Hot Topics and Trends in Information Education Research: Higher Vocational College Teachers' Informatization Instructional Competence in China

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Abstract

With advances in technology in recent years, information education has received widespread attention. The purpose of this study is to explore the research hotspots and research trends in information education from 2000 to 2022. Using CiteSpace as our research tool, we conducted a visual analysis based on social sciences citation index (SSCI) and science citation index (SCI) journal literature based on web of science (WOS) database data and explored the limitations of information education research development and future development trends by conducting thematic keyword colinear analysis and cluster analysis, and analyze the challenges in the current development of information instructional competence among higher vocational college teachers in China.

Keywords: higher vocational college teachers, informatization instructional competence, information education, visualization, citespace

1. Information Education: Current Status and Challenges

Information technology in education and the internet has become a major catalyst for change for teaching and learning models and curriculum content, both by disrupting traditional curriculum instruction and by enabling blended learning and teaching approaches to stimulate learners' interest in learning, innovation, and discovery (Haleem et al., 2022). The COVID-19 pandemic has driven transformative developments in education and technology; this push has forced all education stakeholders to shift from traditional education to online education. This involves training students and teachers in competencies, knowledge, skills, and abilities related to information education (Babieva et al., 2022). The future megatrend in global education is global and digital; current education models cannot meet the needs of the talent market, and the accurate introduction of digital platforms and the use of artificial intelligence in education are essential to expanding the talent pool for the tech business (Mertanen et al., 2022).

Traditional teaching methods have been impacted by innovative information and digital technologies, leading to their reorientation from subject to object. ICT has become a major object of pedagogical research, and Inna et al. (2022) analyzed the interaction between classical and innovative pedagogical approaches at the theoretical and practical levels to construct a pedagogical research model in line with modern education. To capture the evolving nature of the research domain in the most efficient manner, CiteSpace implements cascading reference extension functions based on the API of dimensions. Direct reference networks generated in CiteSpace, along with the resulting datasets, core graphs, and clustered network coverage maps, depict the scope of the research domain at different levels of granularity (Chen & Song, 2019). Visual mapping of research hot topics and trends in information education can provide researchers with valuable insights into the prevailing topics and developments within this field (Jing et al., 2023). This fosters interdisciplinary research and contributes to the comprehensive advancement of the information education field (Tekdal, 2021).

The research objectives of this paper are:

(1) To understand the growth trends of information education in the last two decades.

(2) To recognize the deepening of the connotations of information education competence based on the TPACK theory.

(3) To discuss the future development trend of information education.

2. Method

2.1 Data Source

Education is a multidisciplinary professional discipline that integrates sociology, anthropology, and psychology, and its complexity requires the cohesiveness of core journals to provide a focus for researchers' thinking (Goodyear et al., 2009). The volume of studies in this paper is derived from the core collection in the WOS database, a scientific mapping tool for ensuring that subject searches can be used extensively. The source of the input data derives from a combination of multiple topics, and the exported data contain publication and article titles, abstracts, keywords, and other relevant information (Shao et al., 2021). The WOS database is available under the subject headings "education," "teaching" and "digitalization," "informatization." The search focused on articles and review published in English between January 1, 2000 and September 18, 2022, and yielded a final result of 1521 valid documents. After conversion by CiteSpace software, five duplicate samples were removed, resulting in 1456 valid samples. We used the following search string in WOS:

※WOS: TS=(("Informatization" OR "digitalization") AND ("education" OR "teaching"))

2.2 Tool

The knowledge mapping analysis tool used in this paper is CiteSpace, a Java-based visualization software developed by Chaomei Chen of Drexel University (USA). CiteSpace's visualization analysis is based on theoretical measures such as co-citation analysis theory and pathfinding network algorithms, which are used to map critical paths and knowledge in selected research areas. CiteSpace has become the most influential visualization software in recent years (Zhou et al., 2020) because of its ability to analyze the covariance and emergence between authors, institutions, countries, keywords, and journals to reveal the frontier dynamics and trends of different research topics.

2.3 Procedure

The 1456 documents were exported to CiteSpace software in plain text file format, with the time set to "2000–2022" and the "Time Scaling" value set to 1, representing a time slice of 1 year. The software was used to analyze the statistics and organize the visualization to form a knowledge map of the literature on information teaching from 2000–2022, to better show the trends in research.

