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Overview of Online Learning Behavior Analysis in the Context of Big Data

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Abstract. Under the Internet era, various technologies such as big data and cloud computing are becoming more and more a hot issue of concern. Big data provides a large number of network resources with great economic as well as social value, which has a certain impact on various fields in society, and its use in education has received more attention from scholars. After the outbreak of the new crown epidemic, online learning has become a normalized way of learning, online learning platform records a large number of learners' learning data, through the processing and analysis of these massive data, not only is conducive to the realization of students' personalized learning, but also helps teachers to understand and master the current situation of students' learning, and then adjust their teaching. In order to have a clear understanding of the current research status of online learning behavior analysis in the context of big data, the article uses the visual analysis software CiteSpace to analyze the literature selected from the China Knowledge Network (CKN), from which the current status of the research, research hotspots, and future research trends in this field are obtained. The analysis results show that the number of publications has gradually decreased in the past two years, and there is less cooperation and communication between the core publication authors as well as the publication institutions; the analysis of learning behavior data on MOOC platforms has become a research hotspot at this stage, and in-depth learning, multi-scenario, and focusing on the students' learning experience are the future research trends.

Keywords: Big Data; Online Learning; Learning Behavior Analy;Visual Analytics;MOOC

1. Introduction

The development and reform of China's education field is facing great challenges, and the combination of big data and education has become an inevitable trend of the times, bringing new development opportunities for education. Big data in education is a collection of data, which refers to all the data generated in the process of education that is useful for education or collected from the needs of education[1] .

Due to the outbreak of the new crown epidemic, online learning has gradually entered the vision of most people, although it is now in the post epidemic era, but any many people adopt online learning, online learning by a few people's way of learning into the majority of the people involved in the learning mode, online learning platforms record some people can not get to the learning behaviors, these behaviors are fragmented, and compared with the episodic behaviors, it can respond to the students' The more real learning situation, of course, these behaviors are also not easy for teachers to see[2]. Learning platforms are rich in data about student behavior, and if appropriate technology is used to analyze them, these data can be used to track, evaluate, and improve student learning. The analysis of learning behavior data generated by online learning can not only provide personalized guidance for the learners themselves, but also help teachers to comprehensively and systematically grasp the learning situation of students, so as to better guide the students' learning.

The arrival of the big data era has made how to combine big data with educational change, and the subsequent application of learning analytics has gradually become a research hotspot in this research field[3]. Therefore, by using CiteSpace analysis software to visualize and analyze the literature on online learning behavior analysis in China Knowledge Network in the past ten years, this study intends to explore the current development status, research hotspots, and future development trends of online learning behavior analysis in the context of big data, with the expectation of providing

references for subsequent studies on online learning behavior analysis in the context of big data. It is expected to provide a reference for the subsequent research on online learning behavior analysis in the context of big data.

2. Literature Sources and Analytical Tools

2.1. Literature Sources

The literature of this study was obtained from the "China Knowledge Network (CNKI)" database, and journals in the last ten years (from 2012 to 2022) were selected in the advanced search option of CNKI. The search was conducted with the subject terms of "learning behavior analysis", "online learning behavior analysis" and "big data-supported online learning behavior analysis" respectively, and a total of 646 articles were obtained. A total of 646 documents were obtained, and the data sources unrelated to the topic, conference reports, newspapers, and school bulletins were excluded, so that a total of 496 target documents that met the research conditions were finally selected.

2.2. Analytical Tools

This study mainly adopts the visualization method to analyze the research situation of online learning behavior analysis in the context of big data, so we use the CiteSpace tool, which can visualize and analyze a large amount of literature, and finally obtain some relevant knowledge graphs, and from the annual number of articles, related authors and issuing institutions, we can understand the current research status of the problems in this field and the cooperation between scholars and institutions. From the annual number of publications, related authors and publishing organizations, we can understand the research status of the problems in this field and the cooperation between scholars and institutions, and from the knowledge map of keywords, we can understand in which direction scholars focus their research, i.e., the hotspots in this field. In addition, the emergence map and time series map of the keywords can be used to analyze the research trend of the study, which provides a direction for the subsequent research on the analysis of online learning behaviors based on big data.

