

Innovations and Challenges of the Flipped Classroom Model in The Digital Era: Personalized Learning Path Design based on Artificial Intelligence

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Abstract. With the rapid development of information technology, the field of education is undergoing profound changes. As an emerging teaching mode, flipped classroom has revolutionized the traditional teaching mode with its unique concept of "learning before teaching". However, in the digital era, how to further improve the teaching effect of flipped classroom has become an important issue in the field of education. The rise of artificial intelligence technology provides the possibility of personalized learning and new ideas for the innovation of flipped classroom mode. This paper discusses the innovation of flipped classroom mode in the digital era, especially the design of personalized learning path based on artificial intelligence technology. Through theoretical analysis and practical cases, the study elaborates the implementation strategy of flipped classroom, the application of artificial intelligence in personalized learning, and the challenges and solutions faced by the integration of the two.

Keywords: Flipped Classroom; Artificial Intelligence; Personalized Learning.

1. Introduction

Flipped classroom is a student-centered teaching mode that originated at the beginning of the 21st century and has been gradually promoted and applied worldwide in recent years. The core concept of this teaching mode is to subvert the traditional teaching process, changing the original lecture-style teaching in the classroom to independent learning by students before class, while the classroom time is mainly used for discussion, practice and in-depth learning, while technological progress has led to the rapid development of the trend of intelligentization, and the close integration of artificial intelligence and education heralds a new round of innovation in the field of education. As early as 2012, China's Ten-Year Development Plan for Education Informatization emphasized the vision of creating a personalized learning environment for each learner; and in 2016, the "Thirteenth Five-Year Plan for Education Informatization" further clarified that online learning spaces should be personalized to achieve the goal that each learner has an exclusive space with their own unique characteristics. With the in-depth implementation of the Education Informatization 2.0 Action Plan, personalized learning with technical support has gradually become a key issue in the construction of national education informatization. This shift is not accidental, but based on a profound reflection on the current situation of education and forward-looking judgment of future development, personalized learning emphasizes learner-centered, respect and make full use of the uniqueness of each learner, aiming to achieve the optimal allocation of educational resources and personalized adjustments in teaching methods by technical means, how to actively apply artificial intelligence to guide the students to carry out personalized learning in a flipped classroom teaching model is the main content of this paper. is the main content of the research in this paper.

2. The Rise and Characteristics of the Flipped Classroom Model

2.1 Short and Concise Micro Video

With the rapid development of information technology and the popularization of the Internet, especially the wide application of smartphones, tablet computers and other intelligent terminal devices, students can learn online anytime and anywhere. This provides strong technical support for

the implementation of the flipped classroom model, enabling students to access and watch teaching videos more conveniently, thus improving the flexibility and autonomy of learning. Micro videos in the flipped classroom are usually shorter in length, generally between a few minutes and ten minutes, and this short and concise video length is in line with the characteristics of students' attention, which helps students to focus on learning in a short period of time and avoid learning fatigue. Moreover, each micro-video is aimed at a specific knowledge point or problem to explain, the content is concise and focused, and this precise content design helps students to quickly understand and master the key information, and improve learning efficiency. For example, Chongqing Jukui Middle School adopted the flipped classroom teaching method in the high school language subject. In the poetry appreciation course of "Short Songs", the teacher collected relevant video clips from film and television works and audio recordings of famous recitations, and compiled a preview guide for the lesson, and the video teaching content not only covered the appreciation of the poem itself, but also additionally supplemented with examples of how Cao Cao solicits, treasures, and respects talents, and through practice, this After practice, this flipped teaching mode has achieved good results.

