

Review of the Personalized Learning In China

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Abstract: *Teaching students per their aptitude and individualized training is the focus of the world's attention, and it is also one of the eight major concepts of Chinese education. Based on the Chinese Social Sciences Citation Index database, this paper systematically analyzed the concept and connotation of personalized learning in China. Meanwhile, it reviewed the progress of its theoretical research and various support technologies including learning analysis technology, personalized recommendation technology, personalized learning path planning, personalized learning system and environment. We further reviewed the characteristics and key points of China's personalized learning theory research from the perspective of theory, practical application and technological development, and then analyzed the development trend of personalized learning in the era of artificial intelligence.*

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Overview

WITH the development of Internet technology and big data, Internet information technology has revolutionized various industries. Countries around the world have tried to use big data education to promote education innovation and reform. Big data technology is driving more remarkable changes in the education field. “Teaching 2030” in the United States pointed out that the teaching ecology will change: advances in cognitive science and technology enable teachers and students to conduct immersive and personalized learning. Teachers will combine discoveries in brain research and cutting-edge technology to improve teaching based on students’ learning styles. Customized and personalized learning programs are required; learning will focus on 21st-century skills centered on critical thinking and problem solving, communication skills, cooperation skills, and creativity and innovation skills. Germany, Finland, Canada, Japan, etc., have all put forward new visions and goals for future education. The Central Government of China and the State Council of China has issued “*China Education Modernization 2035*”. One of the eight concepts of education proposed is to teach students by their aptitude and individualized training. It has become an unstoppable trend in modern education to promote education application innovation driven by data and realize the organic unity of education scale and individualization.

Use “personalized learning,” or “personalized teaching,” or “precision teaching” to search on China National Knowledge Infrastructure (CNKI). Select “EI,” “Peking University Core,” and “Chinese Social Sciences Citation Index (CSSCI)” as the journal source to get 351 records. The annual trend of publication is shown in **Figure 1**.

In addition to the keywords “personalized learning,” “personalized teaching,” and “precision teaching” used in the search, the most prominent keyword is “big data.” Followed by “personalized teaching model,” “personalized learning system,” “personalized learning resource recommendation,” etc. There are also topics related to the environment and disciplines. Excluding subject teaching and research content, as well as news releases, 106 articles of highly relevant CSSCI sources over the past two decades, were selected. Follow-up research was conducted around these 106 documents.

Analysis of the Research Trend

From the time sequence of the occurrence of keywords, this field’s research trend can be drawn. The keyword sequence diagram of the past ten years is shown in **Table 1**.

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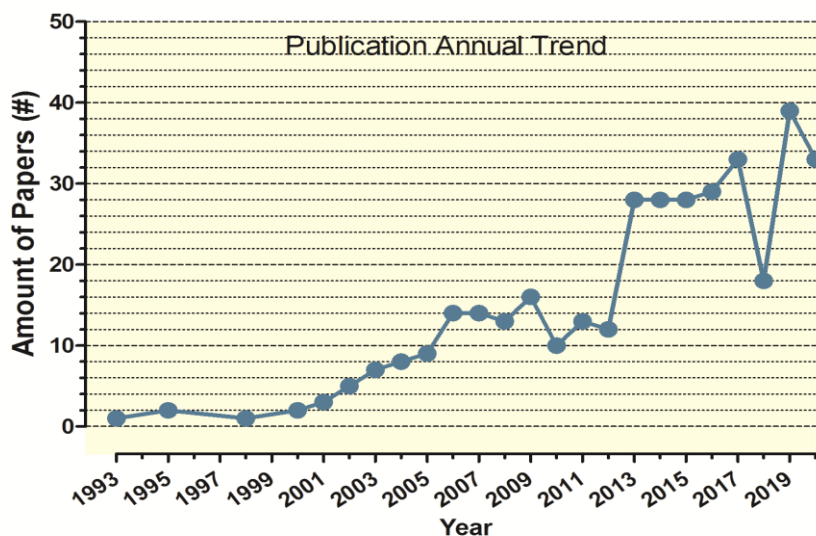


Figure 1. Overall Annual Trend Analysis of the Volume of Related Documents.

Table 1. Keyword Distribution in the Past Ten Years.

Years	Keywords
2011-2012	Personalized Learning, Personalized Teaching, Teaching Mode, Learning Resource Service, Learning Process Service
2013-2014	Personalized Teaching, Precision Teaching, Learning Process Service, Interactive Teaching
2015-2016	Learning Analysis, Electronic Bookbag Learning-Centered, Precision Teaching
2017-2018	Big Data, Learner Model, MOOC, Personalized Learning Platform, Personal Learning Environment, Personalized Learning Path
2019-2020	Personalized Education Artificial Intelligence, E-Learning Smart Learning, Big Data in Education, Online Diagnosis Personalized Learning Path Planning, Rural School

Every two years, it can be seen that the learning analysis was relatively adopted in 2014, and then big data was the most prominent in 2016-2017. Big data and learner models have become research hotspots, followed by personalized learning paths and concepts

related to artificial intelligence technology. In the past two years, education big data and personalized learning path planning are still research hotspots; at the same time, cognitive diagnosis, online diagnosis, development path, and rural education informatization related research appeared.

Personalized learning focuses on the development of students' personality and the improvement of their learning ability. It emphasizes student learning as the center, respecting students' learning needs, learning methods, knowledge background, intelligence, interests, attitudes, values, and other personalized learning characteristics or laws. Exploit the learning potential of each student and promote students' realization' personalized learning goals. In the past, limited by the times, personalized learning only stayed at the level of theoretical exploration. Now the emergence of big data has dramatically changed the way people think and make decisions. Educational big data makes students quantifiable and personalized learning will usher in the era of big data.

Analysis of Current Research Hotspots

By analyzing keywords within five years, the current research hotspots are learning analysis, big data, learner models, personalized learning paths, teaching models, etc. Personalized learning path planning and learning resource push, etc., all belong to the learning analysis category and are based on big data. Teaching mode is a continuous research hotspot, and there are more keywords such as smart education and smart classroom, reflecting the characteristics of the era of artificial intelligence + and the influence of artificial intelligence technology on education.