3. Analysis of the Current State of Research

3.1. Distribution of Annual Issuances

By counting the literature on learning behavior analysis obtained from screening from 2012 to 2022 in the order of years, the number of articles issued is obtained as shown in Figure 1. The number of domestic literature on learning behavior analysis has been in an upward trend, with the largest number of papers issued in 2019, a total of 85 papers, and the state also issued some relevant policy documents in 2018 to promote the development of learning behavior analysis.The smallest number of papers was issued in 2012, only 8 papers, when with the progress of science and technology, learning behavior analysis gradually entered the field of vision of researchers, and the number of researchers was only a few. The number of researchers is only a few. From 2020, there is a decreasing trend, because the statistics of 2022 is only up to June, the number of literature is not complete, so there is a straight downward trend from 2021 to 2022.

3.2. Distribution of Core Authors

By analyzing the core authors in the field, we can clearly understand which scholars in the field, which scholars' main research direction is related to this topic, which scholars are more articles, and this information will help to follow up on the further understanding of the topic of study, in addition, understanding this information can also be a better grasp of the dynamics of the field of research, to obtain the latest research, to facilitate the subsequent scholars' research.

Using CiteSpace software to analyze the distribution of core authors of the selected literature, the number of nodes N=290, its number of connectivity E=128, and the density Density=0.0031, which

indicates that the cooperation and communication between the core of the authors of the published articles is very little, and there are nodes with no connectivity between them, and only a few authors are connected to each other. In addition, for the research on this topic, the top five scholars in terms of the number of published articles are Zhijia Mou, Zhi Liu, Yang Zong, Wenyan Wu, and Qingtang Liu, among which Zhijia Mou from Jiangnan University has the most number of published articles, with four, and the rest of them all have published three, and he mainly researches on the personalized learning of students, the analysis of their behaviors, and prediction of their learning outcomes in the context of big data. Liu Zhi from Central China Normal University, his main areas of interest are big data in education, learning analytics, learning behavior, SPOC and other aspects. In the third place is Zong Yang from Beijing Normal University, whose research areas are learning analytics, online learning behavior, MOOC, Moodle platform and so on. Wu Wenyan from Guangdong University of Technology's research area is in the areas of personalized learning space, online learning, and deep learning. Finally, Qingtang Liu from Central China Normal University, his main research areas of interest are learning analytics, analytic models, and Web services.

3.3. Distribution of core issuers

By using CiteSpace software to analyze the issuing institutions, the institutions with more articles are the National Engineering Research Center for Digital Learning of Central China Normal University, the Network Language Information Center of Yunnan University, and the Department of Educational Information Technology of East China Normal University. As can be seen from these institutions, most of the core research institutions are independent research departments or specific colleges in institutions of higher education. Compared with other departments, professional research departments are more aware of the development of the research field, so it is easier for them to put forward the research frontiers of the research field as well as some new perspectives, and the scientific research results are more significant. However, as can be seen from the figure below, there is no connection between the various issuing institutions, and there is no cooperation among them. Therefore, in the subsequent research, the institutions should strengthen their cooperation and learn from each other, and only in this way will the development of the field become better and more comprehensive.

4. Research Hotspots

The analysis of keywords can summarize the hot issues for this research direction, and the research hotspot reflects the key research direction and research content of a certain research field in a certain period of time, and knowing and understanding the hot issues of a certain research field is of great significance to the development of subsequent research. Co-occurrence clustering analysis method is to study the simultaneous occurrence of theme words in a piece of literature, and then through these co-occurring theme words to connect the related literature to form an interrelated network, which analyzes the summarized and standardized theme words in scientific and technical papers[4]. Co-occurrence clustering analysis of studies related to the analysis of online learning behavior in the context of big data can identify important research directions in this research area and predict future research trends.

The keywords are analyzed, the node type selects the keywords, and the other parameters are set the same as analyzing the core authors and the core issuing institutions. The module value Q = 0.6455, indicating that the clustering effect is relatively significant, and the average profile value S = 0.7428, indicating that the structure of the clusters is better, and the clustering results are acceptable. The nodes in the figure represent the keywords in the literature, and that one connecting line between the nodes and the nodes represents the co-occurrence of the keywords, and this line also has its own indicated content, and if the keywords co-occur more often, this line will also become thicker[5]. From the results of the analysis, it can be seen that the hot research areas of online learning behavior analysis research in the context of big data are: learning behavior, online learning, learning analytics, MOOC, big data, and learning effect.