3. Results

3.1 The Overall State of Information Education Research

3.1.1 Time Map

Looking at the annual distribution and growth of the 1456 publications in Figure 1, we see that the number of publications peaked in 2016 and 2020, with 31 and 453 articles respectively. Taking these two key years as nodes, we can divide the research on IT teaching competency into three stages. The first stage is the slow development period from 2000–2015, where there is research on IT teaching competency starting in 2008, and the number of articles published in the following 15 years does not exceed 10 per year. The second stage is the period of rapid growth from 2016–2019, starting from 31 articles in 2016 to 143 articles in 2019, with the number of articles published each year basically in a state of steady growth. The third phase is the peak dividend period from 2020–2022. As countries around the world continue to focus on information technology and information teaching, 2021 is the year when the highest peak of 453 articles is reached; a third peak is expected after 2024.

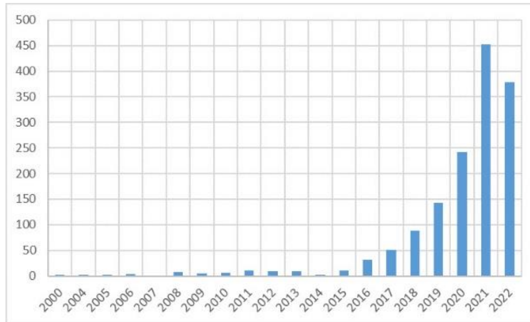

Figure 1. Number of Publications and Trends in Information Education from 2000 to 2022

3.1.2 Leading Authors

In CiteSpace, we set the period to 2000–2022 and the analysis item to “Author,” then ran the software to visualize and analyze the researchers’ collaboration. The relationship network map of the researchers is shown in Figure 4. The minimum number of publications by core authors was calculated using the Price formula (M = 0. 749×√Nmax). Authors with M or more publications were considered core author candidates (Zhou et al., 2020). The author with the highest number of publications were J. Li (LI J) with a total of 13 publications; the minimum number of publications for core authors was calculated as $M \approx 2.7$. The total number of authors with three or more publications is 164, with a total of 381 publications, accounting for about 25.05% of the total, which is below the 50% benchmark required by Price’s law, so it can be judged that a core group of researchers has not yet been formed. The top 10 authors in terms of the number of articles published and their number of articles published are shown in Table 1.

Table 1. Core Author Statistics (10 Representatives with 3 or More Publications)

Rank	Count	Year	Authors	Rank	Count	Year	Authors
1	13	2009	LI J	6	4	2020	GAPSALAMOV A
2	7	2021	LIU Y	7	4	2021	CHEN L
3	6	2021	WANG X	8	4	2022	LI Y
4	6	2020	VASILEV V	9	4	2022	LI X
5	5	2020	AKHMETSHIN E	10	4	2020	BOCHKAREVA T

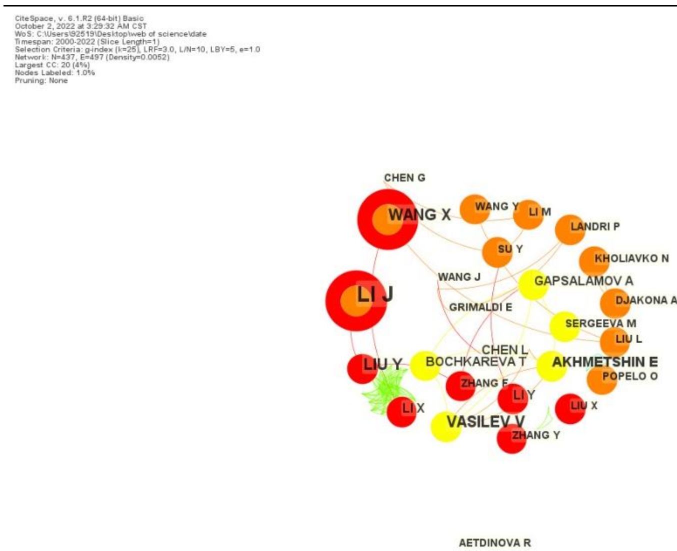

Figure 2. The Collaboration Network Map of the Core Authors of Information Education Research

