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Research Progress and Prospect of Artificial Intelligence Education in China: Statistical Analysis Based on CNKI Journal Literature

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Abstract

In recent years, the combination of artificial intelligence and all walks of life has gradually become a social hot spot. The in-depth integration of artificial intelligence technology and education has had a profound impact on the traditional educational concept, educational system and teaching mode, and has become a key issue in China for some time to come. In this paper, the core journals in the field of artificial intelligence education in China in recent 30 years are statistically studied. This paper sorts out its publications, research institutions, subject distribution, research levels, fund projects, highly cited papers and high-yield authors in detail. The research status and hot spots in the main fields of artificial intelligence education are summarized and discussed, and the future research trends are considered, in order to provide reference for the follow-up research.

Key words: Artificial intelligence education; Research review; Future expectations

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In 1954, artificial intelligence (AI) was first proposed at Dartmouth Conference. It has been more than 70 years since then. In recent years, the combination of artificial intelligence and all walks of life has gradually become a social hot spot. The deep integration of artificial intelligence technology and education has had a profound impact on the traditional educational concept, educational system and teaching mode.

The Chinese government attaches great importance to the development of artificial intelligence education. In 2017, China's State Council issued the "*Development Plan for New Generation of Artificial Intelligence*", which clearly pointed out that "Intelligent technology should be used to accelerate the reform of personnel training mode and teaching methods, and to build a new education system that includes intelligent learning and interactive learning". In April 2018, the Ministry of Education issued the "*Action Plan for Artificial Intelligence Innovation in Colleges and Universities*", emphasizing the need to "speed up the innovative application of artificial intelligence in the field of education, and use intelligent technologies to support the innovation of personnel training modes, the reform of teaching methods, and the improvement of educational governance capabilities". In January 2018, the National Natural Science Foundation of China added F0701 Classification of Educational Information Science and Technology to further promote the research on basic theories, methods and key technologies related to the integration of artificial intelligence and educational disciplines. The "*Education Informatization 2.0 Action Plan*" also clearly points out: "Continue to promote the in-depth integration of information technology and education, and the in-depth integration of information technology and intelligent technology into the whole process of education." It can be seen from this that the application of information technology represented by artificial intelligence in the field of education has become a key issue in China for some time to come.

Timely sorting out the research results of artificial intelligence education is an important foundation for deepening and expanding artificial intelligence education in the future. In order to fully understand the current situation of the development of artificial intelligence education in China, this paper takes the core journal database of HowNet as the data source, searches and analyzes the relevant literatures of artificial intelligence education, discusses in detail the research progress of artificial intelligence education in China, and puts forward suggestions for the future development of artificial intelligence education.

1. LITERATURE STATISTICS

Based on (China National Knowledge Infrastructure) CNKI journal database, with the retrieval method of "papers and abstracts", taking "intelligent education", "artificial intelligence education", "educational artificial intelligence", "AI education" and "artificial intelligence + education" as the key words, there is no limit to the starting date of retrieval. As of June 30, 2020, a total of 2232 related documents of core journals (including Core, CSSCI and CSCD) were retrieved, and 1688 remaining documents were deleted, including reports, manuscript solicitation notices, topic selection plans, information, missing authors, keywords and other field titles, as well as unrelated titles of research topics.

2. PUBLICATIONS AND RESEARCH INSTITUTIONS

2.1 Analysis of the Number of Papers Published

Table 1 shows the statistical data of 1688 papers published on an annual basis. It can be seen from this: ① The average annual number of papers published is 58.21, of which the maximum is 534 in 2019 and the minimum is 1 in 1996; Since the retrieval date is June 2020, 159 papers in 2020 are only the number of papers published in the past half a year. ② Starting from 2017, the annual number of papers published in core journals on artificial intelligence education research doubled, and the annual number of papers published from 2018 to 2020 increased sharply.