4.1. Learning Behaviors

In traditional classroom teaching, learning behaviors are external and visible, and the keywords for this clustering are "learning analytics", "big data", "internet", "data mining" and so on. "data mining" and so on. Students in the classroom to answer questions, communicate with classmates to discuss are in the process of learning behavior, these behaviors can be directly captured by the teacher, the teacher can be based on the learning behaviors shown by the students to determine whether the students are listening to the class seriously, whether the degree of learning engagement is high, and in the class in a timely manner to intervene. However, with the arrival of information technology in education, more and more teachers use information technology to teach, especially after the outbreak of the new crown epidemic, online learning has become a normalized way of learning, and many of the students' learning behaviors teachers can't see all, most of them exist in the learning platform, and these learning behaviors hidden in the platform are more responsive to the learner's level of thinking and learning attitude, and it is beneficial to process and analyze the educational data, not only for the benefit of the students, but also to help teachers to determine whether students are listening attentively to the lessons. The processing and analysis of educational data is not only conducive to the realization of personalized learning, but also helps teachers to grasp the current situation of students' learning and adjust their teaching in a timely manner.

Fully understand the characteristics of the learning behavior of online learners and the actual implementation of the results of these analyses to provide students with support services and corresponding recommendations, which are conducive to the assessment of the quality of online teaching, supervision and data support for the implementation of teaching reform[6], only on the basis of understanding the learning behavior in order to better analyze the online learning behavior, so as to achieve the personalized teaching of students.

4.2. Online Learning

The keywords of this clustering are "data mining", "behavioral analysis", "online learning", "learning behavior" and so on. Online learning is slowly developed along with the development of the network and the development of modern communication technology, and nowadays people often say online learning specifically refers to web-based learning. It is different from traditional learning, focusing on the broad level of learning and focusing on social behavior[7]. During the New Crown Epidemic, online learning was carried out nationwide, which transformed online learning from a minority participation to an all-volunteer form, however, in the post-epidemic era, the integration of online and offline learning appeared in the public's view, and online learning has all but become a normalized form of learning[8]. In the face of such a normalized form of teaching, it is necessary to make full use of the existing technical support, so that the technology serves the learners and provides them with a good learning experience.

4.3. Learning Analysis

The keywords of this cluster are "cluster analysis", "correlation analysis", "case study", "self-directed learning", and so on. For several consecutive years, "learning analytics" has been recognized as one of the major trends and key technologies affecting the development of education in the Horizon Report, and in order to promote the development of learning analytics, the international academic community has strengthened academic exchanges in this area, and organizes the "International Conference on Learning Analytics and Knowledge" every year. Knowledge" is organized annually at[9]. Through the analysis of learning analytics related literature, it is found that at present, learning analytics is used as a means, method and research tool at home and abroad, but it is different from the general method, and its method involves tools. Learning platform it records a lot of learners' invisible learning behaviors, but these learning behaviors are generally fragmented, and the students' most real thinking and learning are also shown by these behaviors, of course, these behaviors can not be seen by the teacher, and other related evaluation methods can not be captured. However, teachers can analyze the data in the platform used by students for online learning and then analyze the data,

and the analysis results can judge the students' learning needs, learning styles, and learning progress, so as to implement personalized teaching.

4.4. MOOC

MOOC, i.e. "Massive Open Online Course", can be directly translated as "Massive Open Online Course", and some people in China also translate MOOC as "Mucue" (慕课). "[10]. The keywords of this cluster are "SPOC", "data analysis", "learning motivation", "online teaching", etc. On the MOOC platform, the keywords of this cluster are "SPOC", "data analysis", "learning motivation", "online teaching", "online teaching", etc. There are a lot of free courses for learners on the MOOC platform, of course, it has comprehensive functions, provides diverse learning resources, and allows communication and discussion, so it is a high-quality platform for online learning. With the promotion of education informatization and the rise of online learning, the MOOC platform is loved by most people. Because the platform itself has more functions, the data generated is not only diversified in form, but also very large in quantity. At the same time, with the rise of learning analytics technology, researchers have begun to analyze the data generated in the MOOC platform in different forms, and some researchers analyze the data in the MOOC platform and then analyze the learning behaviors of the learners, so as to realize the study of the relationship between learning behaviors and learning motivation, learning outcomes, learning effects, and ultimately achieve the prediction of learning outcomes; in addition, others study what kind of relationship between learners' learning behavior characteristics and learning effects. Making full use of the data generated in the learning platform to analyze learners' learning behaviors is a research hotspot for the analysis of online learning behaviors in the context of big data.