3.1.3 Leading Institutions

The scientific knowledge graph analysis software was then set to "Institution," with other settings left unchanged by default; the co-occurrence graph of the issuing institutions was thus plotted (Figure 5), showing that the number of articles issued by the top 10 issuing institutions ranged from 8 to 30, with a total of 382 nodes and 416 links, with a network density of 0.0057. The attributes of the institutions were Kazan Federal University (KFU), Russian State Social University (RSSU), and Financial University under the Government of the Russian Federation (FinU).

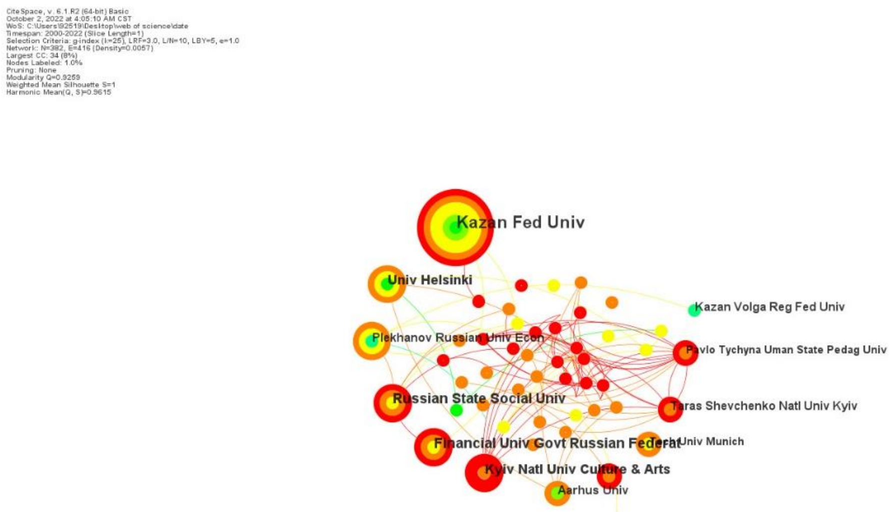

Figure 3. The Collaboration Network Map of the Core Institutions for Information Education

3.1.4 Leading Countries/Territories

Setting the Scientific Knowledge Graph Analysis software to "Country," with other settings left unchanged by default, yields a co-occurrence map of countries or regions (Figure 4), with a total of 95 countries and regions, 61 of which published more than three articles and 36 of which published more than ten articles. Figure 4 shows the mapping of the network between countries or regions, and the strength of the links shows the strength of the collaboration. It can be seen that Russia, China, Germany, and Ukraine have a high number of publications, while Canada and the United States had the earliest studies.

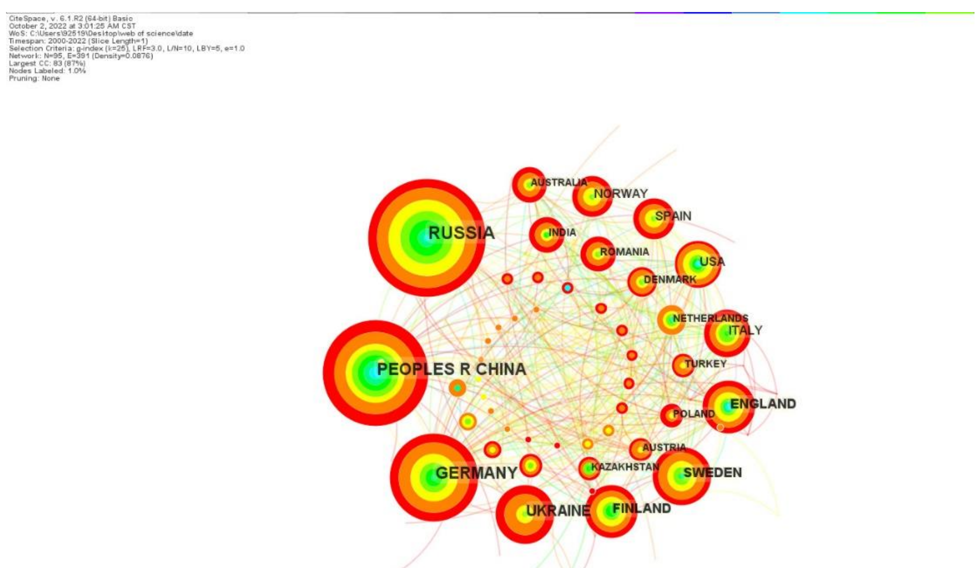

Figure 4. The Collaboration Network Map of Core Countries or Territories for Information Education Research

