promoting educational equity, and improving educational quality. At the same time, the results of this study will also provide a reference for research on teachers' digital capabilities in similar educational contexts around the world.

Methodology

Data Sources

In the process of bibliometric analysis, the quantity and quality of documents directly affect the authenticity and objectivity of subject evolution. On the one hand, this study entered "teachers' digital competence" and "China", "teachers' digital literacy" and "China" in the Web of Science (WoS) database respectively. The document types are articles and review articles. There is no year limit. Obtained respectively 33, and 35 articles. Duplicate articles were removed, resulting in 57 articles. On the other hand, this study searched "teachers' digital competence" and "teachers' digital literacy" in the Chinese academic journals of China National Knowledge Infrastructure (CNKI), regardless of year, and obtained 116 and 206 articles respectively. Excluding duplicate articles, a total of 309 articles. The article search time is March 26, 2024.

Research Tool

One program that can help in making and viewing bibliometric maps is VOSviewer (van Eck & Waltman, 2010). Academics frequently use it to examine and display connections between keywords, authors, and scientific articles. For academics working with massive bibliographic datasets, VOSviewer's visualization capabilities make it easy to create network maps and clustering maps, among others. Finding prominent writers, developing themes, and new trends within a subject area are some of its most valuable applications.

Data Analysis

This study imported the number of publications, publications, authors, institutions and other information related to Chinese teachers' digital capabilities into Excel 2019 for analysis and used the VOSviewer tool system to sort out the retrieved literature and explore the digital capabilities of Chinese teachers by building a visual knowledge map. Research hotspots and dynamic trends in capabilities.

Results

Article Count Analysis

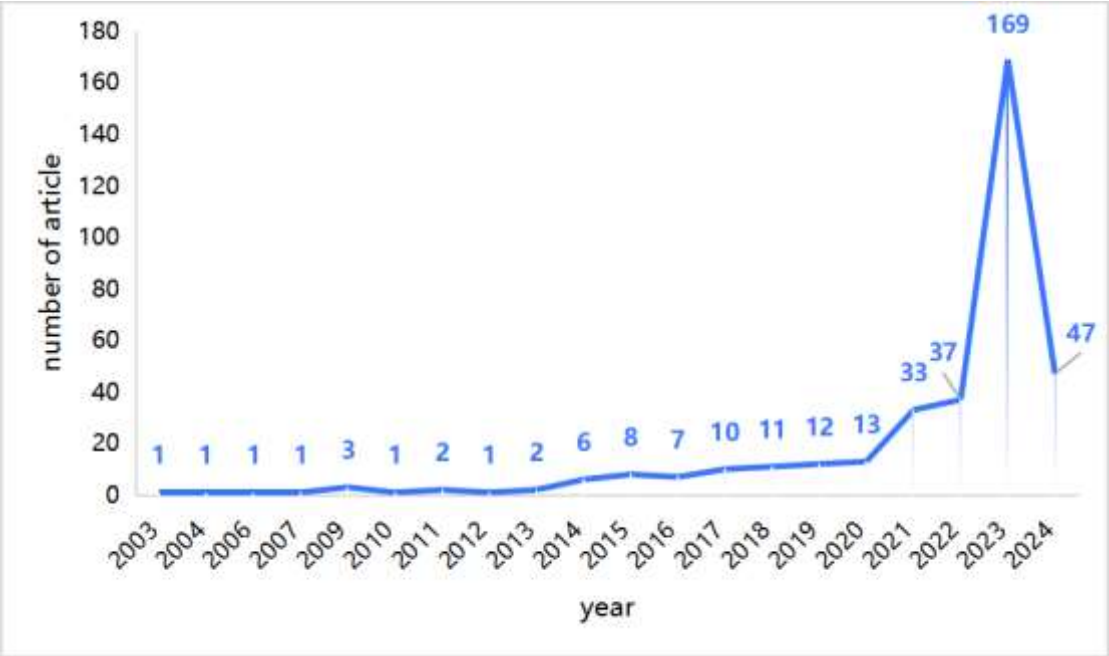

Fig. 1 Trends in the number of articles on teachers` digital competence in China research