Table 1
Statistics of papers published

Year	Number of papers	Percentage of total papers	Year	Number of papers	Percentage of total papers
2020	159	9.43%	2005	34	2.02%
2019	534	31.65%	2004	34	2.02%
2018	351	20.81%	2003	27	1.60%
2017	92	5.45%	2002	24	1.42%
2016	44	2.61%	2001	14	0.83%
2015	30	1.78%	2000	13	0.77%
2014	32	1.90%	1999	10	0.59%
2013	20	1.19%	1998	7	0.41%
2012	28	1.66%	1997	6	0.36%
2011	40	2.37%	1996	1	0.06%
2010	26	1.54%	1995	9	0.53%
2009	26	1.54%	1994	3	0.18%
2008	36	2.13%	1993	6	0.36%
2007	41	2.43%	1992	3	0.18%
2006	38	2.25%	Total	1688	100%

Figure 1 visualizes Table 1 in the form of a combination of bar chart and line chart to facilitate intuitive display and deep understanding. In Figure 1, bars represent the number of papers published and broken lines represent the percentage of papers published in the total number of papers published. As can be seen from the figure, the annual number of papers published can be divided into three stages: ① Between 1992 and 1999, the broken line was close to the horizontal axis, and the annual number of papers published was very small, only less than 10 papers; ② From 2000 to 2017, the broken line is located above the horizontal axis, with ups and downs, indicating that the number of papers published in the year has increased to a certain extent compared with previous years, and there are certain fluctuations at the same time. ③ From 2018 to 2020, the broken line rose rapidly, indicating that the annual number of papers published has increased significantly compared with previous years, and the research in this direction has increased greatly, showing explosive growth. Therefore, the industry calls 2018 the first year of artificial intelligence education. The number of papers published in the field of artificial intelligence education is not only related to the innovation and breakthrough of artificial intelligence technology, but also related to the national policy guidance.

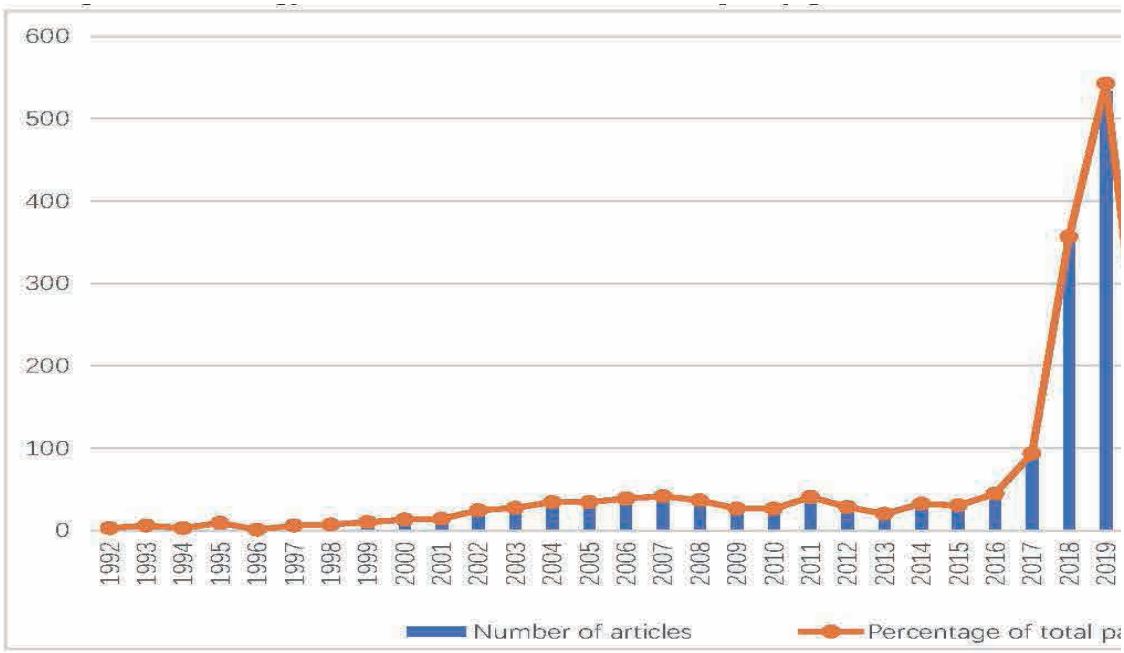

Figure 1
Statistical chart of papers published

2.2 Publications Published

It is found that there are 150 core academic journals that publish research papers on artificial intelligence education in China, and the distribution of the top 20 journals is shown in Table 3.

