The Hotspots of Smart Education in China: Base on the Bibliometric Analysis and Knowledge Mapping

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Abstract. To explore the hotspots in the area of Smart education in China, 245 related articles form the China National Knowledge Infrastructure (CKNI) were analyzed by the visualization software of CiteSpace. The results show that: (1) the studies of smart education began in 2003 while there were sporadic papers published in the next ten years. There was an increasing trend year by year from 2013 to 2017 and the number of articles reached the historical peak in 2017 with 52 articles. Xianming Yang, Jiangsu Normal University and E-Education Research topped the lists of contributing authors, organizations and publications respectively. (2) “smart education”, “educational informationization”, “intelligent education” and “smart campus” were the top four largest clusters in the domain of smart education in China.

1. Introduction
With the development of educational informatization, smart education has received more and more attention, for example, the State Council issued the “New Generation Artificial Intelligence Development Plan” in 2017, proposing to improve the artificial intelligence education system and implement intelligent education [1-2]. The Education Informationization 2.0 Action Plan issued by the Ministry of Education in 2018 marked the beginning of a new era in smart education in China [3-4]. Smart education, that is, education informatization, refers to the process of comprehensively and deeply applying modern information technology in education (education management, education and education, and scientific research) to promote education reform and development [5]. The researchers from Malaysia, South Korea, Singapore, the United States, and the United Kingdom have paid more attention to the smart education in the 21st century, for example, IBM originally proposed the concept of Smart Planet, and then extended to smart education [6]. However, the research of smart education in China is still in its infancy when theoretical research still stays on a shallow level in general [6]. The earliest research on smart education started in 2003, which mainly discussed the experience of foreign smart education [7]. In the next six years, the research on smart education was less while there was an upward trend until 2013, and the research on smart education in China can be summarized in four aspects including theory research, environment research, technology-supported research and practice research of smart education [8]. However, the development of smart education and the specific content of the related research in China are still unclear. This study, therefore, set out to explore the status and hotspots in the domain of smart education in China with the help of the visualization software Citespace.
2. Methodology

2.1. data sources
245 articles were yielded by the search conducted in the China National Knowledge Infrastructure (CKNI) under the heading of “smart education”, and the journal source categories were limited to Peking University core journals, CSSCI and CSCD. Among the 245 articles, there were 204 journal articles and 41 Dissertations.

2.2. data processing
The RIS format of the 245 articles was carried out by the bibliometric analysis and visual analysis by the visualization software CiteSpace.5.5. R2 [9].

3. Results

3.1. Bibliometric analysis

3.1.1. Publishing trend. Fig. 1 demonstrates the publishing trend of studies on smart education in China. The earliest research of smart education in China began in 2003 while there were sporadic papers published in the next ten years. After 2013, the research on smart education in China has shown an increasing trend year by year and appeared at a historical peak in 2017 with 52 articles.

3.1.2. Author statistics. As shown in Tab.1, all of the top 10 contributing authors have published more than four articles and Xianming Yang topped the list with fifteen articles, followed by Lin Chen and Zhiting Zhu, each of them published more than ten articles.
3.1.3. Affiliation statistics. As seen in Tab.2, all of the top 10 organizations have contributed more than three articles on the studies of smart education in China. Jiangsu Normal University was the best performer among the list, followed by East China Normal University and Beijing Normal University, each of them contributed more than fifteen articles.

| Rank | Organizations                        | Frequency |
|------|--------------------------------------|-----------|
| 1    | Jiangsu Normal University             | 27        |
| 2    | East China Normal University          | 20        |
| 3    | Beijing Normal University             | 16        |
| 4    | South China Normal University         | 4         |
| 5    | Shaanxi Normal University             | 4         |
| 6    | Tsinghua University                   | 3         |
| 7    | Zhejiang Normal University            | 3         |
| 8    | Bohai University                      | 3         |
| 9    | Nanjing Normal University             | 3         |
| 10   | Northeast Normal University           | 3         |

3.1.4. Source publication statistics. As seen in Tab.3, all of the top 10 source publications contributed more than four articles on the studies of smart education in China. E-Education Research topped the list with twenty-nine articles, followed by Modern Educational Technology and China Educational Technology, each of them published more than twenty articles.

