

The Bibliometrics and Visualization Analysis on the Research of Maker Education based on Internet Plus in China

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Abstract—"Maker" is closely related to "mass entrepreneurship and innovation" and refers to people who have innovative ideas and start their own businesses. In this context, Chinese domestic researchers have begun to carry out many researches on maker education in the context of internet plus, and have achieved fruitful results. To reveal the research status of maker education based on internet plus in China, 208 related papers from National Knowledge Infrastructure (CNKI) were analyzed by bibliometrics and visualization analysis. The results showed that: (1) the research of maker education based on internet plus in China started since 2015, and showed a trend of rapid growth, with more than 10 articles published annually. Rongchuan HUANG, Jiangsu Normal University and Central China Normal University, China Educational Technology & Equipment topped the list of the contributing authors, organizations and source publication, respectively. (2) there were eight largest clusters in the area of intangible cultural heritage based on internet in China, which were "maker education", "internet plus", "internet plus era", "the teacher of maker", "innovation and entrepreneurship", "education of internet plus", "innovation ability", and "maker space". The evolution of the popular research trends followed the degree of integration between maker education and informatization and education governance and education service supply were the latest research trend, indicating that future research needs to pay attention to this research topic.

Keywords— maker education, internet plus, bibliometrics analysis, visualization analysis

I. INTRODUCTION

"Makers" are closely related to "mass entrepreneurship and innovation". They specifically refer to people with innovative ideas and self-employed entrepreneurs. The origin is that Premier Li Keqiang pointed out in the Government Work Report on March 5, 2015 that the "mass entrepreneurship and innovation" has become one of the "dual engines" that promotes China's economic advancement [1]. For this reason, domestic researchers attach great importance to maker education, especially in the context of internet plus. Although maker education originated in the United States,

colleges and universities from China have set off an upsurge of maker education in recent years.

Related to but different from STEAM [1] and smart learning [2], maker education not only deepens the project learning ability, but also pays more attention to the cultivation of learners' innovative ability. With the emergence and popularization of various new technologies and new media [3], maker education, as one of the reform paths of "Internet +" education, had received extensive attention from all walks of life in recent years [4], "Internet + maker education" conducive to the formation of a new ecology of innovation and entrepreneurship education in colleges and universities[5]. However, maker education was still facing difficulties such as an imperfect maker education system, weak maker education teachers, lack of specialized maker space, and lack of maker communication platforms [6-7]. Based on this, the researchers called on colleges and universities to organically integrate the "internet plus" new information technology methods with maker education, and have carried out a lot of exploration. Researchers mainly carried out research on the integration of maker education, professional education, and innovation and entrepreneurship education based on internet plus. In terms of integration with professional education, researchers had explored the comprehensive integration of university maker education and professional education in five aspects: educational thinking, communication platform, teaching space, course content, and teaching process [8-9], while in terms of integration with innovation and entrepreneurship education, researchers have realized the integration of the two from four aspects: teaching philosophy, course content, base platform, and faculty [10-11]. In addition, there was study examining the integration of maker education and educational services supply socialization [12]. In summary, the domain of maker education based on internet plus in China had achieved rich results in theory and practice, but previous studies had not been carefully combed and summarized. To provide follow-up research enlightenment, this research will quantitatively comb the research in this field through CiteSpace.

II.METHODOLOGY

A. data sources

214 articles were yielded by the search conducted in the China National Knowledge Infrastructure (CKNI) with the subject of “maker education” and “internet plus”. After deleting 6 book reviews or minutes of the meetings, 208 valid articles were finally obtained, and there were 5 master dissertation and 203 journal articles.

B. data processing

208 papers were saved in RIS format which includes the crucial information, such as titles, authors' names, issuing time, affiliations, department, abstract and keywords. The bibliometric analyses and knowledge mapping were conducted with the version of CiteSpace 5.8. R1, which was developed by Dr. Chen [13].

