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Development History, Hotspots Analysis, And Trends Of Pre-Service Teacher Education At Home: A Quantitative Analysis Based On Citespace

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ABSTRACT

Purpose Pre-service teacher education is pivotal in shaping the historical trajectory of education both domestically and internationally. **Methodology** This study utilises Citespace software to analyse literature sourced from CNKI (China National Knowledge Infrastructure) and Web of Science, encompassing the period from 2003 to 2023, to examine the developmental history of pre-service teacher education both in China and globally, while identifying key evolving nodes in this field. **Findings**. Results reveal that domestic educational reforms have facilitated innovative approaches to teacher training models and the revitalisation of educational philosophies. In contrast, international pre-service teacher education prioritises the enhancement of teachers' professional attributes and instructional competencies, advocating for practice-oriented methodologies and the integration of pedagogical principles. **Implications for research and practice.** Regarding research focal points, both domestic and international contexts highlight significant themes such as curriculum reform, teacher evaluation, and professional development. Moreover, the emergence of digital technologies has introduced new considerations for teacher education. Looking forward, trends in pre-service teacher education are anticipated to centre on deepening practical engagement and innovating educational theories, alongside fostering international collaboration to collectively advance the field of teacher education.

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Introduction

The developmental history of pre-service teacher education (PSTE), both domestically and internationally, has undergone a process of localisation of global educational philosophies, practices, and policies. Throughout this evolution, Western PSTE has frequently been utilised as a benchmark to evaluate the quality of non-Western PSTE, often perpetuating conventionalised representations of the ideal teacher and teacher education

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(Codd, 2005). The global teacher education reform movement (GTERM), which transpired from the mid-1980s to the mid-2000s, was not a singular movement but rather one primarily led and supported by international organisations such as UNESCO, the World Bank, and the OECD, along with Western aid organisations, all aligned with the Education for All (EFA) goals. This movement was characterised by cross-national policy borrowing and lending, the introduction of global educational governance elements into various countries, and the alignment of educational reforms with the policy requirements of aid donors. GTERM has yielded both positive and negative effects on PSTE across different countries. Currently, it is perceived to be in a state of complex transition and reflection, prompted by lessons learned during its implementation and its varied impacts on educational systems. In the present international landscape, it is essential to reconsider and redefine the roles and objectives of PSTE in numerous countries, with a particular emphasis on the interplay between local and global contexts in the advancement of teacher education (Jing et al., 2019).

The analysis of global research hotspots in PSTE provides insights into research foci and their responses to evolving social and educational contexts. This overview offers researchers a broader perspective on the research landscape and heuristic suggestions (Kang & He, 2018). Global research communities can benefit by identifying general trends and assessing the significance of their work in both local and global contexts. The analysis process can vary from basic mapping to more complex examinations of the flow of ideas and their micro-level impacts. This study will employ the Post-Keynesian Societies of Science paradigm to explore the relationship between natural and social science research and education and their influence on material and social outcomes, as well as institutional and cultural changes. Furthermore, advancements in technology and shifts in educational paradigms have significantly transformed pre-service teacher preparation, making it crucial to understand its historical evolution, current research hotspots, and emerging trends both locally and globally (Bai et al., 2021).

The reform of the domestic education system has created opportunities for pre-service teacher education, fostering innovation in teacher training models and the renewal of educational philosophies. Since the implementation of the reform and opening-up policy, the Chinese education system has progressively moved towards a quality education-centric model. In this context, pre-service teacher education has received considerable attention and support (Jones et al., 2010). In response, the government and educational authorities have introduced a series of policies and initiatives aimed at enhancing the reform and development of normal colleges and universities, thereby improving the quality and effectiveness of teacher training.

In contrast, pre-service teacher education internationally emphasises the cultivation of teachers' professional qualities and teaching skills, advocating for practice-oriented approaches and the integration of normal education. Many developed countries have engaged in extensive research and practice in teacher education, exploring innovative training models and methods (Park et al., 2022). They prioritise the integration of theory and practice, offering abundant internship opportunities to develop teachers' practical experience and adaptability to modern educational needs. Both domestic and international research hotspots concentrate on curriculum reform, teacher evaluation, and professional development. With the evolving educational philosophies and changing societal demands, teacher training content and methods are continuously refined (Gozálvez-Pérez, 2011).

Furthermore, the rise of digital technology has prompted new considerations in teacher education, leading the sector to explore how to incorporate digital tools to enhance teaching effectiveness and foster educational innovation. This paper employs the CiteSpace literature visualization analysis tool to delineate the research focuses of domestic and international studies, aiming to inform future research on pre-service teacher education in China.

Understanding the historical development of pre-service teacher education provides a valuable context for examining changes in curriculum design, instructional strategies, and educational legislation. This historical perspective elucidates the developmental trajectories that have shaped the profession over time, offering critical insights into the foundations of contemporary educational practices. By analysing past trends in pre-service teacher education, teachers and policymakers can discern patterns of innovation, adaptation, and transformation. Furthermore, tracking the historical progression of teaching methodologies—from traditional lecture-based instruction to more student-centred and inquiry-based approaches—enables stakeholders to comprehend the driving forces behind pedagogical change and the impacts of various instructional strategies. Investigating the historical evolution of curriculum design highlights the shifting ideologies and objectives that have influenced teaching content and methods. This evolution reflects broader cultural trends, educational philosophies, and pedagogical theories, evidenced by the transition from an early emphasis on content knowledge to the integration of interdisciplinary and project-based learning.

By analysing previous achievements and challenges in pre-service teacher education, stakeholders can derive valuable insights for future strategies and initiatives. For instance, understanding the impacts of earlier innovations or reforms can aid policymakers in anticipating potential outcomes and mitigating unintended consequences in forthcoming policy decisions. Additionally, educators can leverage historical perspectives to enhance their teaching methodologies, adapt curricula to better meet the evolving needs of learners, and advocate for institutional changes to address persistent issues in teacher training. The concept mapping knowledge base posits that development entails a continuous process of change and progression from one state to a more advanced state, whether concerning an idea, design, or object. Selwyn (2007) and other scholars in the history and philosophy of science have employed the term "development" within the framework of Kuhn's theory of paradigm shifts in science, which reflects a particular understanding of the concept. Since its emergence as a field of study in the late 1960s and early 1970s, driven by the pioneering efforts of Su and Lee (2010) concept mapping has primarily been utilised within higher education. However, there is no evidence to suggest that children cannot also benefit from learning to create concept maps as a means to organise their knowledge and prepare for examinations. Such tools may also assist in diagnosing children's understanding and misconceptions regarding specific topics. As educators increasingly recognise the significance of metacognition and knowledge construction, concept mapping has been embraced as a valuable tool for students and teachers across all educational levels. Furthermore, documenting the application of concept mapping in organisational settings. The influence of these diverse applications and their expansion into various sectors suggests that concept mapping is an evolving practice. Consequently, the tools developed for constructing and visualising concept maps are expected to adapt to meet the specific needs of users and the contexts in which the maps are created and employed.

