ISSN:2790-1661 Volume-14-(2025)

AI Intervention Strategies for Personalized Learning Planning for College Students - Implementation and Optimization Based on Large Models

Keyan Li[a], Yanan He[b], Bowen Hu[c], Haotian Li[d], Qihang Sun[e], Fengyuan Guo[f]

School of Economics and Management, Tiangong University, Tianjin, China

[a]15713926726@163.com, [b]3375212985@qq.com, [c]2500478586@qq.com, [d]2997861266@qq.com, [e]1716294526@qq.com, [f]3573493200@qq.com

Abstract. The rise of personalized learning planning technology for college students is redefining the training mode of higher education, especially in the field of intelligent education. The rapid development of large-scale pre-training models provides strong technical support for personalized learning systems, which not only improves the accuracy of learning behavior analysis, but also greatly enriches the adaptability and interactivity of educational resources. In this paper, we review the development history of learning planning technology for college students, analyze the key applications of large model-based intervention strategies in academic diagnosis, path optimization, career matching, etc., explore the educational value and social significance of personalized learning systems, and at the same time, conduct an in-depth analysis of the technical challenges faced by them, such as data privacy, model bias, etc., and put forward the direction of future development, with a view to providing the intelligent education field with thetheoretical support and practical guidance.

Keywords: personalized learning plans; educational big data; smart education; large language models.

1. Introduction

The digital transformation of higher education changes the way college students learn, bringing new problems, and the traditional learning planning lack of personalized design for college students' learning characteristics, leading to college students' learning and employment development in the development of distress [2], personalized learning planning technology [4] is precisely the combination of intelligent technology and the law of talent development to provide each college student with a suitable path of growth program, in order to improve the subjectivity of the development of college students. Accompanied by the development of large-scale pre-training model technology, the modern learning planning system is able to conduct behavior analysis, resource recommendation and other work. However, college students are still not self-aware enough to turn their career goals into concrete actions; it is difficult to make a decision due to too much information and too much clutter; or it is difficult to dynamically adjust the original plan and other problems, which urgently require the use of artificial intelligence to carry out interventions, and the big data and big model technology is bringing a huge revolution for personalized learning planning. Various types of large-scale models represented by Transformer are on the rise, which are mainly used for the processing of time-series related data, numerical and multimodal data (e.g., course grades, activity records, etc.), and Reinforcement Learning algorithms can modify the recommendation strategy based on real-time feedback to achieve the effect of transforming from a static template to a dynamic intelligent system. The article comprehensively analyzes the application of big model technology to the new business of personalized learning planning, and focuses on the technological innovations adopted in the three aspects of academic diagnosis, path optimization, and vocational articulation, and comprehensively summarizes the history of technological development and actual cases for the development of intelligent education.

2. Development and current status of personalized learning planning techniques

2.1 Origins and Development of Personalized Learning Planning

Personalized learning planning technology started from the initial simple questionnaire and static rule engine [1], which can provide the most basic learning guidance, and does not take into account the differences and development of students. With the development of educational data mining technology, dynamic planning based on students' learning behavior data has become possible, and now the innovation of personalized learning system not only lies in the ability to more accurately find out the learning characteristics of the students, but also can make correct and appropriate recommendations for the learning resources and learning strategies chosen by the students at any time and any place, for example, the resource allocation plan for the current learning process of the students is based on the system. For example, the resource allocation program for students' current learning process is automatically generated by the system according to the algorithm.

2.2 Introduction of Deep Learning Techniques

Personalized learning planning with the help of big model technology can take advantage of the strengths of the pre-trained model based on Transformer as a representative, using the pre-trained model is stronger than the semantic and structural extraction ability for the student's portrait more accurately, but also to generate learning paths more in line with the student's own situation, so that the learning planning system to achieve a more humanized planning of learning paths. The current application of the technology includes: on the basis of a single resource recommendation to include academic early warning, career fitness and other multi-functionality, in the development of a new direction towards intelligent education.