3.2 Research Hotspots and Frontier Developments in Information Education

3.2.1 Keywords Knowledge Map

The keywords are a high-level summary of the information in a given article and reflect the core ideas of its thesis. In the CiteSpace software, the node type was selected as “Keyword” and the rejection function was set to “Pathfinder+ Pruning.” The higher the frequency, the larger the corresponding nodes. After eliminating similar terms, we observed that, in addition to the search terms, words such as “acceptance,” “technology,” “education,” “information technology” and “digital competence” were consistently prominent keywords. The frequency, year of first publication, and centrality statistics of the top 10 high-frequency keywords are shown in Table 2; the centrality of high-frequency keywords is not necessarily objectively high, meaning that the frequency and centrality of the keywords are inconsistent. The centrality represents the strength of the keyword’s ability to act as a mediator in the colinear network relationship. These central keywords were “education,” “information technology,” “digital competence,” “computer,” “behavior,” and “cloud computing.”

Table 2. Top 10 Keywords by Frequency

R	K	F	C	R	K	F	C
1	acceptance	11	0.32	6	computer	6	0.15
2	technology	103	0.27	7	behavior	9	0.1
3	education	118	0.2	8	cloud computing	7	0.1
4	information technology	54	0.18	9	management	31	0.09
5	digital competence	24	0.15	10	attitude	12	0.09

Note. Description: R = rank; K = keyword; F = frequency; C = centrality

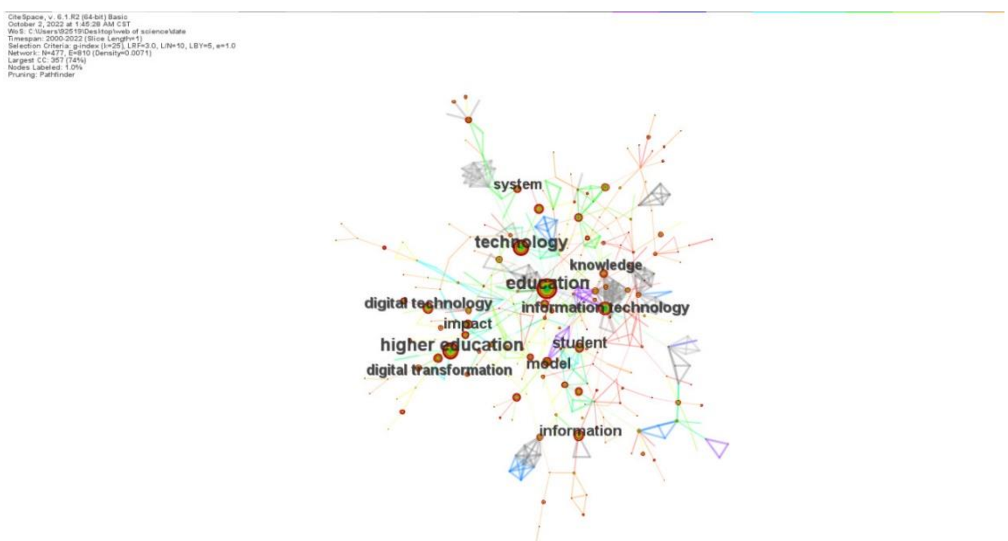

Figure 5. Keyword Colinear Mapping

3.2.2 Keyword Clustering Knowledge Map

Cluster analysis assembles a collection of similar research objects, focusing on the structural features between clusters, highlighting key nodes and important connections to reflect current hot research topics (Tan, 2022). Cluster analysis was conducted using the log-likelihood method (LLR); the resulting keyword clustering map is shown in Figure 6. We found 14 clustering modules with a modularity Q of 0.8419, which is much higher than the critical value of 0.4, indicating that the network size of the clusters is closely related. The mean silhouette of 0.9167, much higher than the critical value of 0.5, indicating that the clusters are in the credible interval and the clustering quality is relatively high. The specific information for each clustering module in Figure 5 is collated in Table 3.