The number of published documents can reflect the research status of a certain field Liu Shangwei (2023), and the annual distribution of the number of published documents can generally predict future research trends in this field. As can be seen from Figure 1, the number of published articles on research on teachers' digital competence in my country is generally small. A total of 366 articles have been published since 2003, but the overall trend is increasing. According to the changing trajectory of the number of publications related to teachers' digital competence in China, it can be divided into three periods. (1) From 2003 to 2013, the understanding of teachers' digital competence in China is still immature, and the number of documents is small. The maximum number is only 3 articles per year, which is the initial stage of research; (2) From 2004 to 2020, the number of relevant literature publications increased year by year, with a maximum of 13 articles per year; (3) After 2020, publications The growth rate of the number of articles has accelerated, with more than 30 articles published per year, reaching a research peak in 2023, with a total of 169 related documents published throughout the year. As of March 28, 2024, there have been 47 articles. It is believed that relevant research on teachers' digital competence in China will reach a new high in 2024.

Analysis of Publishing Country

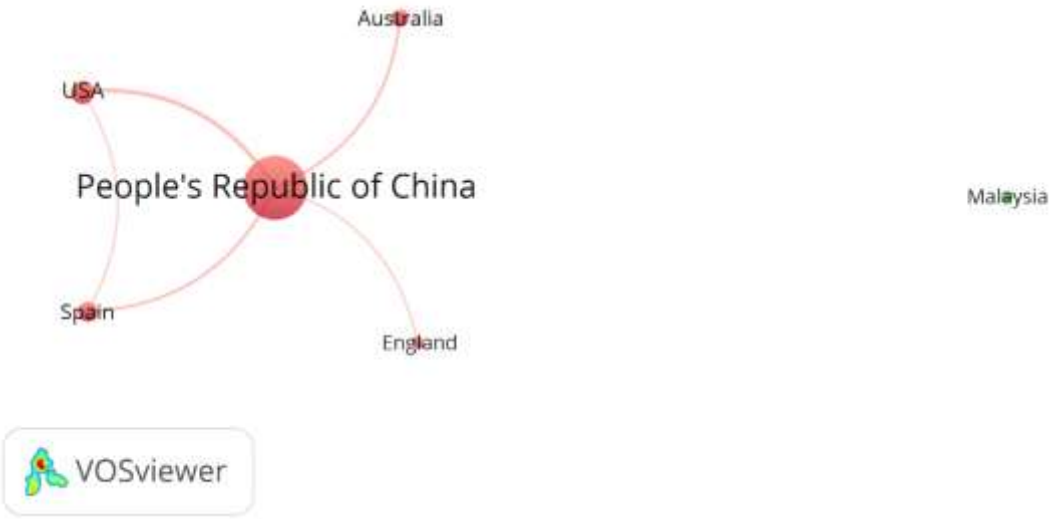

Figure 2 Number of articles in the field of teachers` digital competence in China (national cooperation network chart)

The circle represents the country that published the article. The size of the circle is directly proportional to the number of articles published by the country. The length of the connection distance is inversely proportional to the closeness of cooperation between countries. Different colors represent different clusters among authors. Articles published in the field of research on teachers' digital competence in China in recent years involves 6 countries or regions. Of course, China has the largest number of publications, with a total of 345 articles. Spain followed, with a total of 7 articles. 6 articles from the United States, 4 articles from Australia, 2 articles from the United Kingdom, and 2 articles from Malaysia. Judging from the national cooperation network diagram (Figure 2), China is the country that cooperates most frequently with other countries, followed by Spain and the United States, and Malaysia has less foreign cooperation and exchanges.

As can be seen from Figure 3, research on teachers' digital competence in China from Australia and the United States was relatively early, around 2019. Research on the teachers' digital competence in China from England and Malaysia in 2023. Only China has continued research over the long term.