The follow-up analysis was carried out from the concept and connotation of personalized learning, personalized learning curriculum system, learning process, and technical services. Besides the research results of personalized learning and teaching models, the literature analysis results focused on the current status and progress of the learning analysis techniques based on big data.

Definition and Connotation of Personalized Learning

The learning process of "individualized learning" should be a process in which appropriate methods, means, content, starting points, processes, evaluation methods, etc. are adopted according to the personality characteristics and development potential of students, to promote students to obtain full freedom and harmonious development in all aspects (Li et al., 2005).

Before the advent of the Internet+ era, learners' learning activities were mainly concentrated in the classroom. How does children's classroom learning reflect individualized learning? From the learning process and cognitive process perspective, each child's classroom learning is a personalized process reflected in the student's cognitive process and the relationship between learning emotions and society. Personalized learning is analyzed and evaluated, and five evaluation dimensions are established, including

knowledge and skill goal achievement, individual cognitive process, the cognitive process of group cooperative learning, positive subject emotions, and peer relationship, in order to understand and evaluate the individualization of students Learning provides an analysis framework and series of tools (Xia et al., 2013).

With the development of the Internet and the diversification of learning methods, the observable and recordable learning process makes big educational data a powerful promoter of personalized learning. The digital learning environment enables learners, learning content, learning resources, learning tools, and learning environment has produced a wealth of process data. These data provide a high-value research foundation for personalized learning and teaching and impact the connotation of personalized learning. Personalized learning based on big data learning analysis technology has become education Research trends in science and cognitive science. Big data learning analysis positively impacts stakeholders such as teachers, students, and education administrators in personalized learning. The value of big data in achieving personalized learning is reflected in five aspects: perfecting personalized learner files and analysis predict individualized learning behaviors, optimize individualized educational decisions, improve individualized learning assessments, and provide individualized learning feedback and suggestions (Yang, 2016). Big data has become a new way of thinking and learning path.

The advent of the artificial intelligence era has had a significant impact on personalized learning theory and practice. Artificial intelligence technology with machine learning and deep learning as the core has reshaped and reinvented personalized learning. In the “artificial intelligence+” era, personalized learning should have the theoretical support of “one center, three orientations,” centered on learners, and oriented by goals, processes, and evaluations (Mou, 2017). Personalized learning must grasp the learner’s mental characteristics first, and then provide content, activities, paths, and evaluations that meet their individual needs for the entire learning process, and finally achieve self-directed meaningful learning on the learning goals. Cultivate the core literacy of independent development on growth goals (Mou, 2017). Personalized learning is a manifestation of the deep integration of technology and education at an advanced stage. With the promotion and assistance of technology, personalized learning has achieved rapid development from organizational form to implementation effectiveness and evaluation methods.

Personalized Learning Curriculum System

The curriculum system of individualized teaching must follow the characteristics of children’s development and realize the harmonious and free development of children (Deng, 2000a). It must be complete and adapt to the times’ changes and be “ecological” (Yang, 2009). The personalized teaching curriculum system should first include practical experience, metaphysics, and fervent beliefs (Deng, 2000b). Simultaneously, micro-courses are designed for a particular concept or theme, contain the latest cultural knowledge, and reflect the time-courses can meet students’ needs for spiritual and prob-

lem courses and maintain dynamic changes in the courses, forming curriculum ecology. To meet students' diverse individual needs, the courses should also have multiple options. Compulsory and multiple optional courses influence and complement each other, embody autonomy and individual thinking, and promote the free development of students' personality.

In recent years, the rise of online learning platforms has made personalized teaching research more online. Under the concept of promoting and supporting learners' personalized learning, The MOOC learner's personalized learning ecosystem consists of four parts: learners' personalized learning, interactive learning environment, technical functions, and evidence-based quality improvement (Yang & Jiao, 2014). MOOC learners' personalized learning is the core part of the MOOC design framework, which provides the basis for designing the other three parts. With the substantial increase in MOOC course construction, MOOC development's value orientation will affect the course subject's value orientation in the MOOC development process. To realize MOOC development's value orientation that promotes personalized learning, it is necessary to start from the education administration department, universities, teacher teams, and MOOC platforms. The operators' joint efforts clarify their critical responsibilities from system supply, MOOC development concept, development process, technical support, etc., to realize personalized learning MOOC (Feng, 2019).

Personalized Learning Process

The Roles of Teachers and Students

The individualized learning process requires the teacher's individualized teaching to meet the students' individualized learning to promote students' overall development. As early as the end of the 20th century, personalized teaching advocated "student freedom theory," emphasizing that students start from their personal needs in the process of personalized learning, are the masters of their learning, and have personalized learning plans according to their wishes. It embodies the idea of "student-oriented."

Learning Mode

Individualized learning and teaching aim to fully consider learners' individual needs and provide more targeted learning resources to obtain a more efficient learning process. How to organize personalized teaching to promote personalized learning, teaching design and implementation strategies to adopt, teachers and researchers continue to explore and research from the theoretical and practical levels and develop some effective learning and teaching models.

Take the Individual as the Starting Point, Goal-Driven

The primary condition for personalized learning is individualized needs. Learners have a clear goal to have strong learning motivation. The goal-driven personalized learning model is based on a computer application system. The learner proposes clear learning goals and is driven by goals. Learners create all kinds of necessary learning conditions and stage goals and promote the advanced process. The system focuses on individualized development and has the characteristics of clear goals, independent choice, transparent process, etc., which is very positive for learners' learning enthusiasm (Zheng et al., 2010).