III.RESULTS

A. Bibliometric analysis results

1) *Chronology statistics.* Figure 1 visually presented the publishing trend of maker education based on internet plus in China. As shown in Figure 1, Research in this field started in 2015, and then showed a trend of rapid growth, with more than 10 articles published annually. Reached the highest peak in history in 2017, with 50 articles published annually.

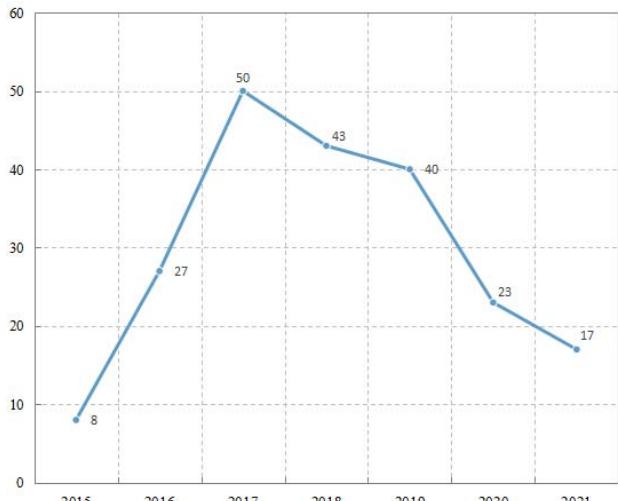


Fig 1. Publishing trend.

2) *Author statistics.* Table 1 outlines the top 10 contributing authors and number of their published papers in China. As indicated, Rongchuan HUANG topped the list with a total of three articles, followed by the other nine contributing authors, each of them published two articles. It can be seen that the number of articles published by the top ten authors is generally low, and they have not been able to form a core author unfortunately.

Table 1. Top 10 contributing authors.

Rank	Author	Frequency
1	Rongchuan HUANG	3
2	Lixin HONG	2
3	Lei ZHANG	2
4	Kun WAN	2
5	Hongliang MA	2
6	Youyi TIAN	2
7	Xianmin YANG	2
8	Xiaowen XIE	2
9	Dinghui LIU	2
10	Yonghe WU	2

3) *Affiliation statistics.* Table 2 depicts the top 10 organizations contributing to the studies on maker education based on internet plus in China. As seen, Jiangsu Normal University and Central China Normal University topped the list with a total of five articles, followed by South China Normal University, Shaanxi Normal University, East China Normal University, indicating that normal universities were the main research force in this field.

Table 2. Top 10 contributing organizations.

Rank	contributing organizations	Frequency
1	Jiangsu Normal University	5
2	Central China Normal University	5
3	South China Normal University	3
4	Shaanxi Normal University	3
5	East China Normal University	3
6	Jishou University	3
7	GuangXi University for Nationalities	3
8	Guangxi Polytechnic Vocational School of Technology	3
9	National Institute of Education Sciences	2
10	Tangshan Vocational & Technical College	2

4) *Source publication statistics.* Table 3 depicts the top 10 source publication contributing to the studies on maker education based on internet plus in China. As shown, China Educational Technology & Equipment topped the list with a total of four articles, followed by Pioneering with Science & Technology Monthly and China Educational Technology, each of them published three articles. It should be noted that China Educational Technology is a top-level journal for education technology in China, which indicated that research in this field had been gained interest from top-level journals.

Table 3. Top 10 contributing publication.

Rank	contributing organizations	Frequency
1	China Educational Technology & Equipment	4
2	Pioneering with Science & Technology Monthly	3

3	China Educational Technology	3
4	Journal of Distance Education	2
5	The Chinese Journal of ICT in Education	2
6	Modern Distance Education	2
7	China Market	2
8	Science & Technology Vision	2
9	Modern Educational Technology	2
10	Journal of Chongqing University of Science and Technology(Social Sciences Edition)	2

B. Knowledge mapping results

1) *High frequency keywords.* Table 4 listed the top 10 keywords of studies on maker education based on internet plus in China, as well as their frequencies. As shown, “maker space” was the most frequently keywords except the subject keywords “maker education” and “internet plus”. Additionally, “innovation and entrepreneurship”, “internet plus classroom”, “product design model” and “teaching model” were positioned in the 2nd, 3rd, 4th and 5th places on the list respectively except the subject keywords. It is indicated that the current researchers concern on the teaching model of maker education based on internet plus. Figure 2 further visualized the situation of high-frequency keywords in this field.