Research Hotspots Analysis

Research hotspot analysis provides valuable insights into the current state of pre-service teacher education research. By identifying significant themes, focal areas, and emerging trends, researchers can effectively allocate resources, prioritise research initiatives, and address pressing challenges within the field.

Exploration of Trends Prospect

A forward-looking perspective on developments in pre-service teacher education can provide valuable insights. By anticipating potential changes and forecasting future challenges, educators and policymakers can proactively adjust their policies to align with the evolving needs of students, teachers, and educational institutions.

Role of Visualization and Quantitative Analysis

A comprehensive understanding of the pre-service teacher education research landscape necessitates the integration of both quantitative analysis and visualisation techniques. By employing tools such as CiteSpace, researchers can visualise complex data, identify trends, and draw evidence-based conclusions. This approach not only aids scholars in making informed decisions but also fosters academic discourse within the field.

Evolution of Pre-Service Teacher Education

In the mid-20th century, universities experienced a surge in teacher education aimed at enhancing the status and quality of teachers through improved academic qualifications. This movement was marked by debates over whether subject matter knowledge or pedagogical expertise was more essential, reflecting the tension between viewing teaching as a learned profession versus a technically skilled occupation. In many countries, including the UK, the initial phase of PSTE involved training non-graduate teachers in "teacher training" institutions until the 20th century. Typically, these training programmes were based on assumptions about prospective teachers' abilities and needs, often neglecting to enhance their academic skills or subject knowledge. This approach persists in many countries and cultures today.

The modern period has shifted towards preparing teachers to adapt to and influence change in their students and societies, presenting significant challenges for education systems and teacher educators. This has highlighted a tension between developing general theories of teaching and learning applicable to all teachers and producing specific knowledge tailored for individual educators. Recently, this has manifested as a conflict between advocating for a knowledge base in teaching and learning and deriving insights from targeted research on effective teaching practices. The evolution of PSTE can be categorised into three distinct periods, each defined by a dominant educational philosophy. The first period, known as the traditional period, was primarily guided by the philosophy of essentialism. The second, termed the transitional period, was characterised by reconstructionism, while the third period, identified as the modern period, is characterised by reflective liberalism. During the traditional and transitional periods, efforts to enhance the quality of teachers largely focused on improving their academic abilities and professional skills, often based on assumptions regarding the nature of

teaching and the significance of specific teacher characteristics. The contemporary concept and practice of PSTE are significantly shaped by educational psychology and are closely aligned with evolving trends in educational philosophy.

Literature Review

Jin and Jian (2024) conducted a study on the Learning Cycle Model (LCM), a research-based teaching method that has positively impacted science education in primary and secondary schools for nearly fifty years. This study utilised bibliometric analysis with the CiteSpace program to provide a comprehensive overview of recent developments and research trends in LCM. The analysis examined 498 publications from the Web of Science core collection from 2000 to May 16, 2023, focusing on publication patterns, authors, countries, and research institutions. Additionally, keyword co-occurrence and clustering maps were created to identify key topics and future directions in LCM research. The findings highlighted current areas of interest, including authentic learning, integration with other teaching methods, and teacher professional development. The study suggests potential future research topics, such as the impact of LCM on 21st-century skills and comparisons with other inquiry-based teaching approaches.

Li et al. (2023) examined the development of high-quality rural teachers in China, which is predominantly reliant on the rural teacher development system. This study aims to investigate the current rural teacher development strategy in China through bibliometric analysis. The dataset was sourced from the Web of Science (WoS) core collection, employing advanced retrieval features for the literature data, with the retrieval period aligned with the selected publications. Utilising CiteSpace, the analysis encompasses geographical perspectives, research paradigms and philosophies, research themes, hotspots, keyword co-occurrence, and the evolution of research interests within China's rural teacher development strategy (Kang & He, 2018). The findings indicate that as the development and transformation of rural primary education progress, scholars are increasingly focusing on data-driven, diverse empirical studies, as well as exploring the complex dynamics of rural teacher policy.

Wei et al. (2023) investigate the increasing focus on teacher perception as a component of teacher competence in mathematics education through a bibliometric study. This research analyses the current state, hotspots, and development trends of teacher perception in mathematics, providing a resource for future studies on mathematics teachers' observational skills. Articles from the Scopus database, published between 2006 and 2021, were examined using bibliometric tools such as CiteSpace and R to assess publication trends, research characteristics by country and institution, core journals, keyword co-occurrences, and citation analyses. The findings indicate a growing awareness among mathematics teachers about the importance of publications, yet significant gaps remain in the knowledge base. The United States, led by UC Irvine and North-western University, is the frontrunner in this field. The primary research focus identified is on the structure of teacher training, utilising video as a research tool, with future teachers as participants, aiming to enhance teaching skills. The study highlights a lack of regional and global collaboration and offers recommendations for future research directions.

Jian et al. (2023) explore the LCM, a research-based teaching strategy that has positively impacted science education over nearly fifty years, particularly in primary and secondary

schools. This study employs bibliometric analysis via CiteSpace to map the evolution of LCM and identify current research trends and hotspots, analysing 498 publications from the Web of Science from 2000 to May 2023. The research examines publication patterns, authors, countries, and institutions to determine the direction of LCM research. The findings highlight key areas of interest, including conceptual learning, legitimacy research, and integration with other teaching methods. The study focuses on teacher professional development and the impact of LCM on learning outcomes, concluding with suggestions for future research topics, including LCM's role in developing 21st-century skills and its application in engineering education.

Aim and Objective

To establish a robust foundation for visualization studies and effectively delineate the intellectual milestones within a research domain, it is essential to review relevant literature and identify the cognitive underpinnings of a scientific field. Research hotspots emerge, evolve, and transform rapidly over time. Consequently, this study seeks to conduct a historical review of the development of pre-service teacher education both domestically and internationally, employing visualization techniques within the knowledge domain. Based on this database, the study aims to identify document and citation hotspots in this area of research. This investigation is guided by the following questions.

- What are the various developmental trajectories of pre-service teacher education both domestically and internationally?
- What document and citation hotspots can be identified across different stages of bilingual comparison?
- What differences exist across various stages, and what is the current status of pre-service teacher education?
- What are the emerging trends in the development of pre-service teacher education at both domestic and international levels?

Research Methodology

Research Tools

The development history, research hotspots, and trends can be effectively illustrated using a visualization knowledge domain map. Various methods for knowledge domain analysis include Citespace, HistCite, Pajek, and Ucinet, with this study employing Citespace. This tool identifies research hotspots and trends by detecting citations in documents, allowing for note-taking and exporting maps to text formats. Citespace is user-friendly yet comprehensive, making it ideal for examining the development history and research trends in a discipline.

