



# Knowledge Graph Analysis of Mobile Learning Based on CiteSpace

Ruixue Yang<sup>1</sup>, Meng Liu<sup>2\*</sup>, Ruihuai Yang<sup>3</sup>

*1Key Laboratory of Ethnic Education Informatization, Yunnan Normal University, Kunming 650500, China;*

*2School of Information science, Yunnan Normal University, Kunming 650500, China;*

*3Baoshan Shimeng Expressway Investment and Development Co., Ltd., Kunming 650500, China*

*\* Corresponding author: Meng Liu*

*1971385138@qq.com, 2728315308@qq.com, 1679755524@qq.com*

## Abstract

Under the background of the rapid development of mobile technology and its applications, what kind of picture does the domestic mobile learning research shows, and which research topics and hotspots to focus on are issues worthy further exploration. Using CiteSpace analysis software, with the Chinese Social Science Citation Index (CSSCI) in CNKI database as the data source, the literature data related to mobile learning is analyzed, the research context is sorted out, and the research status and development direction of mobile learning are explored. On the basis of analyzing the spatiotemporal distribution characteristics, research hotspots and research fronts of mobile learning, the thesis provides references for the learners and users of mobile learning, and forecasts the development trend of mobile learning.

**Keywords:** *Mobile learning, learning resources, intelligent mobile terminals, data mining and analysis, learners*

## 1 INTRODUCTION

Comrade Xi Jinping emphasized the need to adhere to the development path of socialist education with Chinese characteristics to modernize education and to create a form of learning organization that suits the needs of today's society. Today's information society has seen a gradual increase in the number of users using mobile devices and devices have become increasingly user-friendly. The trend towards personalized learning needs and the development of technology have largely contributed to the innovation of education and teaching, making significant breakthroughs in learning modes and other aspects. With the assistance of mobile devices (iPads, smartphones, etc.), learners can learn at any time and anywhere, effectively presenting the learning content. With the rapid development of mobile network technology, mobile learning has become a new way of learning, and it is a research hotspot in the current learning field. From mobile learning theory to mobile Internet technology, from mobile tools to mobile platforms, from learning resources to mobile teaching design, its research is becoming more and more mature [1], and with the integration of the Internet and the popularization of Wi-Fi facilities, it has greatly promoted

the full popularization of mobile learning to the general public. At present, the trajectory of mobile learning in China should be accurately depicted according to the current development status of mobile learning in China, and the future research trends of mobile learning should be clearly presented to form a knowledge map of China's mobile learning research field in the coming years.

## 2 RESEARCH PROGRAMME

### 2.1 Data sources

This paper uses CiteSpace and other software to visualize and analyze the scientific knowledge map of mobile learning in China, using the Chinese Social Sciences Citation Index (CSSCI) as the basic data source, which boasts a high academic authority and is generally recognized by researchers. The search is conducted with "mobile learning" or "m-learning" or "mobile education" or "mobile learning" as the theme. In order to ensure that the literature is sufficiently relevant to mobile learning, the data is screened to eliminate redundant literature that is not line with the topic and is not essentially related to the scope of mobile learning research. The selected documents were saved as plain text files in text format

starting with "download".

## 2.2 Research tools

The research tool was CiteSpace 5.5.R2, which was developed by Chaomei Chen, a Chinese American from Drexel University, based on the Java language [2], and is an literature analysis software that can visualize information. This paper adopts the knowledge graph analysis method to conduct knowledge graph analysis, cluster analysis and other econometric analysis on mobile learning literature based on co-citation analysis theory and pathfinding network algorithm, and at the same time, with a series of visualization maps drawn from the literature analysis, it shows the current hot research topics of mobile learning in China and explores the development trends and frontier research this field.

## 3 ANALYSIS OF SPATIAL AND TEMPORAL DISTRIBUTION CHARACTERISTICS

### 3.1 Annual volume of publications

On the whole, mobile learning research in China has been developing. As is shown in Figure 1, the research process of mobile learning in China can be roughly divided into three stages according to the annual volume of publications, namely, the initial exploration stage, the development stage and the rising stage.