Make Full Use of Network Platforms and Resources

The development of the Internet makes the use of the Internet to achieve teacher-student, student-student interactions more and more convenient and faster, and the use of the Internet environment to build a personalized learning innovation model can be specifically designed from the aspects of learning path, learning resources, learning support, learning evaluation, etc. The learning path can be divided into goal-based learning, systematic learning, task-based learning, and self-selected learning (Zhong, 2012); students can freely choose according to their learning interests, plans, motivations, and needs, etc., and provide different learning paths. Personalized learning resources; at the same time, provide necessary learning support for students' personalized learning and communication activities, including guidance support and student support, etc.; and through learning evaluation and feedback, help students understand their learning situation and adjust their learning behavior in time. Improve the efficiency of personalized learning.

MOOC learners are mainly engaged in personalized learning in a unique learning situation. If learners want to choose and customize personalized courses and achieve personalized goals, they need to be proactive, immersed in the course content and interactive process, and be creative complete course tasks and reflect. The personalized learning process in the MOOC learner, personalized learning model is divided into five stages: activity/learning path selection, planning/management, conceptual integration of knowledge, and knowledge creation (Yang, 2014). First of all, learners should make their courses according to their private foundation and needs, and secondly, they should make their learning plans by choosing courses. The third is to create a link between the actual knowledge and the new learning; the fourth is to integrate and construct the acquired information to form a new knowledge structure of its own. Finally, through analysis, reflection and evaluation, and abstract sublimation, new knowledge is created (Yang, 2014). From the essential elements of the learning process and supporting MOOC learning conditions, MOOC learners' learning process can be divided into four stages: pre-analysis, MOOC technical functions, interactive learning environment creation, autonomous learning, and learning result evaluation (Yang, 2016). In the preliminary analysis stage, MOOC learners are analyzed in detail from the four aspects of learning purpose, learning experience, learning background, and participating activities. The course platform provides technical support and learning environment services in the learning environment's creation stage; the autonomous learning stage is divided into

five parts: learning resource selection, learning strategy formulation, knowledge conceptualization, knowledge integration, and knowledge innovation.

The development of high-quality online courses gave birth to the flipped classroom teaching model. The flipped classroom puts the traditional knowledge transfer part before the class, and the class focuses on problem-solving, discussion, and collaborative learning, thereby promoting knowledge internalization and ability transfer. Integrate personalized teaching with the flipped classroom model to realize a flipped classroom teaching model based on the concept of personalized learning (Wu, 2015), which consists of three parts: pre-class, mid-class, and post-class (Wu, 2015). Prepare for personalized learning strategies and resources before class, and transfer learning resources and exercises through instant messaging software for corresponding pre-class knowledge transfer. In the class, in a personalized learning environment, a problem-oriented task situation is created, collaborative learning, independent learning, and personalized guidance are carried out, and results are summarized, and personalized evaluation, and finally solve problems and promote knowledge internalization. After class, teachers and students reflect at the same time. This model respects individual differences. In the knowledge transfer stage, students complete it independently before class; in the knowledge internalization stage, teachers guide students to collaborate and complete it independently, which is an efficient mode of personalized learning. However, there are still many challenges in teaching practice, such as the guarantee of the learning effect of knowledge transfer before class, and the time and progress control of the teaching process in class need to be continuously explored in practice.

Diversified Classroom Types

In the field of basic education, the central place of learning is still the classroom. To achieve personalized learning, it is necessary to transform the uniform class teaching mode and present classroom types diversification. Each student is unique, and individualized learning should have various classroom types such as regular classes, lectures, free learning classes, and exhibition exchange classes (Ding, 2013). These classroom models have achieved remarkable results. They organically combine individual teaching, group teaching, and group teaching. They can not only realize independent learning from the needs of students, but also share differences through group cooperation and exchanges, and at the same time give play to the exchange of teachers and students in collaborative teaching (Xiong et al., 2014). Among them, group learning plays an important role as an intermediary between individual learning and collective learning. Group learning can be divided into communication and sharing, division of labor and collaboration, help and support, mutual evaluation, and promotion (Liu, 2014). The type is suitable for different learning scenarios, with different requirements and learning processes.

Personalized Learning Service and Technical Support

Personalized learning aims to take students as the main body and provide personalized resources and services based on students' individual needs to maximize the learning effect. The development of the Internet, the emergence of big educational data, and the popularization of artificial intelligence technology have provided more accurate support services for personalized learning and teaching.

The service and technical support of personalized learning can be summarized in the following three aspects:

Learner Analysis

As the executor of personalized learning, learners are the focus and focus of research. The methods and approaches to acquire learners' learning needs and learning styles become more sophisticated and intelligent with technology development. With the Chinese government's commitment, significant breakthroughs have been made in China's education informatization work. In the past three decades, national informatization construction achievements, especially education informatization construction, have provided a strong technical guarantee for developing this large-scale online education activity (Zhou et al., 2020).

Measurement of Learning Style

Students of different learning styles have different preferences for learning resources, environments, and learning strategies. They significantly impact personalized learning and prompt researchers to design various learning style measurement methods to determine learners' learning styles and match suitable learning strategies and learning resources to provide more targeted learning services. Zhao et al. (2015) designed a learning style measurement and personalized learning strategy online guidance system based on the distance education environment, matching and calculating the learning style and learning strategy, and finding a learning strategy more suitable for learners, which can effectively help distance education under the environment, learners develop personalized learning.

Analysis of Learning Needs

The core part of the analysis of learners is the analysis of learning needs. From the perspective of system dynamics, simulation analysis is carried out on the changes in learners' learning situation and its main factors (Mou et al., 2018). It is concluded that the content difficulty and evaluation criteria are personalities. The main factors for the changes in the demand for oriented learning, the difficulty of content is highly positively correlated with the total knowledge of learners, and the demand for learning interest is highly positively correlated with the evaluation criteria. This positive correlation is different in different courses.

Analysis of Learning Behavior

Compared to teacher-centered teaching that emphasizes knowledge transfer, students' autonomous learning pays more attention to cultivating students' inquiry abilities and thinking styles (Zhou & Li, 2020). The research of personalized learning support services also originated in the field of distance education. Analyzing online learning behaviors and providing personalized resource recommendation is the leading research hotspot before the advent of the big data era. As the measurable data of users' offline learning behaviors increases, education big data Learning analysis has been extended from online to offline, and behavior analysis has also been extended from online data to the classroom. It is profoundly digging into learners' daily learning behaviors.

