Research and Analysis of Smart Teaching Model in the Context of Engineering Education

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Abstract. Smart teaching is the main direction of education and teaching mode change in the new era. This paper takes the research literature on wisdom teaching mode in the context of engineering education in the past ten years as a sample, adopts bibliometric method and visual analysis to examine the research lineage of wisdom teaching mode, reveals the hot research topics and research status in this field and further elaborates the future research trend of wisdom teaching, which provides reference for the research on wisdom teaching mode in the context of engineering education.

Keywords: Engineering education · smart teaching · bibliometric methods · visual analysis

1 Introduction

Engineering education plays a crucial role in higher education in China, and China's engineering education formally joined the Washington Agreement in June 2013 and became a official member state, which marks that China's engineering education has been recognized by international education quality standards and gradually realized the convergence with international engineering education [1]. In the 21st century, computer technology is developing rapidly and "Internet + " has become a new mode of innovation and development in the information age, so the study of intelligent teaching mode in the context of engineering education has become an important direction of education informatization reform [2]. This paper adopts bibliometric method and visual analysis to examine the research lineage of wisdom teaching mode and analyze the literature related to wisdom teaching in the past ten years, so as to provide reference for the research of wisdom teaching mode in the context of engineering education.

2 Smart Teaching Model Research Highlights

2.1 Data Selection

The sample of this paper is selected from China Knowledge Network (CNKI), and the literature related to smart teaching in engineering context included in the database of CNKI from 2010 to 2021 is used as the sample for analysis. After a series of data cleaning

work such as erratum, de-weighting and screening of the search results, the literature in this field is summarized and sorted out to provide some reference for the subsequent analysis, research and practice.

2.2 Analysis Tools

The analysis software used in this paper is VOSviwer, a software that allows the statistical and analysis of a large amount of literature in a database and the identification and display of keywords and key phrases in a large amount of scientific literature. The software visualizes new trends and developments in science through graphical visualization, which allows readers to better understand the development and status of the relevant literature, and it is more effective in bibliometric networks, especially in scientific citation analysis. VOSviewer is a tool to help us understand a field, a direction, a problem, it analyzes a large amount of literature, and finally presents the knowledge structure, the research VOSviewer is a tool to help us understand a field, a direction, and a problem.

Based on the VOSviwer analysis tool, this paper clusters the high-impact authors and institutions, representative journals, the yearly distribution of publications and key literature on smart teaching, identifies the knowledge architecture and research hotspots of smart teaching, and conducts knowledge mapping analysis of related research by the VOSviwer analysis tool, so as to study and judge the future research trends of smart teaching.

3   Research Advances in Smart Teaching and Learning

3.1   Core Author Analysis

Through the statistics and analysis of the literature related to wisdom teaching in the context of engineering in the past ten years, the number of articles published in the literature was used as the evaluation index to analyze its publication pattern. As shown in Table 1, the top ten authors in the literature related to smart teaching are listed in the table, and it can be found that the number of articles published by each author is not very different. Xiaoling Zhou published the most articles, reaching 8 articles, followed by Yonghe Wang with 7 articles. Overall, there was little difference in the number of articles published by individual authors.

3.2   Yearly Distribution of Issued Articles

The volume of publications on smart teaching is shown in Fig. 1. In this paper, the literature related to smart teaching in the past ten years is selected for analysis. From this figure, we can see that the development of wisdom teaching from 2012 to 2016 was relatively slow, with only 40 articles published on wisdom teaching in 2012, and a small increase in the number of articles published on wisdom teaching to 94 in 2016. The number of studies on wisdom teaching models began to rise significantly after 2016, and reached a 2020, when it peaked at 913 articles. The number of research articles related to smart teaching increased year by year without the rapid development of Internet

Table 1. Top 10 authors in the number of articles published in Smart Teaching Research

Serial number	Author	Number of articles	Serial number	Author	Number of articles
1	Xiaoling Zhou	8	6	Qi Yu	5
2	Yonghe Wang	7	7	Hui Huang	5
3	Bangqi Liu	6	8	Yongce Zhang	4
4	Weixing Hu	5	9	Zi Yang	4
5	Yiming Chen	5	10	Shaochun Zhong	3