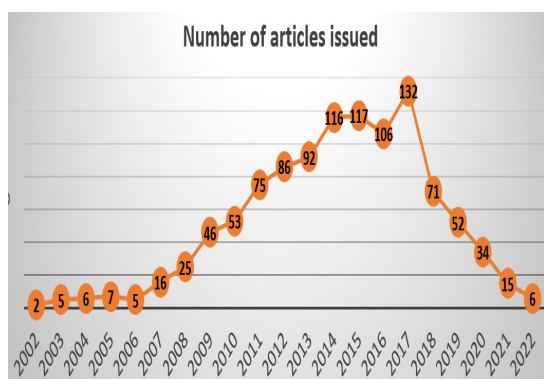


Fig. 1. Number of articles issued

As can be seen from the meandering curve in Figure 1, the research road of mobile learning is not smooth. Researchers continue to explore the twists and turns forward, but never stop the pace of research on mobile learning. From 2002 to 2006, mobile learning research was in the early stage of exploration. According to the analysis of the searched literature, the first literature on mobile learning was Gu Qingyang's "The Future of Learning: From Digital Learning to Mobile Learning" in 2002 [3]. At this time, mobile learning has not yet been popularized, and it is an emerging hotspot. Domestic researchers have great interest in the field of mobile learning, but there are not many research results related to mobile learning in China, and the research topics are

relatively simple, mainly focusing on the theoretical basis of mobile learning and technical foundation. From 2007 to 2014, domestic mobile learning research entered the development stage, and the number of literature published by researchers surged, and mobile learning research became a hot research topic in academia. Since then, domestic scholars have focused on the student group as the main research object, especially the college student group, focusing on the fields of "teaching mode", "course design" and "resource development" of mobile learning.

From 2014 to 2017, the number of documents increased and showed a steady development trend. Mobile learning began to be widely recognized in various research fields. Mobile learning has gradually become popular in my country. Major universities have responded and conducted in-depth and extensive research in the field of mobile learning. Literature research has begun to focus on the Internet, cloud computing and big data, and new mobile teaching platforms such as WeChat public accounts have emerged. The focus of domestic mobile learning research has begun to shift to the development of micro-learning, and WeChat has become a mobile learning platform. Important support platform. As the audience becomes more and more extensive, mobile learning is no longer limited to providing learners with a learning method, but is gradually connected with the social life of learners, cultivating learners' awareness of active learning and promoting the formation of virtual learning communities and then promoting the realization of lifelong learning and learning society goals.

### 3.2 Distribution of core research institutions publishing articles

By setting "institution" as the node type in CiteSpace, we obtained the cooperation network and node map of research institutions in the field of mobile learning research from 2004 to 2021. The study found that the main strength of research in this field in China comes from major universities, with Beijing Normal University, East China Normal University, South China Normal University and Capital Normal.

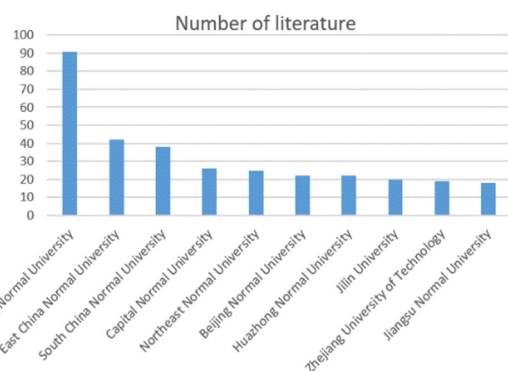


Fig. 2. Map showing the proportion of representative research institutions

University as the main representative universities. A cooperative network analysis of the institutions publishing in the literature shows that the node density of each institution tends to be close to zero, indicating that the density of connections between different institutions is very low, and that major universities are conducting independent research and have not yet formed a very cohesive inter-university research community.

## 4 ANALYSIS OF RESEARCH HOTSPOTS AND FRONTIERS

### 4.1 Analysis of research hotspots based on keyword clustering

Figure 3 shows the keyword clustering mapping in the field of mobile learning research. The size of the clusters is inversely proportional to the number of keywords contained in the clusters, and each cluster consists of multiple related keywords. This study combines the analysis of the content of the literature and divides each cluster into the following three parts according to Figure 3.

(1) Mobile learning is a new form of learning that uses wireless mobile communication network technology to obtain educational information, educational resources and educational services with wireless mobile communication devices [4]. Therefore, this paper summarizes the four clusters of "#0 mobile learning, #2 education informatization, #6 distance education, and m-learning" as the basic theoretical research of mobile learning. Mobile learning is learning that is supported by handheld mobile technology or that occurs across a variety of contexts or locations [5]. It refers to the use of modern communication portable devices for distance learning under the guidance of the social needs of lifelong learning. Although the number of researchers in the field of mobile learning is gradually increasing, a complete theoretical system has not yet been formed, so there are not many classic scientific research achievements and works. The research on mobile learning in my country started from a report made by the famous international distance education expert Dr. Desmond Keegan in 2000 - "From d-learning, to e-learning, to m-learning", has been recognized and supported by a wide range of research scholars. Dr. Keegan divides distance learning into three stages according to the different forms and means of learning: distance learning, electronic learning and mobile learning., Mobile learning is a new development stage of distance education. The most prominent feature is that it can study freely at any time and anywhere. It has the characteristics of intelligent interactive learning and is an important research hotspot in the field of distance education and digital learning.