Table 4. Top 10 keywords.

Rank	Keywords	Frequency
1	maker education	143
2	internet plus	63
3	“internet plus”	35
4	maker space	18
5	innovation and entrepreneurship	12
6	innovation and entrepreneurship education	11
7	internet plus classroom	8
8	product design model	8
9	teaching model	8
10	practical teaching	7

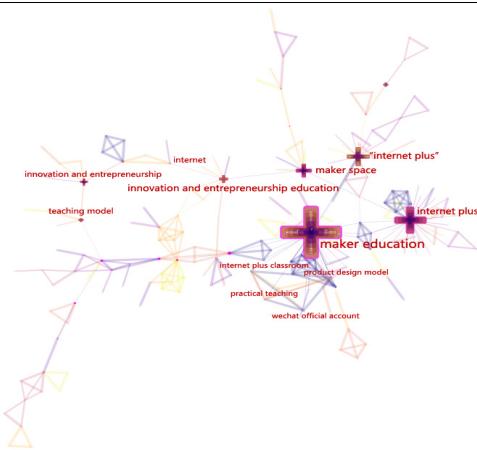


Fig 2. Visualization of TOP 10 keywords.

2) *Popular research topics.* To explore the Popular research topic, a cluster analysis of high-frequency keywords was carried out, and the results found that S value was 0.99 and Q value was 0.82, which indicated that the clustering results were good. Fig 3 showed the top eight largest clusters, which were maker education (#0), internet plus (#1), “internet plus” (#2), the teacher of maker (#3), innovation and entrepreneurship (#4), education of internet plus (#5), innovation ability (#6), and maker space (#7). As shows, the largest cluster was maker education (#0), which contains 36 articles and its S value was 1.00. The high frequency keywords of this cluster contained “maker education”, “smart education” and “internet plus era”. The second largest cluster was internet plus (#1), which contains 35 articles and its S value was 1.00. The high frequency keywords of this cluster contained “internet plus”, “vocational education” and “practice path”. The third cluster was “internet plus” (#2), which contains 25 articles and its S value was 0.99. The high frequency keywords of this cluster contained “internet plus”, “educational technology” and “optimal path”. The fourth cluster was the teacher of maker (#3), which contains 19 articles and its S value was 0.97. The high frequency keywords of this cluster contained “maker activity”, “elementary and middle school” and “internet plus era”. The fifth cluster was innovation and entrepreneurship (#4), which contains 17 articles and its S value was 1.00. The high frequency keywords of this cluster contained “innovation and entrepreneurship”, “teaching mode” and “internet”. The sixth cluster was education of internet plus (#5), which contains 15 articles and its S value was 1.00. The high frequency keywords of this cluster contained “education of internet plus”, “steam education” and “university English”. The seventh cluster was innovation ability (#6), which contains 14 articles and its S value was 0.99. The high frequency keywords of this cluster contained “steam”, “education of internet plus” and “innovation ability”. The eighth cluster was maker space (#7), which contains 14 articles and its S value was 0.99. The high frequency keywords of this cluster contained “maker space”, “maker education based on internet plus” and “maker spirit”.

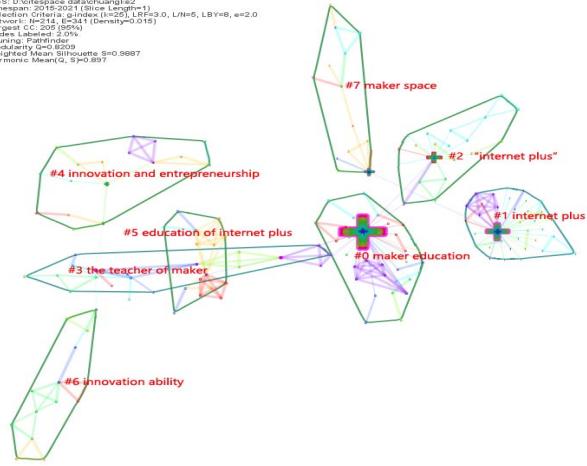


Fig 3. Visualization of cluster analysis.