4.5. Big Data

In the context of the era of big data, education is also undergoing a corresponding change, the previous education is experience-based, but now education with data-driven, education informatization it promotes the personalized development of students. By analyzing learners' learning behavior through big data, we can accurately obtain learners' characteristics, predict learning outcomes, and eventually provide personalized guidance to students, and then teachers can intervene to achieve a more flexible and comprehensive online learning mode[11]. The keywords of this cluster are "deep learning", "analytics", "online learning", "smart classroom". The data generated in the smart classroom can also be used to analyze learners' learning behaviors and then intervene, and big data has also been used in the study to analyze whether learners engage in deep learning.

5. Analysis of Development Trends in Research

Through the analysis of keywords, we can not only know the current research status of the field but also find out the future research trends, understand the future research trends will be conducive to the selection of topics for subsequent research, and at the same time, the understanding of the problem will be more in-depth, the use of CiteSpace software through the keyword highlights and the analysis of the time-series diagrams can be found out from the background of the big data, the behavioral analysis of the study of online learning behavior. Future Research Trends.

5.1. Keyword emergence map

The emergent word is essentially a keyword, which refers to the number of times the keyword is cited in any one time becomes more, so we can use the emergent word to analyze the research trend of a certain research direction in a period of time, from which it can be seen that the keywords "online teaching", "catechism" and "online learning" have been appearing from 2020 to 2022, and are also the future research trend. From the figure, it can be seen that the keywords "online teaching", "catechism" and "online learning" have been appearing from 2020 to 2022, which is the current research hotspot and also the future research trend.

5.2. Keyword Timing Chart

In addition to the keyword emergence map that can reflect the research trends in the field, the keyword chronology map can be used to react to the research content of a certain research topic over time, and in a way, it can also be used to analyze the development trend of a certain research in a certain period of time. The results obtained through the analysis of CiteSpace software are shown below. It can be seen that early attention is more concerned about finding data from online learning platforms for analysis, prediction of performance, and through the study of learners' learning behavior to determine their learning efficiency, learning effectiveness and other aspects of the content, with the development of time, the research is now more concerned about the use of data analysis to determine whether the student is a deep learning, taking into account more of the student's learning scenarios as well as learning experience, using algorithms in machine learning to study students' online learning behaviors and other contents, and all these contents will become the future research trend.

5.2.1. Deep Learning

Deep learning it develops students' higher-order thinking ability and innovation ability, and it is also a major change in the way of education, with the deepening of research, it has become a hot issue of research in the field of education[12]. Among the existing studies on the analysis of online learning behaviors, more studies are conducted to explore the relationship between learning behaviors and learning motivation and learning effects by using educational data and analyzing learners' online learning behaviors, and some researchers are also analyzing students' learning behaviors to make predictions on learning outcomes. From the results, more attention is paid to the final one presented, whether it is learning achievement or learning efficiency, but from the key words in the literature in the last two years, it can be seen that researchers have been less concerned about the students' performance, and turned to the deep learning and machine learning aspects, and their research is to analyze whether the learners are deep learners or not from the data through learning analytics techniques.

Research on deep learning is also very much, but the content of the research is different to a certain extent, some scholars study what affects the deep learning of learners in different teaching and learning modes; some construct models of deep learning, as well as evaluation and detection of deep learning and other directions. In the post epidemic era, online learning has become a very common way of learning, in the face of the large amount of data generated by online learning, it should be analyzed in conjunction with the development and progress of technology, the country wants to cultivate innovative talents, and deep learning can cultivate students' higher-order thinking ability as well as innovation ability, therefore, through the analysis of the online learning behavior, the study of the content involved in deep learning will become a future research hotspot as well as research trend.

5.2.2. Multi-scene

In the Outline of the Fourteenth Five-Year Plan and Vision 2035 for the National Economic and Social Development of the People's Republic of China, it talks about our need to develop scenario-based learning[13]. Scenario-based learning is now a new form of learning that allows learners to actively participate in learning and promote their own abilities by adopting an inquiry-based approach to solving problems faced in real life. Online learning affects the communication between teachers and students, and the quality of teaching is also affected to a certain extent. In addition, due to the gradual expansion of the demand for online learning, the quality of education is gradually declining in some online educational institutions for the pursuit of momentary benefits, so it is necessary to be oriented to educate people, make full use of the new generation of intelligent technology, and build a learning scene that can meet the needs of students and effectively break the sense of isolation brought about by the separation of teachers and students. Scenario[14].