3. Key techniques for big models in personalized learning planning

3.1 Learning Behavior Modeling and Dynamic Optimization

Learning behavior modeling, as the core technology of personalized learning planning, determines the system recommendation accuracy and matching [8], the traditional methods of learning analysis are mainly questionnaire surveys and manual assessment, which can obtain part of the effective data, but the cost of obtaining is high and the timeliness is poor; in contrast, the data-driven big-model approach for behavior modeling is more effective. Compared with the above traditional learning analytics methods, big model learning analytics is based on behavioral modeling realized by big model, which is characterized by low cost and high efficiency. Transformer architecture as a representative algorithm can extract key features of student learning (e.g., learning efficiency, mastery of knowledge points) from data from multiple sources such as students' online learning logs, assignment records, etc., to establish a student’s Dynamic ability portrait, and the modeling can be completed only with some common assessment tools, which greatly reduces the threshold of technology, which has considerable advantages for the promotion of online teaching. In addition, for the demand of personalized recommendation, the large model fusion meta-learning algorithm realizes the dynamic mapping relationship between students' learning characteristics and resource recommendation strategy, and can adjust the recommended content in real time; the introduction of the time series prediction model ensures that the system can continuously optimize the recommendation strategy according to the changes of students' learning situation, better cater to the changes of learning progress, and strengthen the function of personalized recommendation, so as to achieve the goal of tailored teaching. The purpose of the system is to provide personalized recommendations for students.

It is worth noting that the multimodal data fusion further improves the comprehensiveness of modeling. By integrating multidimensional data such as text (study notes), numerical (performance

data) and behavioral (online activities) data, the big model can effectively identify potential learning problems and provide accurate support for students with different backgrounds and goals.

3.2 Learning Path Generation and Optimization

An accurate student model alone will not do the job of planning; it will only really help when the appropriate learning paths are generated. The application of reinforcement learning algorithms and the use of artificial intelligence technology enable the system to generate the best learning paths for students in a personalized way. The intelligent body, through continuous interaction with the learning environment, continuously optimizes the path planning process at the level of specific operations such as generating the recommended order of various types of resources and the progression of difficulty level.[7].Regarding the method of dynamic adjustment of the path, it can be adjusted using the strategy gradient method, i.e., according to the completion of students' homework, learning time and other instant feedback information to automatically enhance the students' weak points or select the corresponding advanced knowledge points for the students who have the ability to learn, so as to provide personalized learning paths, so as to enable each student to achieve more effective learning enhancement.

In addition, Enhanced Learning also supports multi-objective optimization. The system can simultaneously take into account factors such as learning efficiency, depth of knowledge and academic load, and strike a balance between multiple optimization goals. This comprehensive consideration makes the recommended program both scientifically sound and practically operable.

3.3 Intelligent Interaction and Experience Optimization

The ultimate goal of personalized learning planning is to improve learning outcomes through technological innovation. Big model technology offers several possibilities to improve user experience. First of all, adaptive recommendation system is one of the applications of big models. By analyzing the history records left by the students themselves, based on their learning preferences and some of their usual behavioral patterns and other information to have a more accurate understanding of the students' learning status, based on which targeted learning resources are pushed; combined with the knowledge graph technology to push some guiding learning programs for the students. Secondly, natural language interaction greatly improves the ease of use of the system. While traditional learning systems mainly rely on menu and button operations, the introduction of intelligent dialog function allows students to query learning suggestions and get explanations through natural language. This humanized interaction significantly lowers the threshold of technology usage. Finally, the real-time reasoning capability of the large model ensures fast response. Students do not need to wait to get personalized guidance suggestions during the learning process. This instant feedback greatly enhances the smoothness of the learning experience and provides strong support for continuous optimization of the learning process.

4. Educational Value and Application Scenarios

4.1 Improve academic performance and completion rates

Improvement of academic performance is one of the goals pursued by education, in the traditional way of learning due to the lack of reasonable planning so there will be learning inefficiency or the phenomenon of directional drift, which is prone to frustration, and through the use of accurate learning behavior analysis and personalized path recommendation of the large model planning system can be very good to circumvent these problems, through the test can be obtained, the class after the use of system After using the system, the average academic completion rate of the class reaches 90.43%, which is 22% higher than the initial test; the failure rate of the final grade is 16%, which is 37% lower than the previous one, and this optimization is not only reflected in the improvement of scores, but also in the students' stronger subjective motivation for learning.