CiteSpace, developed by Professor Chaomei Chen at Drexel University, is an information visualization tool designed for analysing scholarly literature. This article employs CiteSpace to visually map and assess domain-specific literature, uncovering key developments and turning points in subject areas while identifying potential mechanisms of disciplinary evolution and research frontiers. The study utilises CiteSpace to arrange and analyse teaching evaluation in the context of big data, focusing on authors, institutions, keywords, and timelines to summarise hotspots and emerging research trends in the field.

Data Sources

Data on pre-service teacher education, both domestically and internationally, was collected through a simultaneous lookup and retrieval methodology from the Web of Science Core Collection, CNKI, and ERIC databases, covering the period from 2013 to 2022. This timeframe was selected to facilitate an in-depth longitudinal study, as pre-service teacher education is an emerging discipline in many countries. To ensure comprehensive coverage, both "topic" and "title" searches were conducted using a combination of keywords and operational definitions. The data retrieved from the Web of Science Core Collection was downloaded into a text file, imported into MS Access, and saved in a new document. Given the limited search term capacity of the Web of Science Core Collection, the retrieval was performed in three stages, with outputs merged into a single file. For instance, the combination of keywords (preparation OR preservice) AND (teacher OR instructor) was employed, initiating the search with (preparation AND teacher) in the first stage. Relevant records were marked and saved, after which the search was cleared and repeated with (preparation AND instructor), merging the resulting files. A similar methodology was utilised for the title search, while retrieval from the ERIC database employed the same combination of search terms, ensuring comprehensive coverage of the literature in the field. The keywords utilized were (1) Preservice teacher OR preservice teacher education and (2) student teacher, representing the core themes of pre-service teacher education. These keywords are commonly found in the titles and abstracts of relevant articles. The output was saved in text format and imported into MS Access, with the marked list saved at each stage. This iterative approach maximized the search term capacity, which would have been limited by a simultaneous multi-keyword search. Both the Web of Science Core Collection and ERIC provided functionality to update the search results.

The CNKI was the primary search database used to ensure comprehensive coverage of essential literature. We searched for literature from 2003 to 2023 using the keywords "big data" and "teaching evaluation," selecting SCI and Peking University core CSSCI as publication sources. After manually excluding conference announcements and irrelevant materials, we identified 325 relevant documents, including master's and doctoral theses, that met the precise search criteria. The data were then stored and exported in Refworks format from CNKI. In this study, the frequency of terms within the domain of "big data and teaching evaluation" was analysed using CiteSpace software. A co-occurrence analysis was also conducted to identify research hotspots and developmental trends in this area. The Time Slicing parameter was configured to span from 2003 to 2023, with "Node Types" set to Keyword, Author, Institution, and "Top N" set to 50. The pruning approach employed was "Pruning Sliced Networks," focusing on the specified node types of Keyword, Author, and Institution.

Data Collection

Unlike databases such as SCI and Scopus, the majority of articles indexed in the SSCI focus on the humanities and social sciences, particularly in the context of writing for digital education. Alotaibi's findings reveal that authors publishing in non-SSCI journals employed monoglossic choices nearly three times more frequently than those in SSCI-ranked journals (1.36% versus 0.493%). This aligns with Mei's research, which indicated

that lower-rated student essays contained more instances of monoglossic references compared to higher-rated papers, characterising the research within the SSCI database as more conventional. Additionally, while Scopus, introduced by Elsevier in November 2004, encompasses a wider range of journals, its impact is lesser and limited to more recent articles. In contrast, the SSCI, established in 1956, includes a substantial number of journals, encompassing 1,809 of the leading social science journals globally in full text by 1999. Therefore, this study focuses exclusively on literature from the SSCI database to enhance specificity, as the literature review commenced in 2000. Unlike the approach taken by Fu et al., this research adopts a more targeted data collection strategy, utilising the SSCI database within the Web of Science (WOS) core collection as its data source. The search terms permitted in the database included "digital education," "Educational Transformation," "Digital Educationization," "Digitalization in education," "Digitalization of Education," and "Transformation of Education."

Analytical Methods

CiteSpace and Setting

This study employed a bibliometric approach, defined as "a writing survey through numerical and measurable strategies." Led by Prof. Chaomei Chen, the research team used CiteSpace (6.1.R2) as an econometric analysis tool to examine the data in a multivariate, time-sliced, and dynamic manner. A one-year time slice was selected, with the Top N% selection model set to 25% and visualization options configured for "Static" and "Show Combined Organization." The analysis focused on authors, institutions, countries, co-occurrence of keywords, citation patterns, and other aspects of the literature on digital education research to identify trends, developmental history, research frontiers, and hotspots in the field.

Paths of Analysis

This study employed the analytic features of CiteSpace to conduct a comprehensive examination of the trajectory and trends in digital education research from three key perspectives.

1. Fundamental Data Analysis for Online Learning: This analysis provided an overview of the digital education landscape, encompassing aspects such as the number of publications, authors, countries, and institutions.
2. Review of Research Hotspots in Digital Education: By analysing time zone maps and keyword co-occurrence, we identified the primary themes, core topics, and areas of significant interest in digital education research since 2000.
3. Survey of Directions and Patterns in Digital Education Research: This aspect involved examining a collection of co-cited core publications and their references to delineate research frontiers. References frequently cited were filtered based on these clusters, which were established through the clustering and analysis of co-cited references. A detailed review of these publications illuminated current research boundaries in digital education. Additionally, through the application of citation burst analysis, we identified fluctuations in citation patterns that reflect shifts in research trends over

time, allowing us to ascertain evolving research topics linked to notable changes in reference patterns.

Results

In the context of Chinese literature, high-frequency keywords associated with research on pre-service education employment primarily focus on the following themes (Figure 1):

Figure 1: High-Frequency Keywords in Chinese Literature

1. Pre-service Education Curriculum System: This keyword encompasses research related to the design and structure of curricula in pre-service education. The objective of examining the pre-service education curriculum system is to develop students' vocational skills and knowledge, thereby enhancing their competitiveness in the job market.
2. Pre-service Education Reform: This term refers to the reforms and policy initiatives within pre-service education aimed at improving its quality and effectiveness. The goal of such reforms is to ensure that pre-service education aligns more closely with the evolving demands of the job market.
3. Pre-service Education Employment Research: This keyword focuses on the influence of pre-service education on individuals' employment capabilities and opportunities. Research in this area primarily investigates the relationship between education and employment, assessing how education contributes to individual job prospects and the alignment between educational outcomes and employment requirements.
4. Pre-service Education Models: This keyword includes various models and methodologies employed in pre-service education. The study of pre-service education models aims to identify effective educational strategies and teaching methods that enhance students' employability and vocational skills.
5. Educational Grid Solutions: This term pertains to the application and effectiveness of educational grid solutions within pre-service education. Educational grid solutions involve the integration of educational resources and services to create a multi-tiered,

diversified educational network that meets the needs of diverse learners and provides educational opportunities and support.