Learner Modeling

Learner modeling uses related modeling theories to analyze characteristic learner elements, collect and analyze many user bases and behavior data, and use computing algorithms and artificial intelligence technology to obtain learner learning characteristic data to form a personalized learning characteristic data set.

The initial research of the learners modeling focused on distance education. The CELTS-11 learner model specification is designated explicitly for learners in China's distance education to meet Chinese education's actual conditions. It described learner information from eight aspects: personal information, academic information, management information, relationship information, safety information, preference information, performance information and work information (DLTSC, 2002), a multi-level and multi-dimensional network education personalized learning model designed based on this model (Sun, 2017), consisting of three levels: data layer, logic analysis layer, and application layer composition (Sun & Zhang, 2017), the data layer contains personal description information (personal information, management information, safety information) and learning-related information (academic information, performance information, work information), as well as related information and preference information. The logical analysis layer based on this data layer includes learning content analysis, learning behavior analysis, and interaction analysis. The logical analysis layer based on this data layer includes learning content analysis, learning behavior analysis, and interaction analysis. Many aspects, including the content and types of learning resources, learning goals, learning completion and participation, resources and media selection, as well as learners' social networks, interactive communication, and visit behavior, are analyzed. Furthermore, combined with personal information, extract learner's attributes, learning style, cognitive ability, and learning attitude, realize the construction of multi-dimensional learner characteristics, to provide a decision-making basis for the application layer.

User Portrait

The development of artificial intelligence and big data technology and its popularization in campuses promoted smart campuses' development and gave birth to education big data. Any improvement in learning forms and mobile terminal software and hardware technologies can enable learners' learning behaviors to be monitored, measured, and stored. The personalized learning process's primary data, such as necessary personal information, elective course information, homework and exam information, attendance records, and even classroom status, can be obtained through various platforms and environments. User portrait is to obtain a tagged user characteristic model by deeply digging into various data information related to the learner (such as basic personal information, learning interest, learning style, resource preference, interaction situation, and interest change). Through an in-depth exploration of learners on various platforms (such as educational administration systems, learning apps, social platforms, etc.) to obtain learners' basic information, learning content, learning progress, learning logs, shared learning materials information, published and participated topics and discussion content And other relevant data. Unstructured data and semi-structured data can be identified and transformed into structured data (Liu, 2019), which can an in-depth and detailed description of the student group from the perspective of individual learning needs. Lay a decision-making foundation for providing personalized learning services.

Learning Support Services Based on Learning Analysis

Personalized Learning Resource Recommendation

With the increasing number of open resources, it is convenient to extract useful resources from many learning resources to promote teaching and learning. To achieve personalized recommendation and distribution of learning resources in a resource-sharing environment is the most needed learning support for distance education learners. The early resource publishing and sharing system (Wang, 2008) can automatically track and record learner needs and evaluation data, form learner characteristic data and use appropriate matching algorithms to calculate the relationship between learner characteristic data and resource description data. The learner recommends the distribution of appropriate resources (Wang, 2008). For the online learning environment's resources, the role case reasoning agent's cooperation framework (Yang, 2009) can use case reasoning technology to solve learning resources' personalized recommendation (Yang et al., 2009). Resources and tools were different forms of learning after processing and were the main environmental conditions for teachers and students to complete knowledge construction. Whether at the teacher's terminal or student's terminal, resources and tools included study cases, e-books, micro-courses, and related teaching tools and subject tools based on learning objectives, individuals, contents, styles, and scenarios(Li, 2019).

The development of education big data has made personalized resource recommendations with sufficient data support. Based on big educational data, artificial

intelligence to extract and express test questions' characteristics, establish test questions, and knowledge association network (Liu, 2018) can design and implement test question recommendation. To assist students in extracurricular self-study, and test question recommendation systems can personalize students' learning. There are good promotion and promotion. On this basis, the personalized learning recommendation model LS-PLRM (Su, 2020), which is based on students' learning situation, is more comprehensive than the test recommendation system. The model is based on a collaborative filtering algorithm and uses the learning situation's detection results to improve the recommendation algorithm. The knowledge base of the learner is analyzed to establish a knowledge map, calculate the relevance of the knowledge points, calculate the learner's learning progress and the degree of mastery of each knowledge point, calculate the recommendation of the knowledge points, and generate a personalized learning plan based on the calculation results. Recommend a personalized learning plan for learners (Su et al., 2020).

Personalized Learning Path Planning

The separation between teachers and students in the online learning space means that they are more confused than ever. They have no precise learning path planning in the face of abundant resources and have no concept of the sequence and time allocation of their learning content and the combination of learning methods. The individualized learning advantage of "freedom" turns into a disadvantage. To provide personalized learners with more effective learning support, stimulate and maintain interest in learning, and improve learning effects are not enough to recommend only resources to learners. Based on learning resources and learner analysis, we provide accurate, personalized learning path planning.

Learning path planning provides learners with a sequence of organic learning activities based on learner big data analysis results and guides learners to more effective and personalized learning. Learning includes a series of information collection processes, processing, transformation, storage, and re-creation in the digital environment. In this series of activities, the learner group has strong similarities and implicit associations and ability-oriented personality. The recommended path helps improve learning and learning efficiency (Jiang et al., 2015) to promote online learning effectiveness (Jiang et al., 2018).

The development of learner profile technology promotes the accuracy of personalized learning path generation recommendations. The accurate and personalized learning path generative recommendation model based on learning profile (Shi et al., 2019) is more in line with the learner's dynamic changes in learning level during the learning process and improves the accuracy of recommendation. Combine learning content, learning activities, and their effects into learning tuples, which are used as recommended units better to meet learners' needs (Shi, 2019).