| Rank | Source Publication                        | Frequency |
|------|------------------------------------------|-----------|
| 1    | e-Education Research                     | 29        |
| 2    | Modern Educational Technology            | 28        |
| 3    | China Educational Technology             | 24        |
| 4    | Journal of the Chinese Society of        | 14        |
| 5    | Journal of Distance Education            | 6         |
| 6    | Theory and Practice of Education         | 5         |
| 7    | Modern Distance Education Research       | 4         |
| 8    | People's Education                       | 4         |
| 9    | Open Education Research                  | 4         |
| 10   | Distance Education in China              | 4         |
3.2. Knowledge mapping results

3.2.1. High-frequency keywords. The top 10 high-frequency keywords in the domain of smart education in China, as well as their frequencies on the studies of smart education were shown in Tab.4 and Fig.2. “smart education” was the most frequent keywords, and “educational informationization”, “artificial intelligence”, “smart” and “smart campus” were positioned in the 2nd, 3rd, 4th and 5th places on the list. It is indicated that educational informationization, artificial intelligence, smart and smart campus attracted researchers’ attention.

| Rank | Keywords                      | Frequency |
|------|-------------------------------|-----------|
| 1    | smart education               | 186       |
| 2    | educational informationization| 43        |
| 3    | artificial intelligence       | 17        |
| 4    | smart                        | 15        |
| 5    | smart campus                  | 9         |
| 6    | big data                      | 7         |
| 7    | smart learning                | 6         |
| 8    | smart curriculum              | 5         |
| 9    | smart classroom               | 5         |
| 10   | intelligent education         | 4         |

Fig. 2 Top 10 keywords

3.2.2. Popular research topics. Fig 3 outlines the top four largest clusters on the studies of smart education in China, which were “smart education”, “educational informationization”, “intelligent education” and “smart campus” and the Modularity Q value is 0.76, the Mean Silhouette value is 0.51. As shown, the largest cluster is “smart education (#0)”, which contains 11 articles and its silhouette value is 0.85. The high-frequency keywords of this cluster contain “smart education”, “smart education era” and “the integration of production and education”. The second-largest cluster is “educational informationization (#1)”, which contains 10 articles and its silhouette value is 0.97. The high-frequency keywords of this cluster contain “educational informationization”, “educational technology”, “big data” and “artificial intelligence”. The third-largest cluster is “intelligent education” (#2), which contains 9 articles and its silhouette value is 1.00. The high-frequency keywords of this cluster contain “intelligent education”, “cloud computing”, “cloud platform” and “Education Information 2.0”. The fourth-largest cluster is “smart campus” (#3), which contains 8 articles and its
silhouette value is 0.87. The high-frequency keywords of this cluster contain “smart campus”, “smart learning”, “smart classroom” and “smart curriculum”.

Fig. 3 Popular research topics

4. Conclusions and further research

To explore the status and hotspots in the domain of smart education in China with the help of the visualization software Citespace. The bibliometric analysis results showed that the studies of smart education in China while there were sporadic papers published in the next ten years. There was an increasing trend year by year from 2013 to 2017 and the number of articles reached the historical peak in 2017 with 52 articles. Xianming Yang topped the list of contributing authors with fifteen articles, followed by Lin Chen and Zhiting Zhu, each of them published more than ten articles. Jiangsu Normal University was the best performer among the list of the contributing organizations, followed by East China Normal University and Beijing Normal University, each of them contributed more than fifteen articles, indicating that the normal universities are the main research institution on the studies of smart education in China. E-education Research topped the list of the contributing source publication, followed by Modern Educational Technology and China Educational Technology, each of them published more than twenty articles, indicating that smart education particularly attracted the educational technology researchers’ attention in China.

In the section of Knowledge mapping analysis, the results of high-frequency keywords showed that “smart education” was the most frequent keywords, and “educational informationization”, “artificial intelligence”, “smart” and “smart campus” were positioned in the 2nd, 3rd, 4th and 5th places on the list of the high-frequency keywords, indicating that educational informationization, artificial intelligence, smart and smart campus attracted researchers’ attention in China. The clusters analysis results showed that “smart education”, “educational informationization”, “intelligent education” and “smart campus” were the top four largest clusters on the area of smart education in China. Among them, “smart education (#0)” is the largest cluster and the high-frequency keywords of this cluster contain “smart education”, “smart education era” and “the integration of production and education”, indicating that smart education is the product and trend of deep integration of science, technology, and education in China.
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