5.2.3. Learning Experience

After the "student-centered" point of view was put forward, researchers in the field of educational research gradually began to study what kind of relationship exists between the quality of teaching itself and the student experience. At present, scholars have three different perspectives on the understanding of the learning experience: pedagogical perspective, psychological perspective, and user's perspective. But among these three perspectives, online education agrees with the third perspective[15]. According to this perspective, learning experience refers to people's cognitive impressions of and responses to the products, systems or related services they use or expect to use[16]. After the outbreak of the New Crown Epidemic, online teaching began on a large scale throughout the country, but many parents believe that online teaching is unreasonable because their children's academic performance can not be improved, but the root of the problem lies in the online teaching itself, in other words, the resources of high-quality courses are limited and can not meet the needs of all students. In the existing research on learning experience, it has been pointed out that the online learning experience varies from school to school and from program to program, and the learning experience of students has a direct impact on their learning results. Especially if the learning experience of online learning is not good, the learning effect of students is actually conceivable. The learning experience of online learning may be multi-faceted, the learning platform, the quality of learning resources, the quality of the course, the network factors, and other aspects of these aspects will affect the learning experience of students.

In future research, we can pay attention to students' online learning experience as much as possible, and judge students' online learning experience by analyzing their online learning behaviors, so as to better adjust students' online learning and improve their online learning effect. In addition, we can analyze the learning behaviors and judge the learning experience according to the data of students in the platform, and then re-select or improve the learning platform. In addition, we can analyze the learning behavior and judge the learning experience based on the data of students in the platform, and then re-select or improve the learning platform.

5.2.4. Learning Outputs

At present, the concept of learning output is not clearly put forward, but the academic community has put forward some views, which is relatively representative of the view that the learning output includes the mastery of knowledge and skills, but also includes the enhancement of the cultivation of emotional values[17]. Wang Yongping et al.[18]think that learning outputs need to pay attention to the knowledge, skills and emotional values learned by students, but also to make them visible, the form of learning outputs is diversified, from small behaviors to large behaviors are considered learning outputs. Emphasizing students' learning outputs is more student-centered and more conducive to the development of students' thinking and expression skills, as well as affective values and creative hands-on practical skills. Therefore, more attention should be paid to the issue of online learning outputs in the subsequent research, and the relationship between online learning behaviors and learning outputs should be explored through analyzing online learning behaviors.

6. Conclusions and Outlook

By using CiteSpace software to visualize, analyze and interpret the journals about online learning behavior analysis in the context of big data in China Knowledge Network in the past ten years, the following conclusions were drawn, through the annual number of publications, China's publication in this research field has been in an upward trend, with the largest number of publications in 2019, and the number of publications in the later years began to show a downward trend, because the 2022 Journal is only up to June, it is not possible to count the amount of articles issued in a complete year, so the amount of articles issued in this year is less; through the visual analysis of the core authors and the core issuing institutions, it was found that there is less cooperation between the issuing authors and the research institutions, and the overall distribution is more fragmented, in order to be able to better explore the field of this research, the major institutions and the authors should strengthen the

cooperation between each other, and In order to better explore this research area, major institutions and authors should strengthen their cooperation with each other and contribute to the research in this area; through the co-occurrence clustering diagram of the keywords, it is found that the current research in this area is to analyze the learning results of the learners and the learning behaviors of the students through the MOOC platform, so as to explore which behaviors affect the learning results and efficiency of students, and the teachers can intervene appropriately; lastly, through the keyword emergence diagram and the time sequence diagram, it is found that exploring the relationship between online learning behaviors and in-depth learning is very important. It is found that exploring the relationship between online learning behaviors and deep learning, learning experience, and learning output is a future research trend, and in addition, multi-scenario teaching should be considered in the future to take into account students' learning experience.

In the Internet era, society is increasingly concerned about the use of big data, cloud computing and other technologies, the network resources provided by big data are extremely rich and of great value, the application of big data in society is becoming more and more widespread, and researchers are mainly concerned about the use of it in the field of education. Making full use of the data generated in the education platform to analyze students' online learning behavior is conducive to teachers providing personalized services for students and timely intervention in students' learning, thus improving students' learning experience and promoting deep learning.

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