Table 3. Specific Information on the Keyword Clustering Module

Cluster-ID	Size	Mean (Year)	Top Terms (Lsl)
0	50	2018	digitalization of education (26.56, 1.0E-4); digital technologies (24.26, 1.0E-4); covid-19 pandemic (16.15, 1.0E-4); teacher education (12.1, 0.001); remote learning (12.1, 0.001)
1	31	2016	economic growth (21.02, 1.0E-4); adult education (10.49, 0.005); business schools (6.82, 0.01); lifelong learning (5.25, 0.05); network teaching platform (5.24, 0.05)
2	29	2018	industry 4.0 (20.5, 1.0E-4); cloud computing (19.2, 1.0E-4); engineering education (18.3, 1.0E-4); big data (16.02, 1.0E-4); online learning (11.09, 0.001)
3	28	2013	information technologies (20.43, 1.0E-4); informatization of education (12.08, 0.001); patient preference (9.66, 0.005); choice (9.66, 0.005); discrete-choice experiment (9.66, 0.005)
4	27	2015	media education (43.55, 1.0E-4); digital literacy (32.94, 1.0E-4); media literacy (14.07, 0.001); digital skills (12.89, 0.001); mass media (12.37, 0.001)
5	26	2014	higher education (34.01, 1.0E-4); augmented reality (15.86, 1.0E-4); digital pathology (8.39, 0.005); 21st century skills (8.39, 0.005); case study (8.39, 0.005)
6	23	2019	computer literacy (11.26, 0.001); medical education (11.06, 0.001); digital learning (10.8, 0.005); e-learning (7.55, 0.01); learning technologies (5.96, 0.05)
7	22	2015	digital divide (55.87, 1.0E-4); digital inclusion (8.12, 0.005); ICT (7.43, 0.01); digitalisation threats (6.75, 0.01); multivariate analysis (6.75, 0.01)
8	21	2018	digital environment (7.98, 0.005); a (5.84, 0.05); education management (5.84, 0.05); posture (5.84, 0.05); assessment (5.84, 0.05)
9	21	2011	artificial intelligence (39.87, 1.0E-4); 3d printing (17.48, 1.0E-4); surgical training (6.32, 0.05); preventive health services (5.81, 0.05); scientific and pedagogical research (5.81, 0.05)
10	20	2019	education system (17, 1.0E-4); online education (12.62, 0.001); sustainable development (12.62, 0.001); communication technologies (11.32, 0.001); educational process (10.51, 0.005)
11	19	2021	industry 4 (15.73, 1.0E-4); 0 (13.41, 0.001); digital twins (6.45, 0.05); circular bioeconomy (6.45, 0.05); maritime education (6.45, 0.05)
12	18	2018	distance education (24.58, 1.0E-4); learning analytics (17.89, 1.0E-4); distance learning (12.03, 0.001); social media (9.42, 0.005); palliative care (5.95, 0.05)
13	13	2013	digital radiography (13.41, 0.001); professional development (12.96, 0.001); digital competence (12.04, 0.001); educational system (8.01, 0.005); digital competences (6.89, 0.01)
14	9	2018	digital economy (36, 1.0E-4); digital transformation (20.54, 1.0E-4); digital competencies (15.87, 1.0E-4); economic development (11.62, 0.001); internet of things (8.33, 0.005)