The personalized learning path planning system can generally be divided into six parts: knowledge map, mainstream learning path, learner, learner big data, learner

portrait, and personalized learning path (Tang, 2019). The recommendation system can be the learning process is described from four aspects: learning goals, learning content, learning activities, and learning evaluation, build learner profile based on big data, build standard feature library, and provide accurate and personalized path recommendation. According to the learning objectives, with the help of textbooks and media, students autonomously or in groups to complete the learning of the basic concepts, basic graphics, and basic methods in the teaching content of this section, focusing on double-based learning and consolidating the foundation (Xia, 2020).

Personalized Learning System and Environment

As a learning model with learners as the whole main body, personalized learning has spatial separation and relative independence. In the early days, people expected to design an independent learning system to support personalized learning. The personalized learning system generally consists of a user interface, a personalized processing engine, a personalized learning process, an administrator port, and a user library. Students select courses to learn through the user interface, and the system provides personalized materials through the learning tool teaching database. The entire learning process circulates between the user interface and the processing engine.

In basic education, relying on the smart learning background basic education, building a personalized learning platform through dynamic data collection, precise learning analysis, and visual feedback can achieve personalized learning (Cao & Zhu, 2014). In the field of basic education, classroom teaching is the theme. The personalized learning platform's realization can use a hierarchical grouping of personalized learning under teachers' guidance, and intelligent learning partners can be used to promote personalized learning in an independent learning environment after class. The method provides a path for individualized learning in the field of basic education. The platform design and learning path push strategy are used in case applications. From the application data, it can be concluded that the personalized learning platform can effectively promote the dynamic and hierarchical personalized teaching of teachers, and effectively promote solving learning difficulties and improving learning motivation of different types of students. On the one hand, it helps teachers master the students' process learning data to improve teaching effectiveness. On the other hand, it frees students from the traditional problem-solving tactics and provides personalized and accurate practice materials to help students improve the efficiency of practice and achieve the maximum practice effect in a limited practice time. Teaching and learning promote each other. This helps the school improve the quality of teaching and help students improve their performance, and achieve personalized learning for students, targeted teaching (Zhao et al., 2020).

In higher education, social networks are an essential expression space for college students and a mapping of human social relationships. It contains a large amount of fragmented information of individuals in the network environment. The information has rich data connections with learners in the network learning environment. A personalized

learning environment with a social network model as a resource aggregation and recommendation framework can promote personalized learning more effectively (Yang, 2015). The personalized learning environment can aggregate personalized resources inside and outside the learning environment, analyze learning behavior data, recommend personalized learning resources to learn and provide decision support to teachers to promote learning process optimization. The development of artificial intelligence technology has promoted to be more intelligent of human-computer interaction. Researchers call the learning space in the intelligent stage of human-computer interaction a personalized learning space (Zhang et al., 2017). The core of the personalized learning space is to use personalized. The learning engine provides learners with personalized learning support services.

Conclusions and Perspectives

The increasingly apparent demands for technological innovation and individualization have prompted significant changes in school education's organizational and management modes, and homogenized education will inevitably lead to a more efficient and individualized education transformation.

(i) *Individualized learning and teaching theories are gradually enriched and comprehensive, focusing on student development*

The research on the theoretical level of personalized learning covers teachers' and students' roles in personalized learning, curriculum system, teaching strategies, and models, among which teaching models are the most abundant.

From the perspective of teacher-student roles, personalized learning students are the main body. The teacher's role is the guide and supporter; from the perspective of curriculum system research, personalized teaching's curriculum system can be more flexible and pay more attention to students' individual development. From teaching, individualized learning can be combined with classroom teaching, using various teaching organization forms as the central group teaching, supplemented by collaborative and individualized teaching.

(ii) *Personalized learning application research pays more attention to online learning behavior*

From the practical application of research content, personalized learning research is more concentrated on distance education, online learning behavior, and less attention is paid to the offline learning process. This is directly related to the difficulty of monitoring and obtaining data in the traditional teaching process. Individualized learning at the theoretical level can be organically combined with classroom teaching, but the practical level is challenging and difficult to control and is interfered with by various factors. Individualized teaching in school teaching is difficult to promote

(iii) *Learning analysis technology based on big data improves the richness of learning models*

Educational big data makes the data sources analyzed by learners more abundant, and learner analysis is more accurate than others. Data-based learning analysis technology has dramatically improved the quality of learning model construction. Abundant learning behavior data makes learning model features richer than ever. Various learning model-based learning resource recommendations and learning path planning services are becoming more accurate and intelligent.

(iv) *The construction and application of learning models in the field of basic education need to be enhanced*

As mentioned above, learners' principal place in the necessary education field to learn is still offline. Compared with universities, the available learner behavior data is relatively small, and there are fewer studies on the construction of learning models and personalized learning systems based on learning models.

With the popularization of smart campuses, accompanying detection technology and methods have entered the classroom, and the speed of intelligent recognition technology to identify paper assignments has been dramatically improved. Offline classroom learning behavior data, paper assignments, and test data have brought rich basic education big data. The value of students' classroom behavior, learning input, and academic level will help implement personalized teaching in school teaching and promote personalized education in basic education.

References

- Cao, X.M., & Zhu, Y. (2014). Research on personalized learning platform from the perspective of learning analysis. *Open Education Research*, 20(5):67-74. [Chinese] DOI: <https://doi.org/10.13966/j.cnki.kfjyyj.2014.05.026>
- Chen, H.J., Dai, Y.H., Han, D.M., Feng, Y.J., & Huang, H.X. (2017). The study of learner portraits and personalized teaching under open teaching. *Open Education Research*, 23(3):105-112. [Chinese] DOI: <https://doi.org/10.13966/j.cnki.kfjyyj.2017.03.012>
- Deng, Z.W. (2000a). Curriculum research on individualized teaching (Part 1). *Global Education*, 2000(2):34-38. [Chinese] <http://www.cqvip.com/qk/96950x/200002/4127816.html>
- Deng, Z.W. (2000b). Curriculum research on individualized teaching (Part 2). *Global Education*, 2000(3):18-21. [Chinese] <http://www.cnki.com.cn/Article/CJFDTOTAL-WGJN200003003.htm>
- Ding, N.J. (2013). Classroom transformation based on personalized learning. *Curriculum, Teaching Material and Method*, 33(8):42-46.

