

# The Analysis of Research Hot Spot and Trend on Artificial Intelligence in Education

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**Abstract**—In this work, a total of 871 papers that were published between 1999 and 2018 were retrieved from the Web of Science™ (WOSTM) platform. The descriptive analysis considered the publication volume, and countries. A global network of authors' keywords and content analysis of related scientific literature highlighted major techniques, including Virtual Reality (VR), Robotic, Machine learning, Artificial neural network, Artificial intelligence (AI), Natural language processing (NLP), most frequent applications in learning, teaching, and managing. AI technology applications in the field of education are summarized, mainly concentrated in self-adaptive learning, intelligent tutoring system and intelligent evaluation.

**Index Terms**—Artificial intelligence, education, learning, science mapping

## I. INTRODUCTION

AI is a hot term in recent years. With the rapid development of the Internet, cloud computing, big data and the Internet of things, Artificial intelligence AI technology has been applied to many industries and fields [1]. Such as transportation, finance, defense, commerce, medical care, agriculture and education.

With in the educational literature, scholars have written extensively on the benefits of AI applications, highlighting the technology's potential to make it easier for learners to learn and to create an environment where teachers can more easily teach [2]. With Virtual Reality (VR) and machine learning capacity, AI applications have assisted teachers and educators in general in the domains of education information systems, Virtual teaching, learning process surveillance, predictive

modeling and decision support [3]-[5]. As AI is rapidly transforming the educational landscape, scholarship on the topic has also mounted substantially in recent years, presenting the need for a comprehensive review of the research patterns as well as trends of AI in education [6].

In their thorough review article on teaching and studying, Katashi Nagao [7] give us a book about AI in education, a chapter is survey the literature on AIE, explain the advanced techniques (learning analytics, deep learning and machine learning) and their applications (e-learning, Intelligent Tutoring Systems (ITS)), and point out the breakthroughs and challenges for the field [8]. The paper, though among the most recent attempts to draw out application of educational AI at various stages, has yet to dig into the entirety of the literature on AIE over a certain period of time [9]. Thus, in order to identify research gaps and facilitate the clear, on-point translation of knowledge that would better inform policy development, this study presents the use of bibliometric analysis in exploring research trends in the subject of AI in education [10].

## II. DATA AND METHODS

### A. Data

With the WOSTM™ database was used as the data source, and “Artificial intelligence and education” or “AI and Education” (AIE) were used as the subjects for retrieval. The publication time was selected from 1999 to 2018, manually cull irrelevant literature (30 articles), and we get 871 articles (retrieval time: 2019,1,2) were obtained.

### B. Methods

CiteSpace is an application for visualizing and analyzing trends and patterns in scientific literature. For

progressive knowledge domain visualization, we set parameters as follows: the period of time is from 1999 to 2018, the time slice is 1 year, the node type is "Keyword", the threshold value of analysis data is top N%=50%, and Pathfinder clippings are used to generate the correlation map.

### III. ANALYSIS

#### A. Characteristics of "AIE" Literature

Publications of AI and the AIE are visually mapped and presented in Fig. 1, from 1999 to 2018. Publications of AI is obtained by the same method as AIE. It can be observed in the figure that the publications of AIE and AI displayed the developing tendency.

That is, the development of AI as the same as AIE. According to the development trajectory of AIE in the past 20 years, there have been two periods of rapid growth from 2007 to 2011 and from 2015 to 2017, which is also in line with the development law of new affairs. But AIE is relatively rare, accounting for 1.4% of AI in 1999 and 1.6% in 2018, with no significant growth.



Figure 1. A bibliometric analysis of the AI and AIE research field

In order to find out the progress of AIE research in various countries, this study counted the papers published in AIE direction by each country, among which the publishing situation of each country, as showed in Fig. 2. The USA leads by a large margin, indicating that AIE receives high attention in the USA, and the following country is PEOPLES R CHINA (China), the United Kingdom, Spain, Canada. There are 37 nodes and 61 links in the national cooperative network, and the overall density of the network is only 0.0916, indicating that AIE research groups are scattered, the cooperation among authors from different countries is less, and a scientific research group with strong cohesion has not yet formed.

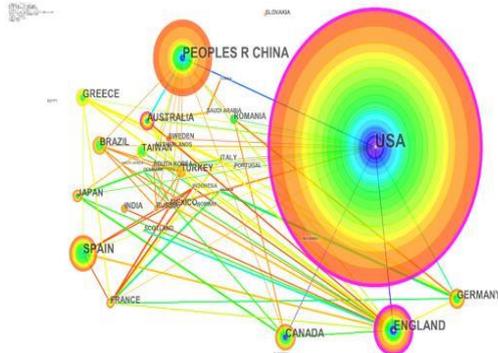


Figure 2. AIE Research nation distribution

Note: The node is the country name, the node size represents the amount of publication, the node ring represents the annual ring, the label size represents the centrality, and the edge describes the cooperation of countries.

#### B. Keyword Analysis

Keywords such as AI, education, and higher education were deleted to obtain the keywords of AI technology and its application scenarios, as showed in Fig. 3. The relevant technologies applied by AI in education field mainly include: data mining; Agent; VR; machine learning; Natural language processing (NLP). The application scenarios of AI in education mainly include: Intelligent Tutoring Systems (ITS); expert system; self-adaptive learning; online and offline education; e-learning; teaching game; Virtual Teaching; monitoring; assessment and so on.