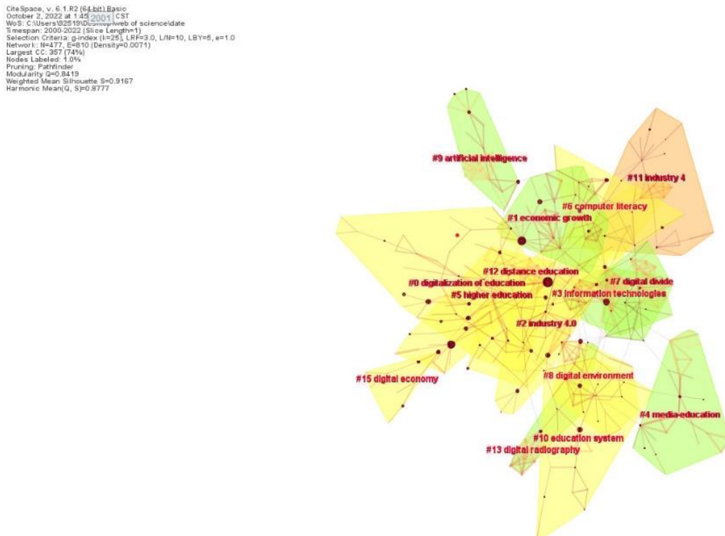

Figure 6. Keyword Clustering Mapping

3.2.3 Hot Topics

The higher the burstiness of a burst word, the more prominent the academic attention paid to the keyword, and the more representative it is of the latest research developments and trends in the period (Zuo et al., 2021). Using the Business function in the control panel of CiteSpace, the interval was adjusted to 0.7 and 11 keywords were obtained (Figure 7). The colors of the interspersed lines indicate the start and end of the keyword emergence, e.g., the emergence period of "information society" is 2006–2018. Combining Figure 7 with the sample of relevant literature, it is possible to divide the main history of research on IT teaching competencies into three phases, each focused on a different topic.

The first phase occurs from 2006 to 2013, during which the terms "information society," "media literacy" and "information technology" emerged. The academic focus, we can infer, was on the development of information literacy among citizens in the context of the information age. The second phase, from 2014 to 2018, saw the emergence of "media education" "computer," and "information and communication technology," among others; information technology was increasingly seen as a necessary skill in the twenty-first century, and so the research began to focus on the sustainable development of information technology skills in the future society. The third phase is from 2019 to 2022, during which the terms "network," "reform," "informatization of education," and "ICT," began emerging. As can be seen from Figure 7, only the study of "digital education" continues to date.

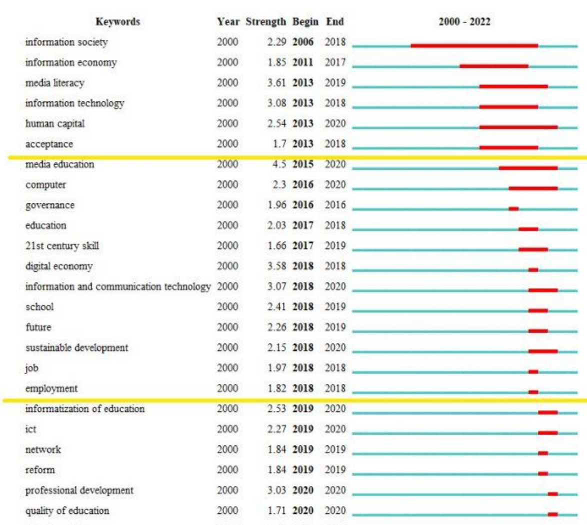

Figure 7. Keyword Emergence Mapping

3.2.4 Trend Analysis of Research Subject Terms

The temporal map reflects the evolution of knowledge from the time dimension, showing the updates and interactions of documents. Based on the common line of keywords, "Tendency Zone" is chosen to draw the keyword time zone map of higher vocational information technology teaching capability from 2000 to 2022 (Figure 8). We can see the focus of research in different periods: technology from 2000 to 2008; education, information technology, perspective, and innovation from 2009 to 2015; and shifting from 2016 onward to policy, impact, literacy, and work.