(2) The clusters of "#1 micro-course, #4 mobile learning resources, #8 MOOCS" are summarized as research on the design and development of mobile

learning resources. From this clustering, it can be seen that the development of mobile learning resources is more focused, such as the design, development and use of "micro-courses" and "MOOCS", and the design of WeChat as a "public platform" for mobile learning, in order to provide students with rich multi-disciplinary Learning Resources. At present, mobile learning research is mainly implemented in primary and secondary education and college education, and research has also begun to focus on teacher education and adult education. Research areas are concentrated in natural sciences and language subjects, and mobile learning can better support its learners for the needs of contextuality and immediate feedback in these areas. One of the typical representatives of online courses to promote the development of education is a kind of large-scale open online courses, MOOCs, which have emerged in recent years. Cultivate more innovative and intelligent talents to provide new learning methods and effectively improve the learning efficiency of learners. In addition, mobile learning builds a teaching knowledge structure through a mobile communication system, which also contributes to the improvement and innovation of my country's education and teaching system. For the learners of the "digital native" generation, it is necessary to design an open and connected learning environment that adapts to their cognitive complexity and individualized learning behavior characteristics.

(3) The third prominent research focus is the application and improvement of mobile learning and related research on mobile device learning support. Therefore, the research hotspots in the clusters "#3 mobile terminals, #5 Internet, #7 students" are summarized as mobile learning applications and refinements. Mobile devices can create new interactive and personal experiences through Bluetooth, global positioning systems, and proximity wireless communication technologies [6]. The development of "Internet+", cloud computing and distance education, also including the launch of 5G in 2019, the development of rapid mobile network technology will bring a qualitative leap to people's online life, so that mobile learning has greater prospects for development. The final point of the development of mobile learning is to make it more convenient for learners to learn. Therefore, as the major groups of mobile learning, combining the characteristics of mobile learning with the learning method and learning style of university students is a more important part of the research.

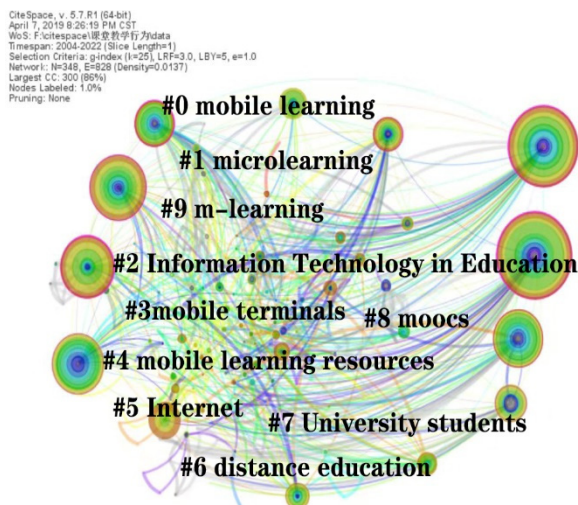


Fig. 3. Mobile learning keyword clustering map

### 4.2 Analysis of research development trend

According to Kleinberg's burst detection algorithm, Chen Chaomei's team designed the mutation detection function of CiteSpace, which can calculate and extract the focus words of word frequency mutation, and these emerging focus words in the rising stage can be used to reveal the frontier of the discipline [7]. The author uses the word frequency mutation detection of literature keywords to obtain 15 mutation keywords in my country's mobile learning research from 2002 to 2022 (Figure 4).

Top 15 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2002 - 2022
Mobile Education	2002	8.3879	2003	2009	[Red bar from 2003 to 2009]
m-learning	2002	3.2248	2003	2012	[Red bar from 2003 to 2012]
3g	2002	3.0917	2010	2012	[Red bar from 2010 to 2012]
Educational Technology	2002	3.2808	2011	2013	[Red bar from 2011 to 2013]
microlearning	2002	3.6417	2011	2014	[Red bar from 2011 to 2014]
Cloud Computing	2002	3.5871	2011	2013	[Red bar from 2011 to 2013]
mobile library	2002	3.4506	2012	2014	[Red bar from 2012 to 2014]
Smartphones	2002	3.5589	2013	2014	[Red bar from 2013 to 2014]
micro-lessons	2002	3.1702	2014	2016	[Red bar from 2014 to 2016]
WeChat	2002	8.8026	2015	2017	[Red bar from 2015 to 2017]
Blended learning	2002	3.1915	2015	2017	[Red bar from 2015 to 2017]
WeChat public platform	2002	3.3548	2015	2020	[Red bar from 2015 to 2020]
flipping the classroom	2002	4.6852	2015	2019	[Red bar from 2015 to 2019]
big data	2002	3.1409	2017	2018	[Red bar from 2017 to 2018]
College students	2002	3.2687	2018	2022	[Red bar from 2018 to 2022]