Table 3
Distribution of publications published research papers on artificial intelligence education (Top 20 in the number of papers published)

Serial No.:	Journals	Total number of papers published	Number of papers published in 2018-2020
1	Audio-visual Education in China	95	54
2	Modern Educational Technology	82	60
3	Journal of Distance Education	81	62
4	E-Education Research	75	50
5	Distance Education in China	47	22
6	People's Education	43	26
7	Open Education Research	40	33
8	Research in Higher Education of Engineering	27	20
9	Information Technology Education in Primary and Secondary Schools	26	0
10	Modern Distance Education Research	24	20
11	Chinese Vocational and Technical Education	21	13
12	Education and Occupation	21	6
13	China Adult Education	20	0
14	Chinese University Teaching	20	14
15	Theory and Practice of Education	19	0
16	Journal of The Chinese Society of Education	19	14
17	Teaching and Administration	19	0
18	Educational research	18	0
19	Vocational & Technical Education Forum	15	8
20	Modern Distance Education	14	4

As can be seen from Table 3, the journal that publishes the largest number of research papers on artificial intelligence education in China is *China Audio-Visual Education*, with a total of 95 papers. Journals that have published more than 70 papers include *Modern Educational Technology*, *Journal of Distance Education*

and *E-Education Research*. Among them, the top four papers from 2018 to 2020 are 62 papers in *Journal of Distance Education*, 60 papers in *Modern Educational Technology*, 54 papers in *China Educational Technology* and 50 papers in *E-Education Research*. The top 20 journals published 726 papers, accounting for 43% of the total number of papers published, which shows that the publication of artificial intelligence education research papers is relatively concentrated. Judging from the nature of publications, research papers on artificial intelligence education are basically published in educational journals. Judging from the level of publications, they are mainly concentrated in core journals. Judging from the location of the publication, it is mainly distributed in areas where information education is relatively developed, such as Beijing and Zhejiang.

2.3 Research Institutions

Research institutions provide an important platform support for the orderly conduct of academic research. See Table 4 for the main institutions of artificial intelligence education and research in China.

Table 4
Major Institutions of Artificial Intelligence Education and Research in China (Top 40 in Number of Papers Published)

Serial No.:	Research institutions	Number of papers published	Serial No.:	Research institutions	Number of papers published
1	Beijing Normal University	104	21	Qufu Normal University	15
2	East China Normal University	84	22	Nankai University	15
3	Tsinghua University	33	23	East China University of Political Science and Law	14
4	Central China Normal University	32	24	Beijing University of Technology	13
5	Tianjin University	32	25	Nanjing University	12
6	Northeast Normal University	29	26	IFlytek information technology Co., Ltd	12
7	Peking University	28	27	Beijing University of Posts and Telecommunications	11
8	Renmin University of China	27	28	Henan University	11
9	Nanjing Normal University	26	29	Henan Normal University	11
10	Zhejiang Normal University	24	30	Tongji University	9
11	South China Normal University	22	31	Sun Yat-sen University	9
12	Capital Normal University	21	32	University of Electronic Science and Technology	9
13	Zhejiang University	21	33	Tianjin Normal University	9
14	Wuhan University	18	34	Liaoning Normal University	9
15	Southwest University	17	35	Communication University of China	9
16	Jiangsu Normal University	16	36	Shenzhen University	8
17	Jiangnan University	16	37	Shandong University	8
18	Shaanxi Normal University	16	38	Hunan University	8
19	Northwest Normal University	16	39	Shanghai University	8
20	Shanghai Jiaotong University	15	40	Central South University	7