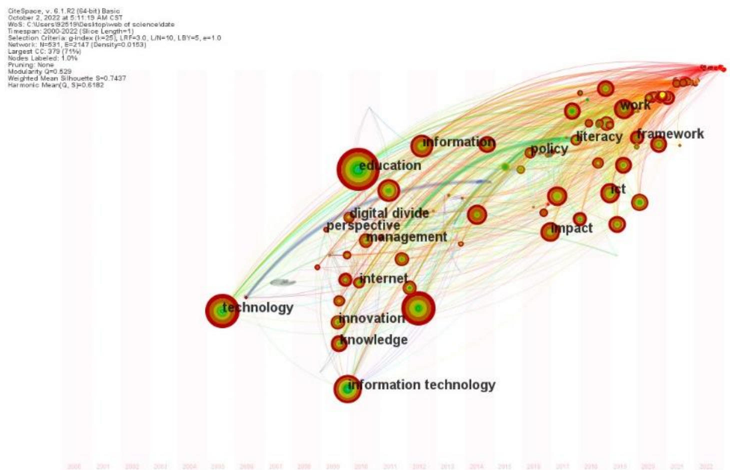

Figure 8. Keyword Time Zone Map

4. Discussion

The first phase of research into information teaching and learning saw researchers suggesting that emerging information technologies were having an impact on teaching, the classroom, and the way students learn, and reflecting on the educational issues that might arise. Gannon-Leary and Carr (2010) suggest that ICT should not only be used as a simple learning aid, but as an important tool in the development of learning objectives and processes with learners. Munnelly et al. (2012) argue that concepts based on "AR" technology can help move teaching and learning away from the traditional classroom, allowing learners to learn anywhere and at any time, and helping students to better express themselves and build a student-centered model of teaching and learning. Augmented reality (AR) technology, for instance, can facilitate the development of students' critical thinking and provide more personalized learning resources. Dearnley et al. (2006) found that the biggest barrier to students using online learning resources was skills acquisition, and that many students chose learning activities that were directly related to assessing "success" rather than those directly related to personal skills development, so changes in information education need to be accompanied by appropriate assessment options.

In the second phase, with the continuous development of information technology and its role in all walks of life, research on information education has also begun to face the needs of the future digital society and carry out a series of practical explorations. Gravemeijer et al. (2017) proposed that policymakers develop curriculum reforms and teaching practices to meet the needs of the twenty-first century digital society and to prepare students with information skills necessary for their future survival in a digital society. Tian et al. (2017) posited a curriculum design model, based on the technological pedagogical content knowledge (TPACK) theory, that can stimulate students' interest in learning and improve the effectiveness of classroom teaching. TPACK organically integrates teaching techniques, teaching methods, and teaching contents, combining student-led and teacher-led teaching models to influence students' learning. The teacher-led teaching model influences student learning. Li (2017) suggests that school digitalization and information literacy are important areas of focus for teacher development for different audiences, as learners can make the necessary changes based on the demands of the workplace to achieve professional satisfaction and enhanced professional self-efficacy, which in turn enhances the learners' ability to do their jobs. Online interactive courseware, a product of interactive media, is used as a way to inform education and enhance teacher-student and student-student interaction through flipped classrooms to achieve better teaching and learning outcomes.

With the explosion of COVID-19 at the end of 2019, the development of informal education has also reached its third-stage peak. It is now commonplace for higher education institutions to be transitioning from campus-based education to online education on different platforms and modes; the focus of distance education has shifted from using the "right equipment" to the ways information technology can be integrated to support teaching and learning, where understanding students' learning methods and choosing appropriate teaching and learning strategies become essential. As digital technologies continue to evolve, the framework for higher education is changing (Bostroem et al., 2021). For instance, in the wake of the COVID-19 pandemic digital distance learning has become one of the main models of vocational education in Germany. Delcker and Ifenthaler (2022) conducted a large-scale survey of nearly 4,000 stakeholders from 15 vocational schools in Germany to analyze the eight elements of digital distance learning: teaching, feedback, organization, collaboration, personal resources, technological infrastructure, perceived learner success, and professionalization. By developing these elements, school administrators and leaders can translate the experience of digital education into sustainable education for their schools. Collecting firsthand data through semi-structured online interviews and written reflections, Nicklin et al. (2022) discussed the issues and lessons learned from the rapid shift to online digital learning in higher education in the United Kingdom following the COVID-19 pandemic—assessing technological barriers to students' online learning, providing students with appropriate digital information learning support, and interactive teaching and learning tools for teachers, among others. Christensen et al. (2022) presented a qualitative analysis based on which teachers should build their capacity to interact and connect with students during online teaching, clarify the perceived connections between professional understanding as well as online teaching, and explore the practical implications of developing online teaching.