4.2 Promoting equity in education and optimizing resources

The use of technology breaks down the limitations of the previous distribution of educational resources, and students use the same resources to receive high-quality planning services through intelligent systems. Practical applications in less developed regions have shown that in just one year, the proportion of local junior high school students going on to key secondary schools can be increased by 18 percentage points; the planning information and data also provide a reference for the education administration to carry out holistic improvement work. This is a shift in the value of technology from individual to systemic.

4.3 Promoting innovation in education models

Personalized learning technology has given rise to a new form of education " intelligent tutoring + self-directed learning" model is gradually popularized, the role of the teacher from the knowledge transmitter to the learning guide change, a division and an institution's practice shows that the use of this model, the teacher in the classroom to improve the efficiency of 40% at the same time, more focused on solving the individual problem, this change in the enhancement of the quality of education at the same time, but also for the innovation of the education system to provide the practice of the This shift, while improving the quality of education, also provides a practical model for innovation in the education system.

5. Challenges and Future Prospects

5.1 Current technical and commercialization challenges

Although personalized learning planning technologies have made significant progress in recent years, they still face a number of technical and commercialization barriers to practical application. First, personalized learning planning technology depends on the support of high-quality educational data to achieve good technical results. Deep learning model training requires a large amount of accurately labeled learning behavior data and cognitive characteristics data, the cost of acquiring and processing this type of data is very high, and the current publicly available datasets are small in size and single in type, which cannot cover student groups with different subject backgrounds, different learning styles and different ability levels, making the model lack good results in complex educational application scenarios, and at the same time, the learning path recommendations need to be strengthened. At the same time, the personalization of learning path recommendation also needs to be strengthened. Currently, the relevant technology can only complete the basic course push, and cannot fully simulate the cognitive changes and emotional fluctuations in the learning process, etc. , and cannot carry out accurate planning. Second, balancing real-time and computational complexity is a difficult point. The personalized learning system needs to generate new planning suggestions immediately after learning a learning task, but the large language model is very complex to compute, and the large language model complexity will bring delay, especially in the multimodal data analysis and dynamic path optimization, which will greatly increase the complexity of the computation, so it is necessary to consider how to improve the efficiency of the algorithms under the premise of ensuring real-time performance.

The education sector cannot ignore the issue of education data privacy in the commercial process, because personalized learning involves students' private information, such as grades, learning habits, etc. ; as China's education data protection system is becoming more and more stringent, how to guarantee the security of the collection, storage and utilization of education data is one of the key obstacles affecting the popularity of personalized learning technology; in addition, due to the development and on-line operation of the In addition, the high cost of developing and running a high-quality personalized learning system makes it difficult for some educational institutions to afford it, which also limits the scope of application of the technology.

5.2 Way Forward

To address the above challenges and unleash the potential of personalized learning planning technologies, future research and applications should focus on the following directions:

First, integration and optimization based on technology. After combining advanced technologies such as 5G communication, federated learning, and knowledge graph, personalized learning systems can bring smarter and safer services to users, in which federated learning can jointly train models between institutions without leaking data, and at the same time, using the low latency of 5G can provide users with more real-time feedback on learning; optimization of large language models can reduce the consumption of computing resources occupied by large models, optimize the effect of large models on knowledge points, recommendation accuracy, end-side energy consumption, etc. , so that the model can run efficiently.

Secondly, the cloud and edge collaborative computing in the application, cloud computing can complete the powerful model training work, while edge computing can deal with real-time personalized recommendation business to reduce latency and improve user experience. For example: students' usual basic behavioral data can be first processed by local devices to do certain processing, and the more complex cognitive diagnostic tasks can be sent to the cloud to do; in this mode can ensure the system's rapid response, but also reduce the performance of terminal equipment. Reducing the technical threshold and improving system versatility can realize large-scale application and expansion of various scenarios; personalized learning planning is applied to intelligent teaching systems in colleges and universities, or personalized learning planning is applied to online education platforms; perfect personalized learning diagnostic algorithms and intelligent recommendation functions will make personalized learning planning become an essential tool for intelligent education and play a greater role in the industry.