3) *Popular research trends.* Fig 4 pictured the popular research trends in the area of maker education based on internet plus in China by the time zone analysis. As shown, research topics mainly included maker education, internet plus, internet plus classroom, web-chat official account and practical teaching in 2015, innovation and entrepreneurship education, maker space and education of internet plus in 2016, teachers of maker and teaching model in 2017, SPOC and maker education of internet plus in 2018, experimental teaching in 2019, smart campus and educational information 2.0 in 2020, educational governance and educational service supply in 2021. It can be seen that the evolution of research in this field follows the degree of integration between maker education and informatization, from the initial use of the Internet to carry out maker practice teaching, to the exploration of maker space and teaching models, and then to education informatization 2.0 and smart campus in the context of the exploration of maker experimental teaching, finally it comes to education governance and education service supply.

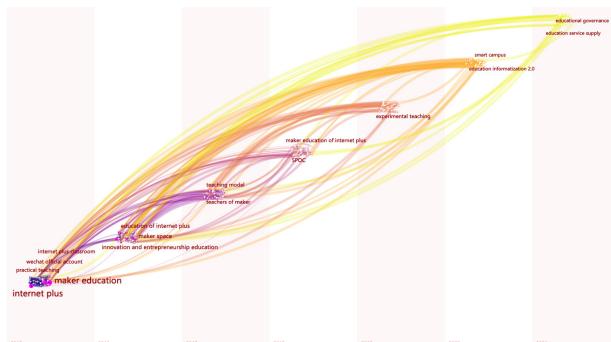


Fig 4. Visualization of time zone analysis.

IV.CONCLUSIONS AND FURTHER RESEARCH

In order to explore the research status and development trend of maker education based on internet plus in China, bibliometric analysis and visual analysis were used to analyze 208 articles published on the China National Knowledge Infrastructure (CNKI) from 2015 to 2021. The bibliometric analysis results showed that the research of maker education based on internet plus in China started since 2015, and then showed a trend of rapid growth, with more than 10 articles published annually, indicating that maker education was highly valued by domestic researchers as an emerging field. Rongchuan HUANG topped the list of the contributing authors with a total of three articles, but all the authors only published less than 3 related articles, each of them published two articles, indicating that there was no core author in the domain of maker education based on internet plus in China. Jiangsu Normal University and Central China Normal University topped the list of the contributing organizations, followed by South China Normal University, Shaanxi Normal University, East China Normal University, indicating that normal universities were the main research force in this field. China Educational Technology & Equipment topped the list of the contributing source publication, followed by Pioneering with Science & Technology Monthly and China Educational

Technology. It should be noted that China Educational Technology is a top-level journal for education technology in China, which indicated that research in this field had been gained interest from top-level journals.

The visualization analysis results showed that “maker space” topped the list of the high-frequency keywords except the subject keywords “maker education” and “internet plus”, followed by “innovation and entrepreneurship”, “internet plus classroom”, “product design model” and “teaching model”, indicating that the current researchers concern on the teaching model of maker education based on internet plus. Further cluster analysis based on high-frequency keywords found that there were eight largest clusters in the area of maker education based on internet plus, which were “maker education”, “internet plus”, “internet plus era”, “the teacher of maker”, “innovation and entrepreneurship”, “education of internet plus”, “innovation ability”, and “maker space”. Finally, time zone analysis revealed the development trend of research in the field of maker education based on internet plus in China. As shown, the popular research trends followed the degree of integration of maker education and informatization, and education governance and education service supply were the latest research trend of maker education. Therefore, this field should focus on how to carry out research on the governance of maker education and research on the supply of maker education services in the context of internet plus in the future.

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