5. Conclusion

Through the sample processing and analysis of CiteSpace software, it can be found that countries have uncovered certain research results on information teaching, which provides scientific theoretical guidance and practical reference for information teaching in countries all over the world. On this basis, the following conclusions are given in conjunction with research hotspots and keyword emergence analysis.

5.1 Research Trends in Information Education Over the Past Two Decades

Over the past two decades, research in information education has undergone three distinct phases. In the first phase, researchers acknowledged the transformative potential of emerging information technologies in the realm of teaching and learning. They explored how technology could reshape the traditional classroom, offering students greater flexibility in their learning processes. This phase also brought to light challenges, particularly concerning skills acquisition and assessment methods.

The second phase of information education research responded to the expanding role of information technology within society. The TPACK theory played a pivotal role in designing curricula aimed at fostering student engagement and enhancing teaching effectiveness. It entailed the integration of student-led and teacher-led teaching models to positively influence student learning.

The third phase, catalyzed by the onset of the COVID-19 pandemic, marked the zenith of informal education development. Online education swiftly transitioned into the new norm within higher education, a trend that has persisted. This phase has seen an extensive exploration of various aspects of online education, including the assessment of technological barriers, the provision of digital information support for students, the development of interactive teaching and learning tools, and the enhancement of teachers' capabilities for online instruction.

5.2 Deepening the Connotations of Information Education Capability Based on TPACK Theory

The current challenge facing instructors at higher vocational institutions is how to deeply integrate information technology and professional teaching. With the help of TPACK theory, we can explore teaching modes to bring about the deep integration of teaching information technology and subject teaching. Three core elements in TPACK theory cross to form three compound elements, and the three compound elements combine to integrate the subject teaching knowledge of technology: Break the mode of "traditional teaching + informatization resources" and sort out and reconstruct the framework of informatization teaching ability in higher vocational institutions; use information technology to create high-quality classroom teaching, analyze the important and difficult points of teaching and teaching design; and promote the deep integration of education and teaching with information technology.

5.3 Future Trends in Information Education

The future promises significant transformation driven by artificial intelligence technology. Countries worldwide are proactively exploring the applications of artificial intelligence within the field of education. As the future of digital technology shifts towards AI, education managers and leaders can explore the development of training models tailored to different professional characteristics, thus creating human-centered, intelligent teaching and learning management models. Promoting the renewal of teachers' perceptions of education, enhancing their sense of identity and urgency in the concept of AI education, and using AI knowledge and application tools to solve problems will improve the adaptability of educational technology in teaching life.

6. Limitations and Recommendations

6.1 Limitations

This study has some limitations. Firstly, the CiteSpace analysis in this study is primarily based on the Web of Science literature database, which restricts our comprehensive understanding of the field of information education. Due to limitations in the coverage and content of the database, our results may not reflect all the research and trends in this field. Secondly, the CiteSpace analysis tool can only analyze literature data within a specific timeframe. Thus our results are constrained by the chosen time range, and cannot represent an exhaustive analysis of long-term trends in the field of information education. When selecting the timeframe, we need to strike a balance between the timeliness of the research question and the understanding of long-term development, which may result in oversights or incomplete presentation of certain trends.

6.2 Recommendations

Given the findings and limitations of this study, it is recommended that future research should consider the following suggestions in conducting a more comprehensive exploration of the information education field.

First, researchers should contemplate the integration of data from various literature databases to attain a more holistic perspective of the field of research. Relying on a single database (such as Web of Science) restricts the depth of understanding and breadth of insights attainable.

Second, for a more profound comprehension of the long-term trends within the information education domain, it is advisable for future studies to analyze literature spanning different timeframes. This approach will facilitate tracking of the field’s the evolutionary trajectory and the capture of enduring developmental patterns.

Lastly, in addition to quantitative analysis, it is recommended that future research incorporate qualitative research methodologies, such as in-depth interviews and content analysis. Qualitative methods provide a deeper understanding of the field’s underlying issues and emerging trends, thus offering a more comprehensive view of the landscape.

By embracing these suggestions, future research endeavors can enhance our comprehension of the development, challenges, and opportunities in the field of information education. This, in turn, will foster further advancement and innovation in the domain.

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