These high-frequency keywords illuminate the focus and trends in domestic pre-service education employment research. Studies emphasize curriculum systems, reform measures, employment impacts, education models, and educational grid solutions, all aimed at enhancing the quality and effectiveness of pre-service education. The ultimate goal is to strengthen the connection between education and employment, thereby improving students' job opportunities and prospects.

High-Frequency Keywords in Foreign Literature

In international literature, high-frequency keywords pertinent to pre-service teacher education research encompass learning environment, classroom discussion, and occupational equality. These keywords are significant in global academic discourse, highlighting critical issues in the preparation of future educators.

1. Learning Environment: This area of research emphasizes the importance of establishing positive, challenging, and supportive learning environments to foster the professional development and academic growth of teacher candidates.
2. Classroom Discussion: This research domain investigates strategies for guiding teacher candidates in effective interaction and critical thinking within the classroom. It examines how teacher education programs develop skills in classroom management, problem-oriented teaching methods, and approaches to enhance student participation and collaboration.
3. Occupational Equality: This theme addresses social and gender disparities within the education system, focusing on cultivating teachers who possess an awareness of equality and inclusivity in their practice.

In summary, high-frequency keywords in international literature on pre-service teacher education research—namely, learning environment, classroom discussion, and occupational equality—reflect essential issues related to the development of future educators. These keywords emphasize the importance of fostering positive learning environments, enhancing classroom management and guidance skills among teacher candidates, and promoting equality and inclusivity within the educational system. The educational community in China should prioritize the provision of equitable opportunities and resources within teacher education curricula and internship experiences to nurture an awareness of equality among teacher candidates. Such initiatives aim to create a fair and inclusive educational atmosphere that affords all students equal learning opportunities. This objective aligns with the necessary reforms transitioning the pre-service teacher education system from 1.0 and 2.0 to 3.0 in the United States.

In the absence of clear definitions for pre-service teacher education, one study interrogates the term and delineates seven distinct meanings attributed to it within the literature. These meanings have evolved over time, shaped by a complex interplay of social, economic, political, and ideological factors, each bearing significant implications for both teacher education and student schooling across various historical periods and geographic contexts. This foundational work highlights the complexity, contestability, and fluidity of the field while providing a clearer understanding of its historical and contemporary

landscape. Utilizing the CiteSpace program, a total of 300 authentic and unique datasets were identified based on literature data obtained from CNKI. A statistical examination of indicators such as publication time, author, publishing institution, and keyword co-occurrence yielded the following conclusions.

Analysis Of the Temporal Distribution of the Number of Articles Issued in a Year

The annual distribution of research output in a particular field can provide insights into the level of progress and overall outcomes associated with that subject. To illustrate the trends in the volume of literature pertaining to teaching evaluation research within the framework of big data, this study compiled and analysed articles published in SCI, Peking University core, CSSCI core journals, and dissertations from July 10, 2003, to June 15, 2023, as depicted in Figure 2. Between 2003 and 2023, the number of papers published in pre-service teacher education gradually increased. Initially, only two papers were published in 2014. However, starting in 2015, there was a noticeable rise, with seven articles in both 2015 and 2016. This upward trend continued, peaking at 79 papers in 2022, signalling significant academic activity in the field. In 2023, there was a slight decline to 60 publications, but overall, the trend demonstrates a consistent increase in research efforts, highlighting the growing importance of pre-service teacher education.

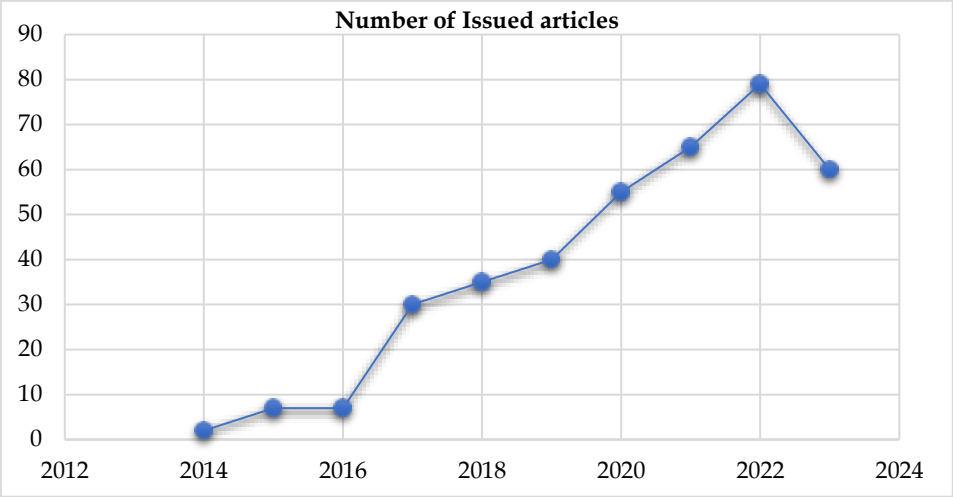

Figure 2: Charting the Yearly Output of Research on Educational Assessment within the Framework of Big Data (2014–2023).

Author Institutional Network Analysis

Using CiteSpace software, we selected "Institution" as a keyword in the Node type box to identify the most productive academic groups and institutions conducting research on teaching evaluation in the context of big data, as well as to examine collaboration among various research institutions in China. This analysis produced a network map of institutional collaboration, revealing a network structure comprising 202 nodes with no connections or tightness. This indicates a dispersion among academic groups engaged in big data teaching evaluation research, suggesting minimal collaboration between different

institutions and the absence of a cohesive, strong research community. The analysis highlights that the College of Teacher Education at Huzhou Normal University and the Department of Education at Southwest University are the leading institutions in this field, while other academic entities have also engaged in research but without any collaborative efforts among them.

Research Hotspot Analysis

Analysis of Keyword-Based Research Hotspots

The author's summary and enhancement of the article's content are encapsulated within the keywords, which also reflect the central themes of related literature. Consequently, analysing the collection of keywords within a specific academic domain allows for the identification of general characteristics of the research and the internal connections among its components, thereby facilitating an understanding of the direction and pace of academic growth in that area. Term frequency serves as an effective indicator of the relevance of a research topic; a higher frequency of a term correlates with increased interest in that subject. Table 1 presents the top 20 keywords ranked by frequency of occurrence, while Table 2 lists the top 20 keywords according to centrality, based on the keyword analysis conducted using CiteSpace. Keywords that exhibit both high frequency and significant centrality effectively represent the prevailing research issues among scholars over time.

Table 1

Top 20 Keywords in Relation to How Often they Appear.