technology and information technology, and at the same time, since the convening of the 18th Party Congress, China began to vigorously promote the reform of education informatization and provide strong support for the construction of wisdom teaching and wisdom classroom [3]. After 2020, the number of articles on wisdom teaching has decreased, which shows that the research on wisdom teaching has reached a "bottleneck" period, but there is still a high number of articles published every year, which shows that smart teaching is still a hot research direction at present.
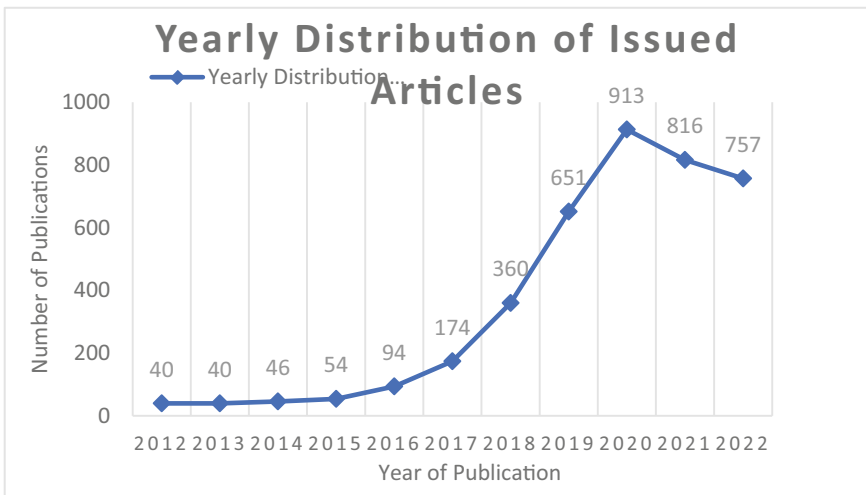

Fig. 1. Yearly Distribution of Issued Articles

Table 2. Cited key literature in 2020

Part Name	Author	Citation Frequency
Exploring the hybrid teaching model supported by rain classroom of smart teaching platform	Zhen Yang	20
A study on the intelligent teaching model of college computer foundation course in rain classroom	Yanhong Zhang	13
Strategies to improve information-based teaching ability of teachers in higher education institutions based on intelligent teaching environment	Jusu Pan	13
Building a smart teaching environment for universities based on educational big data	Tai Yu	11
Evolution and Trends of China's Smart Teaching Research in the Last Decade	Xiumei Zang	10

3.3 Key Literature Analysis

The analysis of the literature by means of literature co-citation reveals that key words in the literature such as teaching environment construction, smart teaching model construction, and smart classroom design are the main key words in the literature related to smart teaching. Since the number of publications on wisdom teaching reached its peak in 2020, the top 5 key documents in terms of citation frequency of wisdom teaching-related literature in the peak year 2020 are listed in the following table, with the corresponding authors and citation frequencies, as shown in Table 2.

Through this table, we can find that the most frequently cited article "Discussion on the hybrid teaching mode supported by the wisdom teaching platform Rain Classroom" published by Yang Zhen in 2020 was cited 20 times, which explored the wisdom teaching mode in Rain Classroom platform. The second most frequently cited article is "Research on the Smart Teaching Model of College Computer Foundation Course Based on Rain Classroom" by Pei-Sheng Cao, with 13 citations, which shows that the research on smart teaching on Rain Classroom platform is more popular [4]. The 5th ranked one is Zhang Xiumei's "Evolution and Trends of China's Smart Teaching Research in the Last Decade", which finds the evolution pattern and gives the main development trend of future smart teaching through the research of China's smart teaching mode in the last decade, which provides valuable experience and reference for the subsequent research of related researchers.

4 Hot Topics and Future Trends of Smart Teaching Research

4.1 High-Frequency Keyword Analysis

Keyword co-occurrence allows for a better understanding of the connections between key themes and thus analyzing the relationships between individual literatures [5]. In this paper, by studying and analyzing the literature related to wisdom teaching in the last

decade, in order to determine the connections and the overall pulse between the subject terms of each literature, this paper uses VOSviwer software to draw a high frequency keyword co-occurrence knowledge map, as shown in Fig. 2.

As shown in Fig. 3, in this graph is divided into large nodes and some smaller nodes, the larger nodes represent the higher frequency of the keyword, and the smaller nodes represent the lower frequency of the keyword. In this co-occurrence knowledge graph, the importance and relevance of keywords can be judged by analyzing the intermediary centrality [6]. In addition to the frequency of occurrence, the intermediary centrality is also a key indicator to evaluate the importance of keywords. In this chart, it can be found that the frequency and centrality changes of keywords are basically consistent, and the top-ranked ones include intelligent teaching environment, intelligent classroom, smart school, education informatization, and big data analysis, etc. The popular words also include the key topics of intelligent teaching research in China from 2011 to 2021. These keywords in this mapping were categorized and compared to obtain four main clusters of keyword classes for teaching mode (smart teaching, smart teaching platform, smart education, high-quality offline open courses), teaching environment (smart campus, education informatization, innovative teaching mode), teaching platform (rain classroom, learning pass, superstar panacea platform), and teaching concept (artificial intelligence, information-based teaching, knowledge mapping). The analysis of the high-frequency keywords and intermediary centrality in this co-occurrence mapping can provide a clearer understanding of the main development process and direction of wisdom teaching in the past ten years, and provide valuable experience for the subsequent research on wisdom teaching.