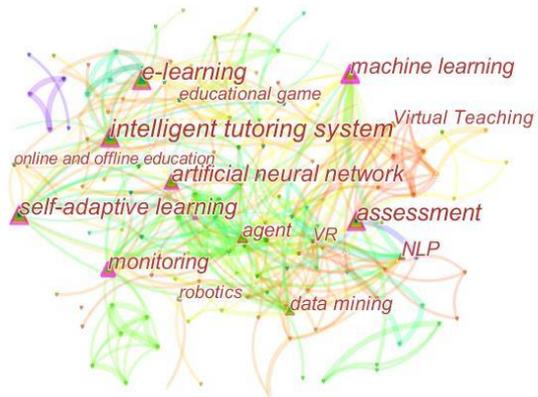


Figure 3. AIE Research keyword analysis

In general, the application scenarios of AI in education field mainly include: Self-adaptive learning, Intelligent Tutoring system (ITS) and Intelligent evaluation.

#### C. Research Frontier Analysis

Burst is mainly appear in a short time or the use of high frequency words, according to highlight the word frequency changes can determine the forefront of research and trend.

Based on CiteSpace correlation analysis, highlighted by artificial intelligence education highlight the theme and the corresponding value and cited the history curve, as showed in Fig. 4 main application research hotspot in the field of AI in education is embodied in five aspects: intelligent tutoring system (2000-2009), AI (2001-2005), the online education (2007-2008), expert system (2015). Visual teaching (2015-2016).

Top 5 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	1999 - 2018
intelligent tutoring system	1999	3.1038	2000	2009	█
AI	1999	12.2264	2001	2005	█
e-learning	1999	4.81	2007	2008	█
expert system	1999	4.6049	2013	2015	█
Virtual Teaching	1999	3.0526	2015	2016	█

Figure 4. Top Keywords with the Strongest Citation Bursts

In order to display the view of cutting-edge keyword evolution from the time dimension, this study adopted the

presentation mode of "time zone view" in CiteSpace to show the updating and mutual influence of keywords, as showed in Fig. 5.

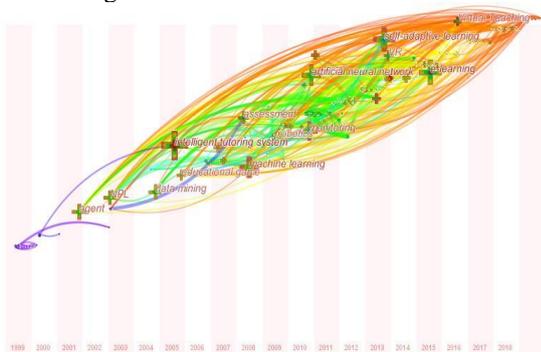


Figure 5. Time zone view of AIE research

The application research of artificial intelligence in the field of education can be divided into three stages:

From 1999 to 2005, artificial neural network appeared in the field of pattern recognition. However, due to the limited data volume and testing environment, artificial intelligence in this period was still in academic research and laboratory, and had no general practical value. The application of artificial intelligence education is limited to the stage of theoretical exploration;

Deep learning technology proposed by Hinton et al. during the exploration period from 2006 to 2012, has raised a wave of artificial intelligence. The application of artificial intelligence technology in education mainly involves teaching management, data mining, intelligent guidance and learning situation supervision;

Since 2013, AIE has gradually expanded its research fields, such as online teaching and virtual teaching.

#### IV. CONCLUSION

The paper describes the impact of AI on the education and presents a perspective on this topic. The wide application of AI technology in the education field has added new vitality to traditional school education and promoted the reform of teaching, learning and management mode. Through CiteSpace software, this study analyzed and visualized the maps and related data generated by literature on artificial intelligence and education from 1999 to 2018 in WOS™ database at different levels, and came to the following conclusions:

1) The time distribution spectrum shows that the overall development of AIE shows an upward trend, which is basically consistent with the development trajectory of literature research on AI. Among them, it entered a rapid development stage 2007 – 2011, 2015 - 2017, and has been widely concerned. However, the number of AIE related research results is small, so more researchers in interdisciplinary fields are expected to actively pay attention to and participate.

2) The spatial distribution map (Fig. 2) shows that 22 (nearly 1/9) countries in the world participated in AIE research, which is relatively small, which also indicates that AIE research has not been popularized globally. Among the countries involved in AIE research, the

United States is the representative, and its research results is far ahead of other countries. AIE theoretical research earlier in the United States, and applied research in learning and estimate, while most other countries remain in the theoretical exploration and embryonic stage. The main reasons are a directly related of the development level of AI and national education policies. In the future, it will be necessary to strengthen international cooperation, base on domestic educational resources, keep abreast of research frontiers, and form a sound mechanism of AIE development.

3) The co-emergence map (Fig. 3) of keywords shows that the hot spots of AIE research are "data mining", "VR", "Agent", "intelligent tutoring system", "online learning", etc. Keywords co-occurrence network structure is relatively loose, low density. Researchers need to broaden the scope of research and explore the depth of research content in the years to com [11].

4) Time Zone View of AIE research (Fig. 5) shows that the research frontier of AIE is reflected in the fields of "intelligent tutoring system", "AI", "online education", "expert system" and "visual teaching". The sequence map also reflects that AIE's research topics are constantly exploring new fields, covering the management of education and teaching. However, there are comparatively few studies on enrollment and evaluation of education [12]. The new research topics need to be developed and AI technology integrated with education.

#### CONFLICT OF INTEREST

The authors declare no CONFLICT of interest.

#### AUTHOR CONTRIBUTIONS

Yan Li and Aihua Jiang conducted the research; Qian Li analyzed the data; Yan Li and Changchun Zhu wrote the paper; all authors HAD approved the final version.

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