Number	Frequency	Keywords
1	65	Big Data
2	25	Teaching Evaluation
3	20	Smart Classroom
4	15	Teaching Model
5	15	Artificial Intelligence
6	16	Precise Teaching
7	9	Instructional Design
8	10	Information Technology
9	6	mooc
10	8	Learning Analytics
11	8	Teaching Reform
12	5	Teaching Decision
13	5	Teaching Quality
14	5	Evaluation System
15	5	Catechism
16	4	Internet+
17	4	Educational Change
18	4	Classroom Teaching
19	5	Online Teaching
20	5	High School

Table 2

Top 20 Keywords Related to Centrality

Number	Frequency	Keywords
1	0.75	Big Data
2	0.20	Teaching Evaluation
3	0.10	Teaching Model
4	0.10	Artificial Intelligence
5	0.08	Intelligent Classroom
6	0.06	Precise Teaching
7	0.06	Information Technology
8	0.06	Teaching Quality
9	0.06	Informatization
10	0.08	mooc
11	0.03	Teaching Design
12	0.03	Teaching Reform
13	0.03	Internet+
14	0.03	Teaching Ability
15	0.03	Data Mining
16	0.03	Data Analysis
17	0.03	Learning Analysis
18	0.02	Evaluation System
19	0.02	Online Teaching
20	0.02	High School

Table 1 and Figure 3 illustrate that the key phrases "big data," "teaching evaluation," "smart classroom," "teaching mode," "artificial intelligence," "precise teaching," "teaching design," and "information technology," among others, appear frequently (more than seven occurrences). The most prevalent terms, "big data," "teaching evaluation," and "smart classroom," highlight significant areas of interest within the research community, particularly in the context of big data. This underscores the extensive scholarly attention devoted to these three concepts, especially regarding their relationship with big data.

Data must play a pivotal role in contemporary education, moving beyond a purely empirical focus. The use of big data in educational evaluation is a fundamental indicator of educational modernization, as it reflects individuals' behaviours, values, and knowledge structures through data analysis. This approach aims to enhance student self-awareness, provide insights into educational trends, and foster value development through data-driven evaluations. The integration of big data in education is increasingly prevalent, particularly as it is essential for implementing smart classrooms within modern educational frameworks. Consequently, big data facilitates improved classroom instruction and more effective teaching evaluations, thereby advancing educational reform and promoting holistic student development.

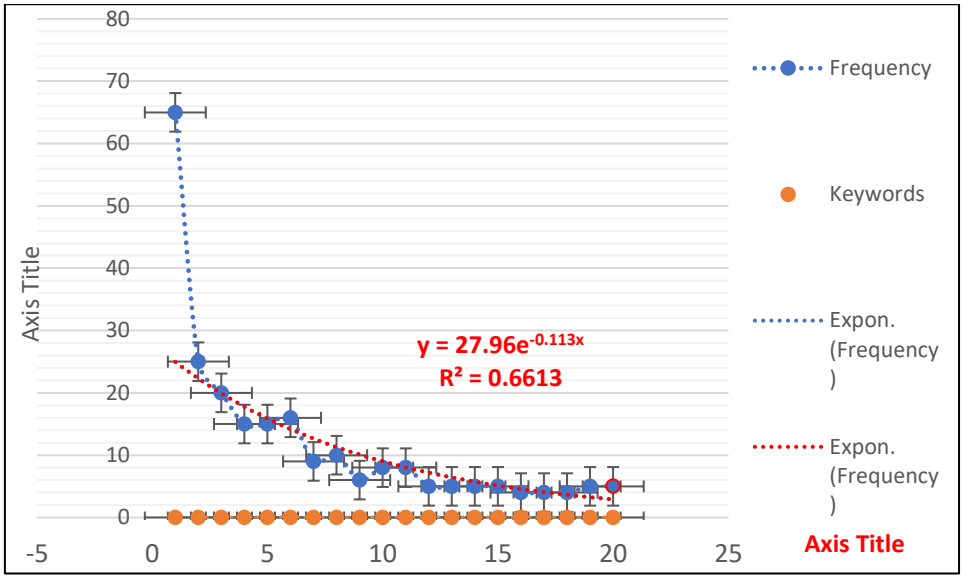

Figure 3: Top 20 Keywords in Relation to How Often they Appear.

As indicated in Table 2 and Figure 4, the key phrases with the highest centrality include "big data," "teaching evaluation," "teaching mode," "artificial intelligence," "smart classroom," "precision teaching," "information technology," "teaching quality," and "informatization." Among these, "big data" and "teaching evaluation" exhibit the highest centrality. Relying on a single data set is insufficient to conduct a scientific, reasonable, and effective teaching evaluation that comprehensively and objectively reflects students' learning outcomes. However, the integration of big data technology can significantly facilitate this objective. Teaching evaluation is a critical component of the educational process.

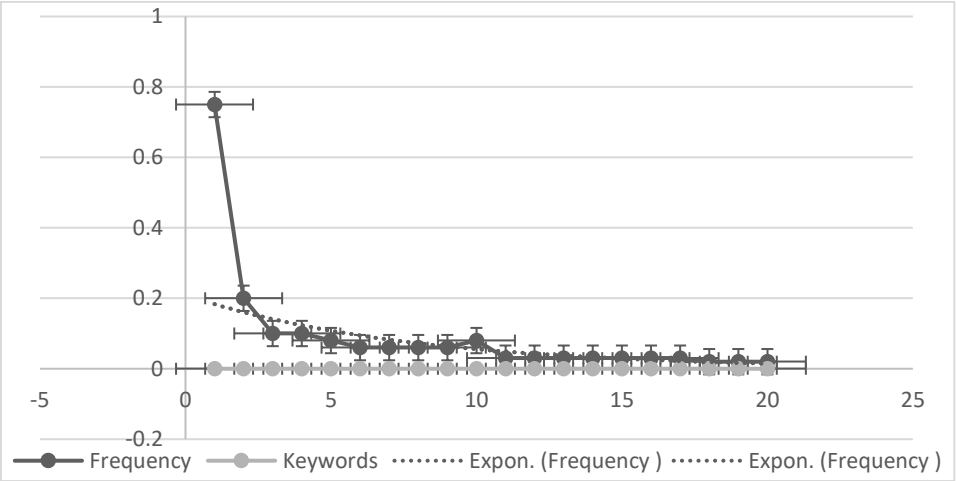

Figure 4: Top 20 Keywords Related to Centrality

The co-occurrence map of teaching evaluation research within the context of big data, illustrated in Figure 5, comprises 250 network nodes and 400 connections, resulting in a network density of 0.0135. The term "big data" emerges as the most prominent node in this map, indicating its significance and the frequency of related terms in the literature on this topic, as well as highlighting the prevailing research hotspots in the field. Following "big data," the second largest node is "information technology," which indicates that areas such as "precision teaching," "intelligent classroom," "artificial intelligence," and "instructional design" are also of considerable interest to researchers. The interconnections among these nodes further suggest a meaningful relationship between these topics.