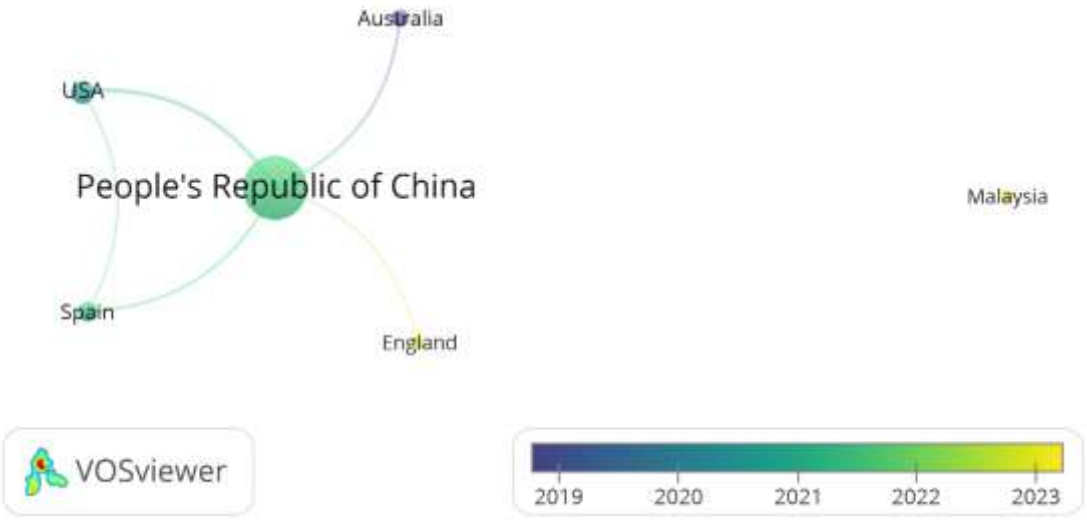

Figure 3 Number of articles in the field of teachers` digital competence in China (national year overlay chart)

Analysis of Publishing Author

An analysis of the number of articles published by authors shows that Jiang Lianjiang (5 articles) is the author who has published the most articles in the field of teachers' digital competence in China, followed by Wu Jiaxia (4 articles), Xue Dong (4 articles), and Yang Junfeng (4 articles), Liu Yuping (3 articles), Li Xiaodong (3 articles), Lin Ruyi (3 articles), Wu Di (3 articles), Yu Shulin (3 articles), Zhu Sha (3 articles), etc. Jiang Lianjiang mainly studied the digital competence of English teachers and the application of digital technology in English teaching and has not yet established a stable relationship with other productive authors. The two authors, Xue Dong and Yang Junfeng, have a stable relationship. They mainly studied the digital teaching capabilities of vocational college teachers and the teacher digital competency framework. The two authors, Liu Yuping and Li Xiaodong, have a stable relationship. They mainly study the status, influencing factors and model construction of international teachers' digital competence in China. Han Xibin and Ge Wenshuang jointly published 2 articles in which they studied teachers' teaching capabilities and framework in the digital age. Wei Fei and Zhu Zhiting jointly published 2 articles, mainly studying the micro-certification of teachers' information technology application abilities. The other authors have not yet established stable relationships with each other. It can be seen that the depth and persistence of research by Chinese scholars studying teachers' digital competence are insufficient. The author network map (Figure 4) shows the cooperation among authors who have published more than 2 documents.

Fig 4 Network map of collaboration between authors who have published more than 2 articles

Keyword Co-Occurrence Analysis

As shown in Figure 5, circles represent keywords. The size of the circle is proportional to the frequency of occurrence of the keywords. The length of the connection distance is inversely proportional to the closeness between keywords. Different colors represent different clusters between keywords.

Import the sample article data into VOSviewer and select "Author keywords" as the analysis object. The study used the full count method to analyze a total of 47 keywords that were identified as co-occurring more than 5 times. Keyword co-occurrence network diagram 9 clusters were formed, and a network visualization diagram (Fig. 5) and an overlay visualization diagram (Fig. 6) of hotspots teachers' digital competence in China research were generated. From the network map of co-occurring keywords, we can see that digital literacy (occurred 195 times), digital literacy of teachers (occurred 66 times), teacher (occurred 45 times), digital competence (occurred 37 times), digital transformation (occurred 35 times), teacher education and college teacher (appearing 23) are high-frequency words in the field of Chinese teachers' digital abilities and are current research hotspots. Based on keyword clustering, the research on teachers' digital competence can be further divided into the following three themes: digital transformation, digital competence/digital literacy, and teachers.