- [Chinese] DOI:
<https://doi.org/10.19877/j.cnki.kcjcf.2013.08.007>
- Distance Learning Technology Standardization Committee, DLTSC. (2002). Distance Learning Technology Standardization System and 11 Draft Standards for Trial Use v1.0. [Chinese]
<http://www.edu.cn/html/keyanzf/ycjy01.shtml>
- Feng, Y.H. (2019). The value orientation and realization of MOOC development to promote personalized learning. *Modern Distance Education Research*, 31(5):46-53. [Chinese] DOI:
<https://doi.org/10.3969/j.issn.1009-5195.2019.05.006>
- Huang, C.Q., Zhu, N., Huang, Q.H., & Han, Z.M. (2019). Research on behavioral big data visualization supporting personalized learning. *Open Education Research*, 25(2): 53-64. [Chinese] DOI:
<https://doi.org/10.13966/j.cnki.kfjyvj.2019.02.006>
- Jiang, Q., Zhao, W., Li, S., & Wang, P.J. (2018). Research on accurate and personalized learning path mining in the context of big data: Analysis of group behavior based on Apriori. *e-Education Research*, 39(2):45-52. [Chinese] DOI:
<https://doi.org/10.13811/j.cnki.eer.2018.02.07>
- Jiang, Q., Zhao, W., Liu, H.X., & Li, S. (2015). Generation and evaluation of ability-oriented personalized learning path. *Modern Distance Education Research*, 2015(6):104-111. [Chinese] DOI:
<https://doi.org/10.3969/j.issn.1009-5195.2015.06.013>
- Jiang, W.T., Wang, C.P., & Tang, Y.W. (2017). Research on the construction of P-N-CRPE personalized learning model based on system theory. *e-Education Research*, 38(5):53-58. [Chinese] DOI:
<https://doi.org/10.13811/j.cnki.eer.2017.05.08>
- Jiang, Z.H. (2013). Model construction and strategy optimization of personalized learning in the network environment. *Distance Education in China*, 2013(2):48-51+95. [Chinese] DOI:
<https://doi.org/10.13541/j.cnki.chinade.2013.02.005>
- Jiao, C.Z. (2012). Construction of the effectiveness of personalized learning in online open universities under interactive teaching mode. *Modern Distance Education*, 2012(6):33-39. [Chinese] DOI:
<https://doi.org/10.3969/j.issn.1001-8700.2012.06.006>
- Kong, J., Guo, Y.C., Guo, & G.W. (2016). Individualized learning supported by technology: a new trend to promote student development. *China Educational Technology*, 2016(4):88-94. [Chinese] DOI:
<https://doi.org/10.3969/j.issn.1006-9860.2016.04.014>
- Li, C. (2019). How does e-book bag promote learning? Video analysis based on classroom recordings. *Science Insights Education Frontiers*, 3(1):135-154.
<https://doi.org/10.15354/sief.19.ar071>
- Li, G., & Jiang, Y.J. (2005). The theoretical construction and characteristic analysis of individualized learning. *Journal of Northeast Normal University (Philosophy and Social Sciences)*, 2005(3):152-156. [Chinese]
<http://www.cqvip.com/qk/81473x/200503/15750395.html>
- Li, H.J., Zhang, Z., & Zhang, P.W. (2019). Personalized learning resource recommendation method based on three-dimensional feature collaborative control. *Computer Science*, 46(S1):461-467. [Chinese]
<https://www.airitilibrary.com/Publication/alDetailedMesh?docid=jsjx2019z1100>
- Li, S.M., & Tian, J. (2011). Research on personalized learning service strategy in online learning. *China Educational Technology*, 2011(6):118-121. [Chinese] DOI:
<https://doi.org/10.3969/j.issn.1006-9860.2011.06.023>
- Liu, H.H., & Pan, Y. (2018). "Learner-centered": Personalized learning practice logic from the perspective of empowerment theory. *China Educational Technology*, 2018(8):100-106. [Chinese] DOI:
<https://doi.org/10.3969/j.issn.1006-9860.2018.08.014>