Fig. 2. Keyword co-occurrence knowledge graph

4.2   Smart Education Connotation

In order to realize the modernization of education, we should vigorously develop smart education. As the name implies, wisdom education needs to include two aspects, namely wisdom and education. The 21st century is the era of information technology, and the field of artificial intelligence is developing at a high speed, so China's education should also make full use of information technology knowledge and information technology to improve the quality of teaching, but also to significantly improve the level of education and teaching, so that it is in line with the information technology era, and gradually realize wisdom education and wisdom teaching. Smart education is the only way to modernize and develop education. The effective integration of education and teaching with information technology, the construction of smart classrooms, online teaching and the cultivation of new education and teaching concepts will not only enable students to quickly integrate into the new teaching mode, but also significantly promote the development of education modernization and lay a solid foundation for the realization of smart education.

Smart education also plays an important role in online education, so that the access to knowledge is not single and boring, and the efficiency of all nationals in acquiring knowledge can be rapidly improved. In order to realize information-based online education, modern information technology should be used as the basis to realize the effective integration of information technology and teaching mode in order to achieve a more free and varied way of learning for the educated, no longer a single classroom, a single time frame, and smart education is recognized by the majority of the nation for its flexible and efficient way. As a new era teaching model, smart education is open, convenient and efficient to provide effective guarantee of continuous learning for the educated. The effective integration of smart education with the Internet also enables learners across the country to have more access to education, significantly improving the process of knowledge acquisition and realizing informationization in education, which will significantly improve the quality of all nationals and is of great significance to the realization of high-quality human resources.

Innovation is an inevitable element of scientific progress, and the cultivation of innovative talents has become a top priority in China's education, and intelligent education plays a crucial role in the cultivation of students' innovative thinking. Due to the difference of individual differences, including the differences of interests and the speed of receiving knowledge, students can independently retrieve and extract knowledge according to their own situation and solve the problems arising in the learning process in time, which can not only improve the efficiency of students' learning, but also greatly help the cultivation of students' innovative spirit and creative ability, which has far-reaching significance to the cultivation of innovative talents in China.

4.3   Future Trends in Intelligent Teaching

During the prevention and control of the novel coronavirus (COVID-19) epidemic, against the background of the obstruction of traditional teaching mode, the new intelligent education scene emerges. With the easing of the epidemic situation, although schools and colleges have returned to the state of daily teaching, the "normalization"

of smart education has also become an important development direction of the current education industry.

Artificial intelligence, Internet, big data, and other intelligent information technology will play a vital role in the transformation of education, the traditional teaching model can no longer adapt to the development trend of the information age, to achieve the deep integration and innovation of traditional education and intelligent information, and to cultivate high-quality innovative talents has become the focus of education. Therefore, the improvement of intelligent teaching mode and the construction of intelligent teaching classroom are the effective integration of education and information technology, such as 'rain classroom', 'learning pass' and other intelligent teaching platform will be the key content of the future teaching mode improvement and development.

5 Conclusion and Outlook

In the new era of rapid development of Internet and information technology and the background that engineering education is getting more and more attention, in order to achieve high-quality development of engineering education in China and cultivate innovative talents, it is necessary to integrate information technology with education, which is also the purpose of China's education informatization reform. In this paper, we take the relevant literature with the theme keyword "wisdom teaching" in the database of China Knowledge Network as the sample, and conduct comparative analysis and research on the relevant literature through bibliometric method and visual analysis method. However, the research on smart teaching has decreased in the last two years. From the analysis of high-frequency keywords and hot topics, information-based teaching, "Internet + ", smart classroom, and smart teaching are the hot topics of research in the field of teaching in China.

The term "comprehensive engineering education" first appeared in the "International Symposium on Multidisciplinary and Interdisciplinary Engineering Education" in 2006, and due to its novelty, it generated heated discussions among the participants as soon as it appeared. With the rapid development of information technology and Internet technology in today's era, promoting education informatization reform has become the main development direction of education, and how to build intelligent teaching mode in the context of engineering education has also become the focus of current research. In short, informatization has become an inevitable trend of research nowadays, and the integration of informatization technology with education and thus the realization of intelligent teaching is an inevitable trend to achieve high-quality development of talents in China and even in the world, so we must continue to strengthen the research of informatization in the field of education and promote the high-speed and high-quality development of education.

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