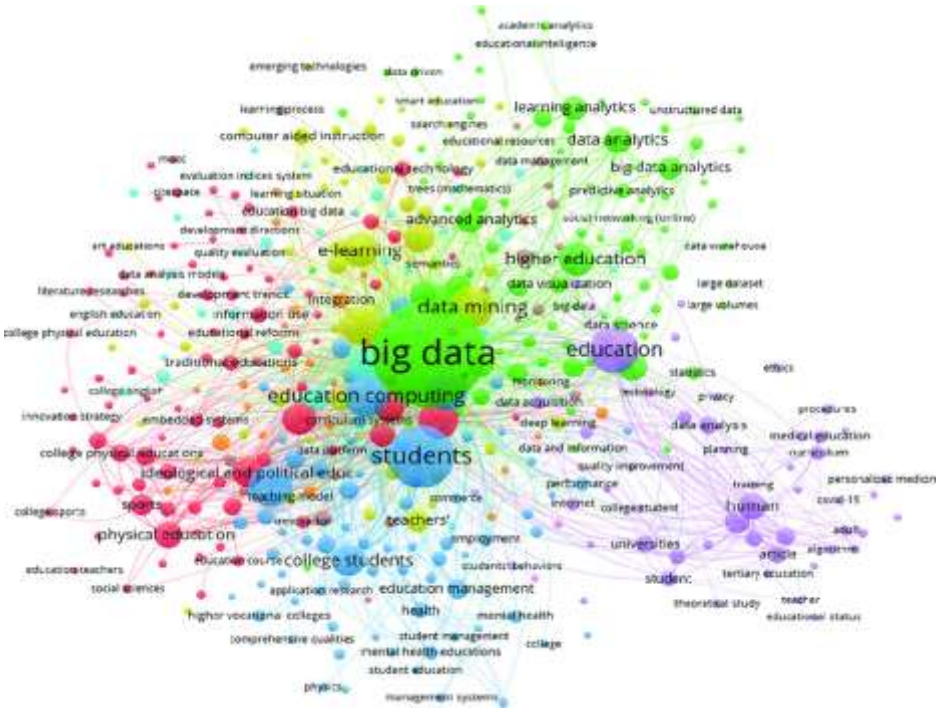

Figure 5: Keyword Co-Occurrence Mapping in Big Data Context for Study on Teaching Assessment.

Analysis of Research Hotspots Based on Keyword Clustering

The keyword clustering analysis feature of CiteSpace facilitates the exploration of research boundaries and hotspots within related topics. In examining teaching evaluation within the big data framework, ten clusters were generated using the spectral clustering algorithm, as illustrated in Figure 3. The designated labels for these clusters are as follows: cluster #0 represents big data, cluster #1 indicates smart classroom, cluster #2 corresponds to artificial intelligence, cluster #3 pertains to teaching evaluation, cluster #4 is labelled as learning analysis, cluster #5 refers to teaching competency, and cluster #6 denotes MOOCs. Additionally, cluster #7 is labelled as performance analysis, cluster #8 as academic evaluation, and cluster #9 as data-driven (Figure 6).

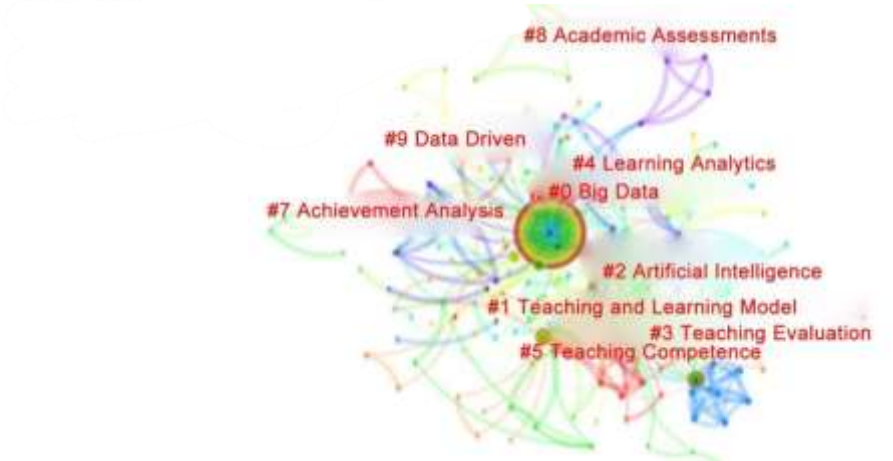

Figure 6: Big Data Context for Keyword Co-Occurrence Clustering Mapping in Teaching Evaluation Study.

Analysis of Research Hotspots Based on Keywords and Clustering

This study performs a keyword clustering analysis, emphasizing the evolution of keyword paths and subsequently generating a timeline mapping based on the identified keywords and clusters. The analysis results from CiteSpace depict the emergence of research hotspots on the horizontal axis, while the vertical axis reflects the clustering module calculated by the software. Each node represents a distinct research topic, with the size and colour of the circles indicating the topic's prominence. The connecting lines illustrate the relationships between different topics. Notably, the node representing Big Data is the largest and has shown consistent growth from 2003 to 2023, indicating its status as a significant focus of research among scholars throughout this period. Furthermore, the nodes connected to Big Data are predominantly centred around education and teaching, highlighting the critical role of big data in the education sector and its integration across various facets of teaching and learning (Table 3 and Figure 7).

Table 3

The Number of Citing and Cited Journals was Consistent Each Year.

Citing journals	Cited Journals	Year	Cited Journals	Cited Journals	Year
1	0	2000	10	320	2013
1	80	2001	10	350	2014
1	30	2002	10	450	2015
1	20	2003	10	160	2016
1	16	2004	20	800	2017
1	10	2005	16	750	2018
0	0	2006	19	1000	2019
4	95	2007	16	1500	2020
5	130	2008	17	1974	2021
5	230	2009	30	2415	2022
3	90	2010	30	1587	2023
9	320	2011			