From Table 4, it can be found that the distribution of artificial intelligence education and research institutions is relatively concentrated and unbalanced. Data show that Beijing Normal University has published the most research papers on artificial intelligence education, with 104 papers in total. East China Normal University took second place with 84 papers. The top 40 research institutions published 804 papers, accounting for 47.63% of the total number of papers published in artificial intelligence education. Judging from the unit attributes of research institutions, among the top 40 research institutions, there are 39 colleges and universities, and only iFlytek Information Co., Ltd. is non-colleges and universities. It can be seen that the vast majority of artificial intelligence education research is concentrated in major colleges and universities in the education department, with less research in social institutions such as enterprises and industries, and the situation of multiple participation has not yet taken shape.

3. DISCIPLINE DISTRIBUTION, RESEARCH LEVEL AND FUND PROJECTS

3.1 Discipline Distribution

Artificial intelligence education is rich in connotation, involving pedagogy, philosophy, engineering, law, economics, management and other disciplines, and has received extensive attention from researchers in different disciplines. See Table 1 for the distribution of disciplines related to artificial intelligence education research.

Table l
Discipline Distribution of Papers in Journals of Artificial Intelligence Education Research in China

Serial No.:	Subject	Quantity	Frequency
1	Education	937	55.51%
2	Control Engineering	213	12.62%
3	News Dissemination	70	4.15%
4	Library and Information Archives	56	3.32%
5	Jurisprudence	45	2.67%
6	Computer	44	2.61%
7	Communication Economy	43	2.55%
8	Language	31	1.84%
9	Labor Economy	28	1.66%
10	Business Administration	23	1.36%
11	Philosophy	23	1.36%
12	Industrial Economy	21	1.24%
13	Society	20	1.18%
14	National Economy	20	1.18%
15	Public Administration	17	1.01%
16	Other disciplines	97	5.75%
Total		1688	100%

From the statistical data in Table 1, it can be seen that the research on artificial intelligence education in our country presents two remarkable characteristics: First, the discipline distribution is quite wide, indicating that the research has attracted extensive attention in other fields. At present, the research field of artificial intelligence education involves 16 major disciplines, including not only mainstream disciplines such as education, control engineering, law, computer, economy, business administration, but also non-mainstream disciplines such as news communication, books and archives, language, society, etc. This fully reflects the richness of the connotation and extensive application of artificial intelligence education, and also reflects the importance attached to artificial intelligence education by other disciplines, which plays an important leading and promoting role in the development of related disciplines. Second, the discipline distribution is not balanced. Among the 1688 journal documents, there are 937 documents in education, accounting for 55.51%, which is the main subject of artificial intelligence education research; Control engineering is the second discipline, with 213 articles, accounting for 12.62%. The research literature of these two disciplines accounts for as high as 68.13%. It can be seen that the main disciplines of artificial intelligence education research in China in the past 30 years are education and control engineering, while the proportion of papers published in other fields is generally low.

3.2 Research Level

Statistics show that the research literature on artificial intelligence education in China belongs to 15 research levels, and the details are shown in Table 5. According to Table 5, from the research level of literature, the research on artificial intelligence education in the past 30 years is mostly basic theoretical research and basic education research. Among them, the basic theoretical research literature is the most, totaling 966 papers, accounting for 57.23% of the total number of papers published. Higher education research took second place, with 204 papers published, accounting for 12.09% of the total number of papers published. There are few literatures on engineering technology, industry guidance, advanced science popularization, practical technology and applied countermeasures, which are the problems that should be paid attention to in promoting artificial intelligence education research in the future, so as to ensure that basic theoretical research and applied countermeasures research support each other and go hand in hand.