- Liu, H.O., Liu, X., Yao, S.M., & Wang, Y.Y. (2019). Research on personalized learning precision service based on big data in-depth profiling. *Research on Library Science*, 2019(15):68-74. [Chinese] DOI: <https://doi.org/10.15941/j.cnki.issn1001-0424.2019.15.009>
- Liu, Q., Ding, P., Huang, X.Q., & Dong, J.J. (2018). Research on personalized learning recommendation system based on test question network. *Modern Educational Technology*, 28(6): 11-16. [Chinese] DOI: <https://doi.org/10.3969/j.issn.1009-8097.2018.06.002>
- Liu, Y.P., Ai, Q.H., & Wang, M. (2014). Group Learning Types in Personalized Teaching Organization Forms. *Journal of the Chinese Society of Education*, 2014(7):48-53. [Chinese] <http://www.cqvip.com/qk/82058x/201407/50155886.html>
- Mou, Z.J. (2016). Deciphering the personalized learning path supported by learner data portrait: The value of learning calculation. *Journal of Distance Education*, 34(6):11-19. [Chinese] DOI: <https://doi.org/10.15881/j.cnki.cn33-1304/g4.2016.06.002>
- Mou, Z.J. (2017). Rethinking and solving the theory of personalized learning in the “artificial intelligence+” era. *Journal of Distance Education*, 35(3):22-30. [Chinese] DOI: <https://doi.org/10.15881/j.cnki.cn33-1304/g4.2017.03.003>
- Mou, Z.J., & Wu, F.T. (2015). Research on personalized learning resource recommendation based on learner model in e-schoolbag. *e-Education Research*, 36(1):69-76. [Chinese] DOI: <https://doi.org/L10.13811/j.cnki.eer.2015.01.010>
- Mou, Z.J., Wang, W.B., Li, Y.T., Yan, & D.H. (2018). Modeling and simulation of personalized learning demand prediction in MOOCs environment: from the perspective of system dynamics. *e-Education Research*, 39(11):29-37. [Chinese] DOI: <https://doi.org/10.13811/j.cnki.eer.2018.11.004>
- Nie, Y., & Jiang, T.T. (2013). Exploration of personalized learning space based on electronic schoolbags. *Modern Educational Technology*, 23(3):87-90. [Chinese] DOI: <https://doi.org/10.3969/j.issn.1009-8097.2013.03.017>
- Pan, Z.Y., Zhong, S.C., Zhong, Y.J., & Zhang, Y.H. (2015). Research on the design and application of personalized learning tools. *China Educational Technology*, 2015(6):86-91. [Chinese] <http://www.cqvip.com/qk/81536z/201506/664918909.html>
- Pei, Y. (2016). Analysis of personalized learning model based on education big data. *Journal of Teaching and Management*, 2016(27):101-103. [Chinese] <http://www.cqvip.com/qk/88084x/201609/670160057.html>
- Ren, J.M., & Chen, Y. (2015). Individualized teaching design and its strategies. *Theory and Practice of Education*, 35(11):57-59. [Chinese] <http://www.cnki.com.cn/Article/CJFDTotal-JYLL201511019.htm>
- Shao, H., & Yu, H.Q. (2015). Research on the personalized learning model of flipped classroom learners based on ubiquitous learning resource sharing platform. *Education Review*, 2015(7):88-92. [Chinese] <http://www.cqvip.com/qk/97172x/201507/665516695.html>
- Shen, Y.F. (2019). A personalized learning path recommendation model based on multiple intelligent algorithms. *China Educational Technology*, 2019(11):66-72. [Chinese] <http://www.cqvip.com/qk/81536x/201911/7100284336.html>
- Shi, Y.F., Peng, H.C., Tong, M.W. (2019). Research on generative recommendation strategy of precise and personalized learning path based on learning profile. *China Educational Technology*, 2019(5):84-91. [Chinese] <http://www.cqvip.com/qk/81536x/20195/7020236135.html>
- Su, Q., Chen, S.Z., Wu, W.M., Li, X.M., & Huang, D.K. (2020). Research on personalized learning recommendation model based on collaborative filtering algorithm of learning situation. *Data Analysis and Knowledge*

- Discovery, 4(5): 105-117. [Chinese] DOI: <https://doi.org/10.11925/infotech.2096-3467.2019.1092>
- Sun, L., & Zhang, T. (2017). Design and analysis of personalized learner model in online education. *Journal of Distance Education*, 35(3):93-101. [Chinese] DOI: <https://doi.org/10.15881/j.cnki.cn33-1304/g4.2017.03.011>
- Tan, J.B., & Gong, M.M. (2005). Research on a multi-agent-based personalized learning system. *Journal of Information*, 2005(11):67-68+71. [Chinese] <http://www.cqvip.com/qk/90226x/200511/20301834.html>
- Tang, Y.W., Ru, L.N., Fan, J.R., Pang, J.W., & Zhong, S.C. (2019). Research on personalized learning path planning based on learner profile modeling. *e-Education Research*, 40(10):53-60. [Chinese] DOI: <https://doi.org/10.13811/j.cnki.eer.2019.10.008>
- Wang, D.Q. (2008). Research on personalized learning support services in distance education. *Distance Education in China*, 2008(8): 38-42+79-80. [Chinese] DOI: <https://doi.org/10.3969/j.issn.1009-458X.2008.08.009>
- Wang, H. (2017). The application of adaptive learning system in the construction of adult education personalized learning model. *China Adult Education*, 2017(3):9-11. [Chinese] <http://library.ttc dw.com/uploadfiles/zk/1507703619.pdf>
- Wang, X.C., & Zhu, L. (2008). ISI: A personalized learning service platform built by teachers and students. *Modern Educational Technology*, 2008(10):93-96. [Chinese] <http://www.cqvip.com/qk/82492x/200810/28446848.html>
- Wang, Y.F. (2008). Research on e-Learning system supporting personalized learning. *China Educational Technology*, 2008(3):102-107. [Chinese] DOI: <https://doi.org/10.3969/j.issn.1006-9860.2008.03.026>
- Wu, H.Y. (2015). The integration of personalized learning concepts and flipped classroom teaching mode. *Modern Educational Technology*, 25(8):46-52. [Chinese] DOI: <https://doi.org/10.3969/j.issn.1009-458X.2015.08.007>
- Xia, J. (2020). Teaching for student learning: exploration of teaching strategies based on protocol-guided learning. *Science Insights Education Frontiers*, 5(1):451-467. <https://doi.org/10.15354/sief.20.ar011>
- Xia, X.M. (2013). Understanding and evaluating personalized learning: a classroom observation perspective. *Journal of the Chinese Society of Education*, 2013(3):35-38. [Chinese] <http://www.cqvip.com/qk/82058x/201303/44967728.html>
- Xiong, J.J. (2013). The implementation path of students' individualized learning under the background of small class education. *Research in Educational Development*, 33(18):40-44. [Chinese] DOI: <https://doi.org/10.14121/j.cnki.1008-3855.2013.18.006>
- Xiong, M., & Bu, Q.G. (2014). Practical exploration of personalized teaching organization form. *Journal of the Chinese Society of Education*, 2014(7):42-47. [Chinese] <http://www.cqvip.com/qk/82058x/201407/50155885.html>
- Xiong, M., Wang, Y.L., & Ai, Q.H. (2011) Individualized teaching design and implementation strategies. *Curriculum, Teaching Material and Method*, 31(8):18-23. [Chinese] DOI: <https://doi.org/10.19877/j.cnki.kcjcjf.2011.08.005>
- Yang, J.Z., & Zhang, J.P. (2015). Research on the construction of personalized learning environment based on social networks. *Open Education Research*, 21(2): 89-97. [Chinese] DOI: <https://doi.org/10.13966/j.cnki.kfjyyj.2015.02.010>
- Yang, L. (2016). Research on the design strategy of independent and personalized learning environment based on MOOC. *Experimental Technology and Management*, 2016(4):88-94. [Chinese] DOI: <https://doi.org/10.16791/j.cnki.sjg.2016.04.046>
- Yang, L. (2016). The construction of learner's personalized learning model in MOOC environment. *Contemporary Education Sciences*,