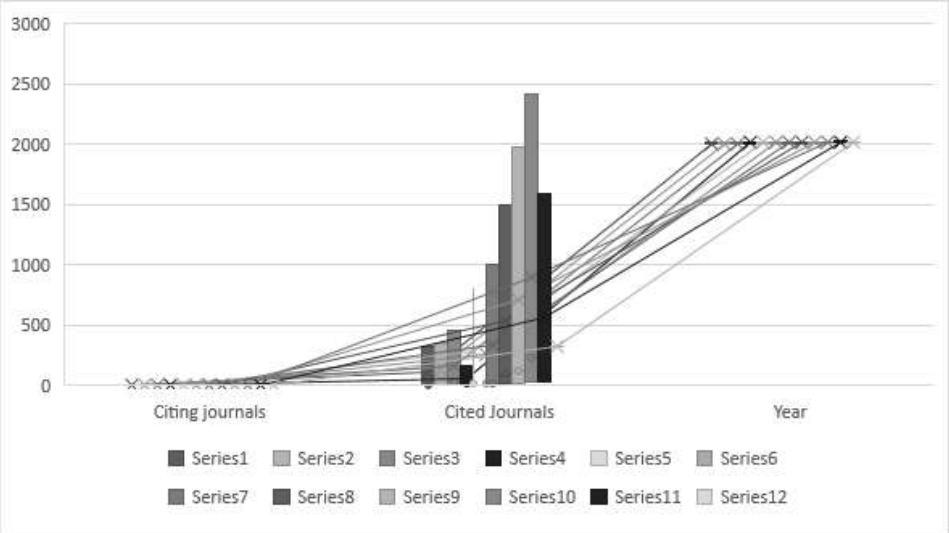

Figure 7: The Number of Citing and Cited Journals was Consistent Each Year

The data concerning the number of citing and cited journals within the realm of pre-service teacher education research illustrates the evolving relationship between these journals over time, reflecting the level of scholarly engagement and citation activity in the field. From the early 2000s until 2011, there was a consistent correlation between citing and cited journals, albeit with some fluctuations. In 2000, there was only one citing journal that did not correspond with any cited journals, indicating a very low level of citation activity. However, by 2011, there was a notable increase, with nine citing journals linked to 320 cited journals, signifying substantial growth in scholarly discourse and citation practices. In the years following 2011, both the number of citing and cited journals experienced significant increases, indicating enhanced scholarly involvement and the expansion of citation networks within the field. Notably, since 2012, there has been a marked rise in the number of cited journals, continuing until 2022, which reached a peak of 2,415 cited journals corresponding to 30 citing journals. This upward trend in cited journals reflects a broader dissemination of research and the incorporation of a diverse range of scholarly sources into academic discussions.

Discussion

Pre-service Education Curriculum System

The primary objective is to equip learners with the essential knowledge, skills, and attributes necessary to fulfil the demands of particular fields. This research is typically conducted by educational institutions, industry associations, professional organizations, or relevant stakeholders. The overarching aim is to identify the core competencies and skills requisite for specific professions and to develop corresponding educational programs. Key research directions encompass the investigation and analysis of the needs and requirements of relevant professions, as well as an understanding of the skills, knowledge, and qualities essential for success within these roles.

Pre-Service Education Reform

The comprehensive investigations and enhancements of the pre-service education system. Its primary objective is to identify and advocate for improvements that align with evolving social and economic demands, thereby enhancing the quality and competitiveness of practitioners. Researchers concentrate on the policies and strategic planning of governmental and educational institutions, analysing the goals, developmental trajectories, and policy frameworks associated with pre-service education.

Pre-Service Education Employment

Pre-service education employment research examines the interplay between educational practices and employment outcomes. This area of study emphasizes the development of individuals' employability skills through educational programs and assesses how labor market demands influence educational practices. Key research directions include aligning educational offerings with labour market requirements, investigating the relationship between the quality of education and employment readiness, exploring the effects of vocational training on job opportunities, and analysing the interactions between educational and employment policies.

Pre-Service Education Models

This field emphasizes the development of instructional methods and strategies, practical training experiences, interdisciplinary education, and the integration of technology and innovation in the learning process.

Pre-Service Education Grid Solutions

Research on pre-service education grid solutions examines the implementation of educational grid solutions within the realm of pre-service education. This research focuses on the integration of educational resources and services to create a diversified educational network that addresses the varying needs of learners, thereby providing enhanced educational opportunities and support. Such investigations aim to improve the quality and effectiveness of pre-service education, facilitate students' adaptation to job market demands, and promote their career development and success.

Insights from Overseas Research

Research on pre-service teacher education in international contexts places significant emphasis on the learning environment. Studies investigate the creation of positive, challenging, and supportive learning conditions that foster the professional growth and development of teacher candidates. Within the Chinese educational framework, it is essential to consider factors such as classroom settings, resource availability, technology integration, student engagement, and cultural diversity to enhance the effectiveness and outcomes of teacher education.

Classroom discussions represent another vital area of inquiry in pre-service teacher education, emphasizing the development of teacher candidates' abilities to facilitate student interaction and promote critical thinking in the classroom. Furthermore,

occupational equality is a prominent theme in this field of research. Investigations examine social and gender disparities within the education system and explore strategies for fostering awareness of equality and inclusivity among future educators.

Trends in Pre-Service Teacher Education

Technological advancements have profoundly influenced pre-service teacher education programs, manifesting in various areas such as administrative processes—including admissions, registration, and enrolment—modifications to the delivery of course content, and the provision of resources for both students and faculty. This period of transformation has unfolded over approximately the last 15 years, during which institutions may occupy different stages of technological integration, resulting in an extended transition period where both old and new processes coexist. This dual system complicates the implementation of technological changes, requiring individuals involved in teacher preparation to possess proficiency in both systems, as illustrated by the varied use of technology for different educational tasks within teacher education. The final section of this paper presents an analysis of prevailing and emerging trends in pre-service teacher education through a series of time zone maps, evaluating the impact of numerous changes that have occurred within the field over the past 35 years on the quality of teacher preparation.

Technological Advancements

The initial emphasis of our discussion centres on technological advancements, which have significantly transformed the delivery of education across various levels and learning contexts. The situated learning and constructivist perspectives have shifted the focus from the teacher to the student by integrating technology into the learning experience and the preparation for teaching. Pre-service teacher education serves as a critical context for training educators in the effective integration of technology within their future teaching disciplines, providing learning experiences that align with the pedagogical approaches they are expected to adopt. This form of technological apprenticeship has demonstrated potential in altering teaching practices. Research by van Laar et al. (2017) as well as Vasilev et al. (2020), exemplifies the effects of technology integration on teaching methods. However, these findings contrast with evidence indicating that teacher education programs have been slow to adopt technology, often failing to equip future educators to use it optimally. In many cases, technology is taught as a separate entity, and when access to technology is limited, it tends to remain peripheral to the core teaching and learning processes. This distinction is critical, as research indicates that not only does proficiency in technology influence teaching methods and student learning, but effective integration of technology must occur within the learning areas themselves rather than as an isolated subject. Moreover, such integration should reflect the educator's values and beliefs regarding teaching and learning.

Pedagogical Innovations

Pedagogical innovations mark a shift towards constructivist teaching, emphasizing student-centred learning and the importance of the learning process in acquiring knowledge. Teacher educators are modelling new instructional strategies that connect

theory to practice, focusing on student learning, implementing inquiry-based methods, and fostering a professional knowledge base among teacher candidates. Inquiry serves as both a teaching and learning strategy, engaging candidates in understanding teaching and developing essential skills while promoting self-directed, lifelong learning (Xiao et al., 2021). Clinical experiences, internships, and student teaching practicums further bridge theory and practice, with innovations aimed at aligning these experiences with the knowledge and skills that teacher candidates are developing. This approach transcends mere survival skills, promoting intentional experiences informed by inquiry, where candidates can experiment and practice skills within a reflective framework. Such clinical experiences seek to integrate learning and teaching, fostering collaboration between P-12 schools and teacher education institutions. However, the emphasis on high-stakes testing and accountability often hampers innovation, creating discontinuities between teacher preparation and actual teaching practices.