Table 5
Research level statistics of artificial intelligence education literature in China

Serial No.:	Research level	Number of papers	Percentage
1	Basic Research (Social Sciences)	966	57.23%
2	Higher Education	204	12.09%
3	Basic and Applied Basic Research (Natural Science)	133	7.88%
4	Basic Education and Secondary Vocational Education	120	7.11%
5	Industry Guidance (Social Sciences)	94	5.57%
6	Engineering Technology (Natural Science)	72	4.27%
7	Career Guidance (Social Sciences)	34	2.01%
8	Policy Research (Social Sciences)	25	1.48%
9	Industry Technical Guidance (Natural Science)	21	1.24%
10	Policy Research (Natural Science)	11	0.65%
11	Advanced Science Popularization (Social Science)	2	0.12%
12	Literary works	2	0.12%
13	Advanced Science Popularization (Natural Science)	2	0.12%
14	Professional Practical Technology (Natural Science)	1	0.06%
15	Popular Literature and Art	1	0.06%
Total		1688	100%

3.3 Fund Projects

Table 6
Project support of artificial intelligence education research in China

Serial No.:	Fund projects	Number of papers	Percentage
1	National Social Science Foundation	45	2.67%
2	National Natural Science Foundation of China	41	2.43%
3	National Educational Science Plan	37	2.19%
4	China Social Science University Humanity	29	1.72%
5	Jiangsu Province Education and Science Programming	7	0.41%
6	China Postdoctoral Science Foundation	6	0.36%
7	National High-tech R&D Program	3	0.18%
8	Other	639	37.86%
9	No Fund	881	52.19%
Total		1688	100%

The sources of fund projects for journal papers provide important financial support for academic research, from which the support of the government and universities for artificial intelligence education research can be perceived, which plays an important role in the research and development of related topics. According to the statistical data in Table 6, 52.19% of the papers on non-funded projects and 47.81% on funded projects in China's artificial intelligence education research. Among the papers supported by the fund, 45 are from the National Social Science Fund, 41 from the National Natural Science Fund, 37 from the National Educational Science Plan, and 29 from the Humanities and Social Sciences Research of the Ministry of Education. This shows that the research on the integration of artificial intelligence technology and education is at the forefront of relevant disciplines and has the potential for further in-depth research. However, more than half of the research documents have not been supported by any fund projects, which indicates that further support for research in this field is needed to promote the in-depth development of artificial intelligence education research.

4. HIGHLY CITED PAPERS AND HIGH-YIELD AUTHORS

4.1 Highly Cited Papers

The number of citations is an important indicator of the academic level of research documents. High citations mean higher academic attention and academic influence. See Table 7 for highly cited papers on artificial intelligence education research in China.

Table 7
Highly Cited Papers on Artificial Intelligence Education Research in China (Top 10 Cited Times)

Serial No.:	Title of the paper	Author	Publish Journals	Time of publication	Number of citations
1	From Digital Learning Environment to Intelligent Learning Environment-Changes and Trends of Learning Environment [J]	Huang Ronghuai, Yang Junfeng, Hu Yongbin	Research on Open Education	2012, 18 (01)	604
2	Smart Phone and "Internet +" Classroom-New Thinking and New Path of Integration of Information Technology and Teaching	Wang Zhuli, Li Xiaoyu, Lin Jin.	Journal of Distance Education	2015, 33 (04)	516
3	Connotation, Key Technologies and Application Trend of Educational Artificial Intelligence (EAI)-Analysis of the Reports of "Preparing for the Future of Artificial Intelligence" and "National Artificial Intelligence Research and Development Strategic Plan" in the United States	Yan Zhiming; Tang Xia Xia; Qin Xuan; Zhang Fei; Duan Yuanmei	Journal of Distance Education	2017 (01)	274
4	Theory of Multiple Intelligences and Educational Technology	Zhong Zhixian	E-education Research	2004 (03)	215
5	Robot Education: Current Situation, Problems and Promotion Strategies	Zhang Jianping; Wang Yi	China Educational Technology	2006 (12)	205
6	The Fundamental Transformation of Vocational Education Talents Training Mode in Intelligent Era	Xu Guoqing	Educational Research	2016, 37 (03)	203
7	On Robot Education (I)	Peng Shaodong	E-education Research	2002 (06)	168
8	Building an Ecosystem of "Artificial Intelligence + Education"	Wu Yonghe; Liu Bowen; Ma Xiaoling	Journal of Distance Education	2017 (05)	156
9	What is the significance of Gardner's theory of multiple intelligences to education?	Zhang Ling	Journal of East China Normal University (Educational Science Edition)	2003 (01)	153
10	Theory of Multiple Intelligences and Its Enlightenment to Quality Education	Zhang Chunling	Journal of the Chinese Society of Education	2002 (03)	141