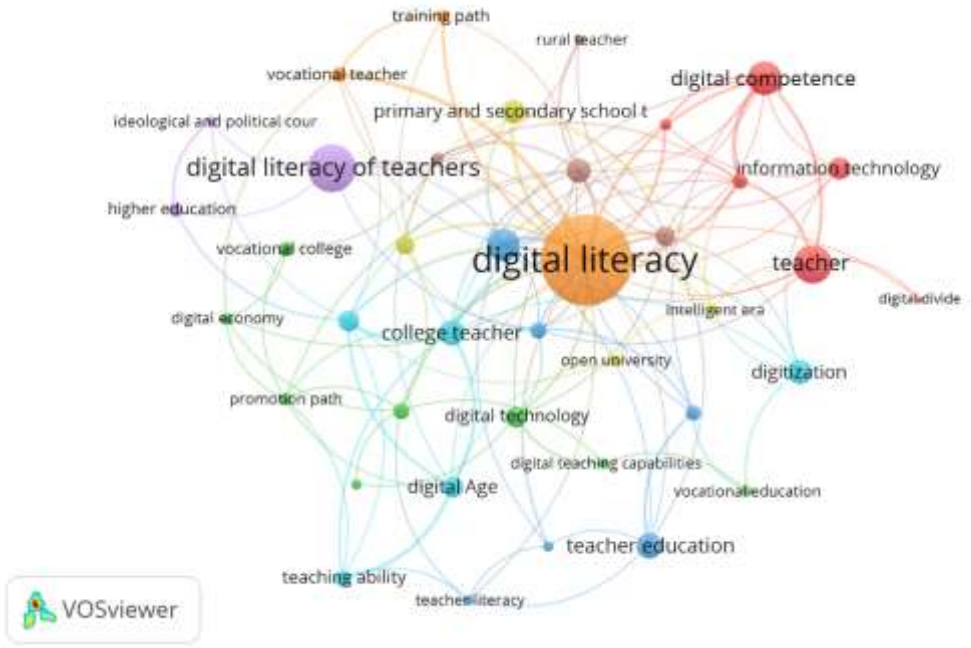

Fig 5 Coverage visualization map of high frequency (＞5)co-occurrence keywords in the field of teachers` digital competence in China (network visualization)

Theme 1 is digital transformation, and the main keywords include “education digitalization”, “digital literacy of teacher”, “digital technology”, “digital competence”, “digital teaching”, "teacher education", “rural teacher”, etc. Official Chinese policy from 2018 stressed the importance of educators being proactive in responding to technology shifts like informatization and AI in the classroom. During the same year, the "Education Informatization 2.0 Action Plan" was put forth by the Chinese Ministry of Education. It included plans to increase the use of digital resource services and to improve information literacy in general. Building a learning culture and a learning nation with universal access to lifelong learning is one of the goals of the Chinese government's 2022 report, which also calls for an increase in the use of digital tools in the classroom. At the end of 2022, the Ministry of Education of China released the "Teacher Digital Literacy" industry standard. China has issued a number of regulations that are pertinent to the construction and growth of education informatization, which is a matter of significant importance to the country (Lu, 2024). Against this background, China’s digital transformation has promoted research on teachers’ digital competence. With the support of digital technology, digital teaching is realized. To realize the digitalization of education, one of the important subjects is teachers. In particular, the digital capabilities of rural teachers with poor digital environment deserve attention(Lu, 2024). Challenges that educators encounter in the process of digitally transforming education include inadequate digital resources, inadequate security protection, inadequate digital knowledge and competence, and weak subject awareness (Hu Weiwei, 2024).

Theme 2 is digital competence/digital literacy, and the main keywords include “information technology”, “digital divide”, “digital teaching” “teacher”, “international Chinese teacher” etc. Among eight essential competencies for lifelong learning, digital competence was singled out by the European Union in 2006. The words "digital competence" and "digital literacy" have been used interchangeably since then, particularly in educational policy texts that discuss how to incorporate digital tools into classroom instruction (Godhe, 2019). Teachers’

digital capabilities are ultimately reflected in digital teaching. More research focuses on the relationship between digital competence and information technology. Some studies on teachers' digital competence start from international Chinese teachers.

Theme 3 is teacher, and the main keywords include "teacher professional development", "teacher education", "college teacher" "training path", "vocational teacher", "primary and secondary school teacher", "digital literacy of teacher", "promotion strategy" etc. According to the teacher digital competency framework, planning and training teachers' professional development is the right way to improve teachers' digital competency. Combined with the actual teaching, the training and ability improvement of teachers at different educational stages focus on different aspects.