Policy and Regulatory Changes

Recent policy initiatives in China have ended concurrent initial teacher education (ITE) programs, mandating that all new teachers obtain a postgraduate certificate in education (PGCE). This shift reflects a changing perception of teaching as a profession, aligning teaching roles with other graduate-level careers. Globally, there is a trend towards elevating entry requirements for the teaching profession, enhancing qualification standards for teacher educators, and devolving control to schools, parents, and students. Additionally, the push for national standards in teacher certification aims to maintain teaching quality and facilitate teacher mobility across jurisdictions. Consequently, teacher education is increasingly aligned with broader educational systems, training educators to support student achievement and welfare beyond traditional classroom roles (Zhan et al., 2022).

Policy and regulatory changes have consistently influenced teacher education significantly. Historically, the processes of teacher education and certification in different countries have been intricately linked to the prevailing political and social contexts, a relationship that persists today. It is widely recognized that contemporary societies are shaped by an unprecedented variety of social, cultural, economic, and political factors, each exerting diverse and complex effects on the nature and substance of professional teaching standards and the criteria for entry into the teaching profession.

Comparison of Pre-Service Teacher Education at Home and Abroad

National Approaches

Zhao et al. (2022) noted that cultural, political, and local factors significantly shape national educational goals and perceptions of teaching. Labaree identifies three key teacher education objectives: academic excellence, human performance, and social commitment. The report on Australia highlights the lack of a shared vision for the teaching profession, resulting in inconsistent teacher quality. To address this, the report advocates shifting from a "mixed economy" to a unified national approach that prepares teachers to high standards, aligning with previous research that educational goals reflect the dominant social objectives of the time (Zhihua et al., 2022).

Teacher education varies significantly worldwide, shaped by dominant teaching philosophies, higher education structures, cultural traditions, and socio-political contexts. For instance, China's "apprenticeship" model emphasizes learning through trial and error under experienced teachers, while France and Finland prioritize preparation in higher education before classroom instruction. Such disparities result in teacher education systems evolving in distinct directions, often lacking comparability. Many developing countries initially adopted educational models from their colonial influences but have since diverged from these frameworks. The previous researches highlights these differences by comparing two-year Post Graduate Certificate programs in England with India's integrated 12-year model. Despite local adaptations, foreign influences often persist in developing nations due to international aid and financial adjustments.

Curriculum Variations

Teacher education in China has undergone a significant transformation, transitioning from the training of teachers in normal schools to education studies within colleges and universities, and the advancement of graduate teacher education. However, these processes have unfolded unevenly and remain inconsistently applied, particularly in the preparation of teachers for instructing older children and youth. Recent reforms in teacher education appear to have shifted focus and resources away from initial teacher preparation towards enhancing the quality of existing teachers' practice, particularly in response to state-mandated testing and assessment. This shift has resulted in a strong advocacy for the professional development of in-service teachers, consequently influencing the methods of teacher preparation. The landscape of teacher education in China reflects a diverse and decentralized system, shaped by policy decisions at higher levels, individual school and district demands, and notable variations across different regions.

Quality Assurance Measures

The Higher Education Quality Council (HEQC) plays a crucial role in ensuring the maintenance and enhancement of quality assurance (QA) in higher education across China. One of its primary functions is to establish specific reference points or standards that educational institutions are expected to meet. These standards serve as benchmarks for measuring the quality of education and its outcomes. The HEQC also provides guidelines for program development, assisting institutions in their efforts to improve program quality. Required assessments of both core and elective subjects are conducted to compare expected outcomes with actual achievements, thereby facilitating continuous improvement in educational quality. Additionally, the HEQC is tasked with disseminating information related to QA to various stakeholders and agencies involved in the higher education sector.

Current Challenges in Pre-Service Teacher Education

Our analysis reveals several critical issues impacting the future success of teacher education, despite an increase in research outputs. First, the proliferation of teacher education programmes across diverse institutions has led to low-status alternatives for colleges and universities, resulting in an overproduction of teacher graduates in certain subject areas and levels, which has exacerbated underemployment and unemployment

issues. This trend has diminished both access to and the quality of teacher education. Second, conflicting pressures to address immediate local needs while providing broader, more academic teacher education programmes have caused instability in programme emphases and directions, resulting in less accumulated knowledge about effective practices and a reliance on ad hoc policy initiatives. Third, many countries are witnessing a shift in teacher employment from schools to various forms of pre-service education, without clear evidence of positive impacts on teacher quality or student learning outcomes. Lastly, the linkage between teacher education and school reform is often based on poorly substantiated assumptions, with major reforms frequently implemented without robust research, leading to mixed outcomes and undermining the reputation and status of teacher education.

Strategies for Improvement

To effectively enhance pre-service teacher education in China, it is essential to have a comprehensive understanding of the current situation. A literature review on this topic has commenced, focusing on identifying areas for improvement in existing practices. Overall, Chinese pre-service teacher education at both secondary and tertiary levels falls short compared to other countries, particularly regarding subject-matter knowledge and pedagogical skills. Additionally, the profession struggles to attract high-achieving students, and those who do enter often lack motivation to enhance their instructional methods or pursue professional development.

Conclusion

Examining teaching evaluation research within the framework of big data underscores the escalating significance of data-driven methodologies in education. The findings reveal critical research areas, including big data, teaching evaluation, and smart classrooms, indicating a burgeoning interest in innovative teaching methods and technologies. The application of keyword clustering uncovers emerging topics such as learning analytics and teaching competency, highlighting the necessity for a more thorough investigation of data-driven solutions in education. However, the analysis of institutional networks reveals a lack of collaboration among academic groups, suggesting a need for strengthened interdisciplinary cooperation to advance research in this field. This study provides valuable insights for educators, policymakers, and researchers seeking to leverage big data to enhance teaching and learning outcomes.

Challenges and Future Directions

Our research indicates that the domain of pre-service teacher education is both fragmented and disjointed, lacking consensus on program objectives and a coherent connection between the learning experiences of teacher candidates and the competencies they are expected to acquire. The foundations that once defined the professional identity of teacher educators and provided a stable knowledge base for teacher education have become increasingly unstable. Although some teacher educators and education reformers possess a clear vision for enhancing teacher education, there is considerable disagreement regarding the appropriate course of action, compounded by a lack of comprehensive knowledge to inform these decisions. Pre-service teacher education at State University has

become a politically charged and contentious undertaking. Central to current discussions are ongoing efforts to redesign teacher education programs, the fragmentation of the formerly cohesive curriculum into an extended series of courses and field experiences, and the expectation that teacher education programs will produce a greater number of qualified teachers with reduced public funding. Schools of education and arts and sciences grapple with determining the appropriate balance of authority in establishing program requirements and defining what prospective teachers should learn, both in terms of subject matter expertise and professional education. State and local policies, along with diverse constituencies, advocate for various, sometimes conflicting, reforms. Consequently, the professional identities of teachers and teacher educators are evolving as policies and societal discourses increasingly depict teaching as a matter of technical proficiency.

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