As can be seen from Table 7, The two most cited documents are Huang Ronghuai's "*From Digital Learning Environment to Intelligent Learning Environment-Changes and Trends of Learning Environment* [J]" (Open Education Research) and Wang Zhuli's "*Smart Phone and "Internet +" Classroom-New Thinking and New Path of Integration of Information Technology and Teaching*" (Journal of Distance Education), followed by Yan Zhiming et al. "*Connotation, Key Technologies and Application Trend of Educational Artificial Intelligence (EAI)*" (Journal of Distance Education). Judging from the composition of the authors of highly cited documents, the top 10 are all achievements after 2000, of which 5 are independent achievements, but only one achievement is independent achievements in the past 15 years. It can be seen that the development trend of multi-author cooperation and multi-unit joint in artificial intelligence education research has emerged. Judging from the publication time of highly cited documents, 4 of the top 10 documents were published after 2015, which indicates that the new generation of artificial intelligence technology has received extensive attention from the academic circle in recent years. Judging from the publications of highly cited documents, 3 of the top 10 documents are published in the Journal of Distance Education, which shows that the Journal of Distance Education has great influence in the field of artificial intelligence education research in recent years. Judging from the publication level of highly cited documents, the top 10 are all core journals, which shows that highly cited documents are mainly published in core journals such as "Chinese Core" and "CSSCI Journals".

4.2 High-Yield Authors

From 1992 to 2020, the number of papers published by the first author (including independent authors) was 12. According to the calculation formula proposed by PRICED, a famous scholar in bibliometrics, statistics were made: $Mp = 0.749\ Npmax = 0.749 \times 12 = 2.5946$. Authors who published 3 or more papers were selected as candidates for high-yield authors according to rounding selection.

Table 8
High-yield Authors of Artificial Intelligence Education Research in China (Top 10 in Number of Papers Published)

Serial No.:	Author	Number of papers published	Author unit	Serial No.:	Author	Number of papers published	Author unit
1	Huang Ronghuai	12	Beijing Normal University	20	Ma Xiufeng	4	Qufu Normal University
2	Wang Zhuli	12	Sun Yat-sen University	21	Wu Yonghe	4	East China Normal University
3	Ren Youqun	11	Ministry of Education	22	Wang Shiwei	4	Shanghai Academy of Social Sciences
4	Zhang Jianping	11	Zhejiang University	23	Tian Yang	4	Beijing Normal University
5	Zhu Zhiting	8	East China Normal University	24	Zheng Qinhua	4	Beijing Normal University
6	Gao Qiqi	7	East China University of Political Science and Law	25	Dong Tongqiang	4	Qufu Normal University
7	Yu Shengquan	6	Beijing Normal University	26	Xiao Junhong	4	Shantou Radio and TV University
8	Gu Xiaoqing	6	East China Normal University	27	Liu Bangqi	4	Xunfei Institute of Educational Technology
9	Jia Jiyou	6	Peking University	28	Wang Yining	4	Northeast Normal University
10	Huang Yao	6	Ministry of Education	29	Liu Zheng	4	Central China Normal University
11	Du Jing	6	Henan University	30	Du Chuanzhong	4	Nankai University
12	Zeng Haijun	6	Beijing Normal University	31	Mang Lee	4	Beijing Normal University
13	Zhang Jiahua	6	Zhejiang Normal University	32	Sun Lihui	4	Tianjin University
14	Cheng Ping	5	Chongqing University of Technology	33	Wan Kun	4	East China Normal University
15	Zhong Shaochun	5	Ministry of Education	34	Wu Guanjun	4	East China Normal University
16	Tang Yuxi	4	South China Normal University	35	Zhu Ke	4	Henan Normal University
17	Liu Dejian	4	Beijing Normal University	36	Ma Yuhui	3	Bohai University
18	Chen Mao	4	Central China Normal University	37	Zhang Jinliang	3	Hunan University of Science and Technology
19	Liu Jin	4	Beijing University of Technology	38	Zhang Zhizhen	3	Beijing Normal University