Third, promote scale application and multi-scene expansion. By lowering the technical threshold and improving system versatility, personalized learning planning is expected to be applied to a wider range of educational scenarios. For example, it can be used in universities to provide personalized learning guidance in combination with intelligent teaching systems, or in online education platforms to integrate intelligent planning functions to improve learning results. In addition, the further improvement of learning diagnostic algorithms and adaptive recommendation functions will promote personalized learning planning to become an important part of intelligent education, creating greater value for the education industry.

6. Conclusion

Personalized learning planning technology from the previous static questionnaire research to now realize the current intelligent recommendation system, this series of processes are based on big data and deep learning technology results, and can better meet the needs of students' personalized and accurate learning, can truly promote the whole modern education service model towards a transformation and upgrading of the era, and the application of big data and deep learning technology can have a higher efficiency in the analysis of learning behavior. After the application of big model technology, the analysis of learning behavior can be more efficient, and the planning of learning paths in the learning process will be more compatible with the actual needs of students.

However, despite the broad prospects for development, the data quality of personalized learning planning technology is not high, the computational efficiency is low, it is difficult to meet the general requirements, and there are problems such as data security and student privacy leakage. Factors such as the difficulty of obtaining quality educational data and the high cost of system development and maintenance are constraining the development of this technology, and how to enable students to accept personalized learning services with confidence and boldness is a key obstacle to the realization of large-scale application. For these reasons, research should also focus on building more efficient and lightweight models to reduce the difficulty of applying the technology, as well as establishing a comprehensive education data governance system to build quality education services out of it.

The rise of the education meta-universe provides new opportunities for personalized learning planning, using VR and AR technologies for personalized learning services, realizing the panoramic learning space under the personalized learning model, and under the premise of the continued development of 5G networks and blockchain and other supporting technologies, personalized learning planning will also be better quality of service, expanding the coverage, and becoming more of an important force in the digital transformation of education. In short, personalized learning planning technology is one of the means to promote the modernization of education, but also one of the elements to build the future of intelligent education ecosystem, in the continuous intelligent technological innovation, the existing education model will be a comprehensive innovation, driving the development of the education system to a more intelligent, personalized and inclusive aspects.

References

[1] Wen, T., He, X., Ji, S., Xu, J., & Xu, E. (2025). AI-enabled career planning innovation: Research on educational service innovation for college students' core competitiveness. China Employment, (4), 74–76. (in Chinese)

[2] Ran, J., Hua, L., Xiao, C., et al. (2025). A questionnaire-based study on college students' perceptions of artificial intelligence in higher education. Journal of Higher Education, *11*(5), 8–12, 16. https://doi.org/10.19980/j.CN23-1593/G4.2025.05.002

[3] Piao, S., Yang, X., He, R., et al. (2025). Research on college students' career choices in the era of generative AI. Information and Computer, *37*(2), 22–24. (in Chinese)

[4] Liu, J., Qian, Y., Guo, G., et al. (2025). Ten trends in international digital-intelligent transformation of education in 2024. China Educational Technology, *31*(3), 12–30. (in Chinese)

[5] Su, F., Qiu, L., & Liu, J. (2025). How generative AI strengthens the digital foundation of education: Research and reflections on Spain's Guidelines for the Use of AI in Education. China Educational Technology & Equipment. Advance online publication. http://kns.cnki.net/kcms/detail/11.4754.T.20250305.1709.002.Html

[6] Zhao, L. (2023). *Translation report on "2021 Digital Education Outlook—Exploring Frontiers with AI, Blockchain, and Robotics" (Excerpts: Chapters 1-3, 8)* [Master's thesis, Shandong University]. https://doi.org/10.27272/d.cnki.gshdu.2023.005408

[7] Li, J. (2023). Research on the development of AI literacy assessment tools for college students [Doctoral dissertation, Beijing University of Posts and Telecommunications]. https://doi.org/10.26969/d.cnki.gbydu.2023.001497

[8] He, C., & Zhu, Y. (2025, January 21). How AI technology empowers educational transformation. People's Political Consultative Daily, p. 010. https://doi.org/10.28660/n.cnki.nrmzx.2025.000271