Fig. 4. Mobile Learning Keyword Emergence Analysis Chart

It can be seen from the figure that mobile education and m-learning rank the top 2 in mutation intensity, indicating that mobile learning has had a greater impact in the field of education. From 2010 to 2013, keywords such as 3g and educational technology appeared, showing that at this stage, mobile learning based on 3g technology began to be applied in the field of educational technology, which increased the transmission rate of mobile learning and enabled the function of audio and video dialogue. The development of mobile learning has risen to a new

level. Since then, after the emergence of smartphones in 2013, WeChat, WeChat public platforms, mobile libraries and other platforms have emerged one after another, and new learning methods such as blended learning, flipped classrooms, and micro-classes have become research hotspots at that time. In 2017, the emergence of big data began to appear. Big data is a technology field that has developed rapidly in recent years. Big data-related infrastructure, analysis tools and application systems are all developing rapidly. In the education system, big data technology is used to analyze and mine learning behavior data and acquire knowledge, so as to improve the personalization and efficiency of mobile learning and better realize personalized learning [8].

### 5 CONCLUSION

In the current society, digital network technology has changed people's way of life. Mobile learning is developed on the basis of digital learning. It is different from ordinary learning. It is an extension of digital learning and supports learners to learn anytime, anywhere. In addition to inheriting all the characteristics of digital learning, mobile learning also has its own unique characteristics, that is, learners are no longer limited to teachers and classrooms, the learning environment is mobile, teachers and students are mobile, and it is a kind of flexibility. It's a flexible way of learning. Mobile learning also has the characteristics of fragmented learning, which is very different from traditional classroom learning that uses a lot of time. Learners can make full use of mobile portable devices to learn in fragmented time. The learning content is usually small pieces of scattered knowledge, which can be called "Shallow Learning" or "Browse Learning". It is beneficial for learners to master a relatively complete and small knowledge point in a short period of time, so as to achieve the purpose of mobile learning. Secondly, from the perspective of the implementation of mobile learning, the implementation tool is a mobile portable device. In the process of discussing the concept of mobile learning, Sariola et al. summarized three characteristics of mobile learning implementation devices: mobility, portability, wireless, embodies the learning advantages of mobile learning. In addition, mobile computing technology and Internet technology have laid a solid technical foundation for its realization. The technologies adopted are mobile communication equipment and wireless communication protocols such as Bluetooth and IEEE802.11. The development of mobile learning will make students more free in distance learning. Learning can take place anywhere the learner chooses, as long as the wireless communication connection is supported.

A series of visual maps of mobile learning are drawn through CiteSpace, and the development trend of mobile learning in my country and the research frontier hotspots are analyzed. Looking at the current situation of China's

mobile learning research field, although there have been many achievements in the field, there are certain problems in the current development of mobile learning in my country. One is how mobile learning can transform teaching and learning in schools, and the other is how mobile learning activities can be integrated into the current curriculum. From this, several research recommendations are put forward:

(1) The research mode of mobile learning should be diversified, and the research on standardized mobile learning activities and strategies should be formed.

(2) There are relatively few researches on the application of mobile learning, which is out of touch with practice. The practical application of mobile learning needs to be promoted, and the effect of mobile learning should be paid attention to. The choice of equipment for domestic mobile learning is relatively simple, and tool applications that effectively promote mobile learning are developed. Focus on the practical application of mobile learning in education, explore the development of mobile learning resources, locate the model of mobile learning teaching design, design a framework for learning projects and activity design, and promote the comprehensive development and popularization of mobile learning.

(3) The government and related enterprises should encourage multi-field cooperation, apply mobile learning to different fields, and give full play to the advantages of mobile learning.

(4) Get rid of the shackles of technology and realize the transformation from "technology" to "learning" research. In 2019, after 30 years of unremitting efforts, China's mobile communication industry has pushed China into the 5G era. 5G empowers mobile learning and will build a new look of mobile learning in the "smart +" era. [9].

Our country still has great development prospects in the field of mobile learning. In the future development, researchers should conduct more in-depth research on existing learning scenarios based on the development of existing mobile technologies, supported by mature technologies such as artificial intelligence, cloud computing, and big data. The combination of artificial intelligence and other emerging technologies and mobile learning in the field of education and teaching will enable the development of domestic mobile learning research to have both breadth and depth, and realize mobile learning in the intelligent era to promote the innovation and development of education.

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