The data in Table 8 show that Huang Ronghuai of Beijing Normal University and Wang Zhuli of Sun Yat-sen University have the most research documents on artificial intelligence education, both of which have published 12 papers. The two authors are both highly cited and high-yield authors. Ren Youqun, Zhang Jianping, Zhu Zhiting, Gao Qiqi, Yu Shengquan, Gu Xiaoqing, Jia Jiyou, Wu Yonghe, etc. Although some papers are not ranked in the top 10 in terms of citations, a careful examination of the citations of papers shows that the citations are better. Some high-yield authors and papers have low citations, which shows that high yield does not mean that all research results are of high quality, and the research level needs to be further improved.

5. ANALYSIS OF RESEARCH HOTSPOTS

5.1 Theoretical Research on Information Technology Promoting Teaching Reform

5.1.1 Research on the Connotation of Teaching Reform

Zhu Zhiting et al. pointed out that education must conform to technological development and seek innovation and change. Yan Zhengshu discussed the characteristics of Internet + teaching and made a personalized and cooperative strategic analysis of Internet+ teaching mode. Zhou Xiaoqing proposed that teaching and learning should realize two changes under the support of information technology: from "factor view" to "ecological view" and from "tool" view to "environment" view. Kang Shumin analyzed the path of teaching mode reform from four aspects: the optimization of teaching resources, the change of teaching organization mode, the change of learning activity mode and the innovation of learning evaluation mode.

5.1.2 Research on Teaching Reform from the Perspective of Technology

Zhu Zhiting and Guan Yueqi have studied what educational changes technology is causing, why educational changes need technical support, and how to use technology to promote educational changes. Wu Fati discussed the changes brought about by artificial intelligence, virtual reality, 3D printing and other technologies in the way of teaching and learning. Meng Zhiyuan et al. have studied the innovation brought about by education big data in teaching mode and knowledge acquisition and related block chain technologies. Wang Tianping discussed the changes in teaching thinking, teaching structure and teaching methods induced by big data, and put forward strategies from the perspective of teaching contents, teaching methods and teaching organization. Zhang Guanglu studied the reform of Chinese teaching from the perspective of AI thinking and proposed that artificial intelligence is helpful to the reform of Chinese learning.

5.1.3 Research on Teaching Reform based on Teaching Elements

Li Benyou et al. put forward through investigation that the main factors that affect the change of students' learning methods include learning content, individual students, teacher guidance, evaluation methods, school culture and teaching resources. Wang Changping analyzed the influence process and development trend of technology on the four elements of teaching and learning methods, teachers' knowledge system, teaching materials and learning environment. Wang Xuejun et al. studied the change of learning methods caused by media changes from two dimensions of resources and interaction. Wang Yunwu studied the criteria and reasons for the change of learning methods, and proposed that the criteria for the change of learning methods are fundamental changes in learning objectives, learning environment, learning tools and learning evaluation in learning activities. This change can be a single or multi-faceted change. Through the analysis of the domestic literature on information technology promoting teaching reform, it is found that most of the research is still at the descriptive and summary level, lacking empirical papers, and there is still a certain gap for the real realization of information technology promoting teaching reform.

5.2 Research on the Application of Artificial Intelligence Teaching

5.2.1 Research on the Application Field of Educational Artificial Intelligence

Many experts and scholars have studied the application of artificial intelligence in various disciplines. For example, Chen Ying has studied the application of artificial intelligence in English teaching in middle schools, aiming at optimizing the English teaching methods and effects in middle schools. Tang Yewei et al. have constructed a STEM interdisciplinary integration model based on artificial intelligence in order to better promote the interdisciplinary integration of STEM. Zhang Xiaoxiao et al. have studied the application of artificial intelligence in medical teaching and proposed that more attention should be paid to the improvement and research of algorithms and the experimental analysis should be strengthened in the future. In addition, in the research of application fields, Li Zhaohan et al. analyzed the automatic correction of homework, online answering of questions by taking photos, searching questions, intelligent evaluation and personalized learning, and discussed the innovative changes of artificial intelligence in learner models, teaching models and specific learning fields.