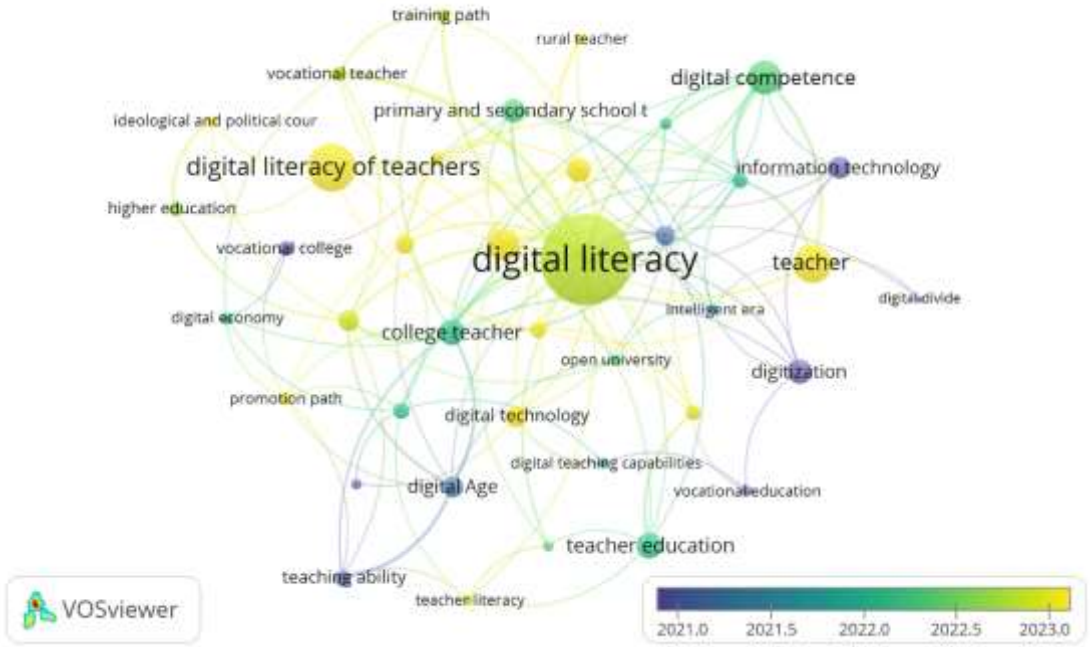

Fig 6 Coverage visualization map of high frequency (＞5)co-occurrence keywords in the field of teachers` digital competence in China (overlay visualization)

As shown in Figure 6, research hotspots in the field of teachers' digital competence in China are constantly changing over time. From the visual map of co-occurring keyword coverage, in recent years, "digital literacy of teacher", "rural teacher", "education digitalization", "ideological and political course teacher", "digital teaching" and "digital transformation" have been the most popular topics. These are research hotspots and trends in the field of teachers' digital competence.

Conclusion

In conclusion, this paper provides a comprehensive analysis of the research progress of Chinese teachers' digital capabilities. Through a bibliometric review of 366 academic papers, the study has identified the status of teachers` digital competence in China and proposed future directions for scholarly inquiry. The number of published articles on research on teachers' digital competence in my country is generally small. A total of 366 articles have been published since 2003, but the overall trend is increasing. In the early period, the understanding of teachers' digital competence in China was not yet mature, and the number of documents was small. After 2020, the number of publications will grow faster. It is believed

that relevant research on the digital competence of teachers in China will reach a new height in 2024. Because it is a study of teachers' digital competence in China, China has published the largest number of articles, followed by Spain, the United States, etc. Chinese scholars' research on teachers' digital competence is not deep enough and sustained enough. Jiang Lianjiang (5 articles) is the author who has published the most articles in the field of teachers' digital competence in China, followed by Wu Jiaxia (4 articles), Xue Dong (4 articles), Yang Junfeng (4 articles), etc. The author of the article has less cross-team collaboration and insufficient communication. A total of 47 keywords that appeared 5 times were analyzed, and 9 clusters were formed, which were further divided into three themes: digital transformation, digital competence, and teachers. It is believed that the next research will continue to extend in these three theme branches. From the visual map of co-occurring keyword coverage, "Digital literacy of teacher", "rural teacher", "education digitalization", "digital teaching", etc. are hot topics in recent research. It can be inferred that the next research will focus on the practical application of teachers' digital competence in teaching. After conducting systematic research to understand the current level of digital competence among teachers, the progression would be to explore how this competence can be effectively applied in educational practice. Overall, focusing on the practical application of teachers' digital competence in teaching would contribute to enhancing the quality and effectiveness of technology-enhanced learning experiences in classrooms, ultimately benefiting students and advancing education in the digital age(Tsankov & Damyanov, 2022; Zhou, 2023).

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