- 2016(9):40-42. [Chinese]
<http://www.cqvip.com/qk/82379a/201609/669144771.html>
- Yang, L.N., Liu, Ke, C., & Yan, Z.J. (2009). Research on personalized learning resource recommendation under the cooperation framework of case reasoning Agent. *China Educational Technology*, 2009(12):105-109. [Chinese] DOI: <https://doi.org/10.3969/j.issn.1006-9860.2009.12.026>
- Yang, L.N., Wei, Y.H., Xiao, K.X., & Wang, W.H. (2020). Research on personalized learning service mechanism driven by educational big data. *e-Education Research*, 41(9):68-74. [Chinese] DOI: <https://doi.org/10.13811/j.cnki.eer.2020.09.010>
- Yang, X., Jiang, Q., & Zhao, W. (2016). Big data learning analysis supports personalized learning research-technology returns to the essence of education. *Modern Distance Education*, 2016(4):71-78. [Chinese] DOI: <https://doi.org/10.13927/j.cnki.yuan.2016.0043>
- Yang, Y.Q. (2014). Construction of MOOC learners' personalized learning model. *China Educational Technology*, 2014(6):6-10+68. [Chinese] DOI: <https://doi.org/10.3969/j.issn.1006-9860.2014.06.002>
- Yang, Y.Q. (2014). MOOC independent and personalized learning environment design strategy research. *Modern Educational Technology*, 24(7):12-17+34. [Chinese] DOI: <https://doi.org/10.3969/j.issn.1009-8097.2014.07.002>
- Yang, Y.Q., & Jiao, J.L. (2014). MOOC learner's personalized learning ecological design framework. *e-Education Research*, 35(8):32-37+56. [Chinese] DOI: <https://doi.org/10.13811/j.cnki.eer.2014.08.005>
- Yi, J.M. (2005). On individualized teaching and individualized learning. *Education and Vocational*, 2005(6):33-35. [Chinese] DOI: <https://doi.org/10.3969/j.issn.1004-3985.2005.06.017>
- Yu, X.J. (2015). Research on the construction of a personalized teaching information service platform based on big data application. *Information Science*, 33(11):53-56. [Chinese] DOI: <https://doi.org/10.13833/j.cnki.is.2015.11.010>
- Yue, J.F., & Chen, Y. (2017). Distance learner modeling and personalized learning application based on big data analysis. *Distance Education in China*, 2017(7): 34-39. [Chinese] DOI: <https://doi.org/10.13541/j.cnki.chinade.2017.07.004>
- Zhang, J.L., Guo, S.Q., & He, X.C. (2017). Personalized learning space (learning space v3.0) and school education reform: the connotation of online learning space and school education development research 5. *e-Education Research*, 38(7) :32-37. [Chinese] DOI: <https://doi.org/10.13811/j.cnki.eer.2017.07.005>
- Zhang, X.X., & Mou, Z.J. (2018). Research on the precise teaching model design for personalized learning under the data-based learning environment. *Modern Distance Education*, 2018(5):65-72. [Chinese] DOI: <https://doi.org/10.13927/j.cnki.yuan.2018.0053>
- Zhao, N., Zhou, X., Liu, B., & Liu, W. (2020). Guiding teaching strategies with the education platform during the COVID-19 epidemic: Taking Guiyang No. 1 Middle School teaching practice as an example. *Science Insights Education Frontiers*, 5(2):531-539. <https://doi.org/10.15354/sief.20.rp005>
- Zhao, X.K., Xu, X.D., Long, & S.R. (2017). Collaborative recommendation: a new perspective of personalized learning path generation. *Distance Education in China*, 2017(5):24-34. [Chinese] DOI: <https://doi.org/10.13541/j.cnki.chinade.2017.05.17.008>
- Zheng, Y.X. (2010). Goal-driven personalized learning mode supported by information technology. *e-Education Research*, 2010(7):89-92. [Chinese] DOI: <https://doi.org/10.13811/j.cnki.eer.2010.07.025>
- Zheng, Y.X. (2014). Research on the individualized learning of college students under the

- information technology environment. *China Educational Technology*, 2014(7):126-132. [Chinese] DOI: <https://doi.org/10.3969/j.issn.1006-9860.2014.07.020>
- Zheng, Y.X. (2015). Research on the status quo of college students' personalized learning under the information technology environment. *Distance Education in China*, 2015(7):19-25+79. [Chinese] DOI: <https://doi.org/10.13541/j.cnki.chinade.2015.07.004>
- Zheng, Y.X. (2015). Research on the teaching mode of college students' individualized learning from the perspective of new constructivism. *Journal of Distance Education*, 33(4):48-58. [Chinese] DOI: <https://doi.org/10.15881/j.cnki.cn33-1304/g4.2015.04.007>
- Zhong, Z.R. (2012). The construction and application of personalized learning mode based on Web2.0 environment. *China Educational Technology*, 2012(8):107-110. [Chinese] <http://www.cqvip.com/qk/81536x/201208/42712968.html>
- Zhou, L., & Li, C. (2020). Can student self-directed learning improve their academic performance? Experimental evidence from the instruction of protocol-guided learning in China's elementary and middle schools. *Science Insights Education Frontiers*, 5(1), 469-480. <https://doi.org/10.15354/sief.20.ar016>
- Zhou, L., Li, F., Wu, S., & Zhou, M. (2020). "School's Out, But Class's On", The largest online education in the world today: Taking China's practical exploration during The COVID-19 epidemic prevention and control as an example. *Best Evidence in Chinese Education*, 4(2):501-519. <https://doi.org/10.15354/bece.20.ar023>

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