5.2.2 Research on the Application of Artificial Intelligence in Personalized Learning

How to enter personalized learning through technical support has become the focus of education. Mou Zhijia studied personalized learning in the era of "artificial

intelligence +" and designed an education cloud service platform to support personalized learning. Yang Xianmin analyzed the key technologies of resource evolution and constructed a model of resource evolution. Wu Jiyi, Huang Ronghuai and Yu Minghua pointed out that personalized push and intelligent retrieval of intelligent resources can be realized through technical support.

At present, relevant scholars have carried out a number of data analysis and application studies on learning platforms and intelligent counseling systems, recommending personalized learning resources according to the results of learning analysis. For example, Zhao Zheng (2016) has built a learning behavior analysis system, which classifies and mines behavior data from three aspects of learning content, learning path and space usage records to recommend personalized learning paths for learners. Zhu Tianyu et al. (2017) studied personalized information filtering in online learning platforms, such as curriculum, forum expert paper recommendation, student grouping, student friend recommendation, etc. Many digital library systems (such as Zhejiang University Library) model and recommend resources according to learners' interests.

5.2.3 Research on Artificial Intelligence Teaching Products

At present, the research on artificial intelligence teaching products is mostly based on educational robots, teaching platforms, teaching software, teaching tools, intelligent virtual assistants, etc., focusing on the specific application effects of the products. Zhang Liyuan et al. studied Siri Personal Assistant for Intelligent Tutor System, analyzed its working principle in cloud environment, and interpreted its technical carrier advantages in learning practice from theoretical and practical aspects. Zhan Zehui et al. analyzed the application of virtual assistant from the perspective of distance learning support services. Through research, it is concluded that virtual assistant can intelligently judge and understand the needs of learners and guide learners in due course. Wang Ping discussed the learning support function of intelligent virtual assistant. Li Zhihe et al. have applied Elomemo, a training robot in the field of music education, and proposed that learners will gradually change from passive learning to active learning.

Many colleges and universities have studied the application of VR in the field of education and teaching, mainly including: (1) virtual simulation campus design, such as Tianjin University and Zhejiang University; (2) Application of VR teaching. For example, the architectural teaching based on VR laboratory carrried out by School of Architecture,Tongji University. Computer simulation products and VR application products developed by Southwest Jiaotong University; China University of Science and Technology widely uses VR technology in physics experiments. Nankai University realizes simulation training of animal living imaging system by VR technology; Dalian Maritime University uses Unity 3D virtual reality engine to develop ship simulation education and training projects. The research on basic education is more extensive, such as Wei Yun's "AR Tu Lele", Cai Su et al.' s virtual experiment program of middle school physics about electromagnetic field, Liu Dong's virtual wall message system, and Jin Zhenwei's English listening application software AR Learning.

6. CONCLUSION

Artificial intelligence technology is comprehensively and profoundly affecting educational concepts and modes. New artificial intelligence educational applications such as big data, speech synthesis, intelligent marking system and electronic partners can effectively solve many drawbacks in traditional education, such as heavy workload of teachers, one-size-fits-all teaching and students' weariness of learning. The integration of artificial intelligence and education has brought new vitality to education. New technologies have improved teaching efficiency and changed teaching mode, making personalized and accurate education increasingly a reality. In the aspect of follow-up research, the research and application can be strengthened from three aspects: a). Carry out systematic practice of artificial intelligence curriculum system construction. b). Strengthen the guarantee of funds, build an artificial intelligence education environment, and carry out in-depth artificial intelligence education practice. c). Cultivate excellent "artificial intelligence + education" teachers, improve classroom efficiency, and truly realize intelligent teaching and learning.

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