2.2 Autonomous and Regulated Teaching Process

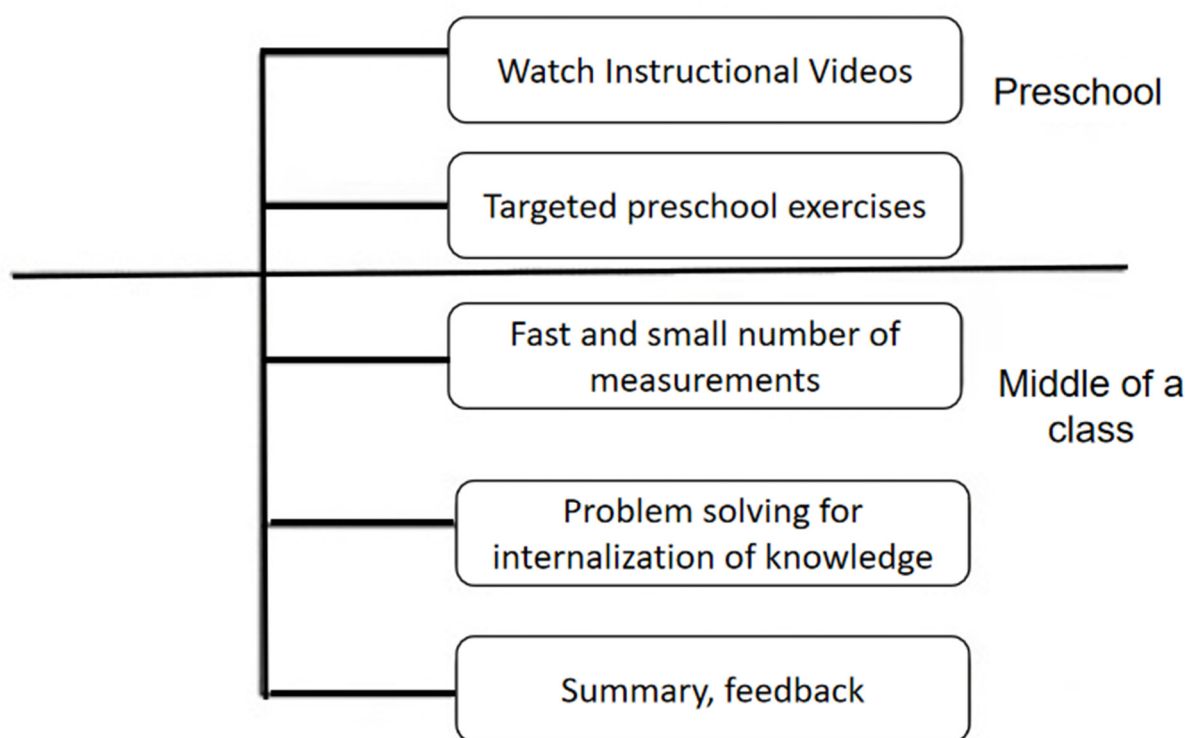


Figure 1. Flipped classroom framework model

Under the flipped classroom model, students become the main body of learning, and they need to learn new knowledge independently before class by watching teaching videos, reading related materials, etc. This kind of independent learning not only requires students to have a high degree of learning initiative and self-management ability, but also promotes the enhancement of students' independent thinking and problem-solving ability. Moreover, in the learning process, flipped classroom allows students to flexibly regulate the pace and depth of learning according to their own learning situation and interests, for the content they have already mastered, students can quickly browse or skip; for the parts that are difficult to understand or interesting, they can watch repeatedly and explore in depth. This modulation helps to meet students' individualized learning needs and improve learning efficiency. Professor Robert Talbert of Franklin College, USA, has successfully practiced the flipped classroom teaching mode in several courses of Mathematics and Computing

Science majors (e.g. "Computer Tools for Problem Solving" and "Linear Algebra"), and has gained We have successfully practiced the flipped classroom teaching model in some courses (e.g. "Computer Tools for Problem Solving" and "Linear Algebra"), and gained significant teaching results. After a long period of teaching practice and reflection, Prof. Robert Talbert gradually refined the implementation framework model of flipped classroom (Figure 1). In addition, in the flipped classroom, teachers no longer spend a lot of time explaining knowledge, but mainly use the classroom time for organizing students to discuss, cooperate, explore and other practical activities, which redistributes the classroom to become a place for exchange of ideas and collision of wisdom between teachers and students, and helps cultivate students' innovative thinking and teamwork ability.

2.3 Possibility of Personalized Teaching

On the one hand, flipped classroom provides more possibilities for students' personalized learning. Students need to learn independently through video lectures, e-books, online discussions, etc. before class, and this kind of learning mode enables students to learn at their own pace and interest, which improves the initiative and enthusiasm of learning, and students can also choose learning resources and learning modes suitable for themselves according to their abilities and needs, such as watching teaching videos of different difficulty levels, and participating in online discussions. On the other hand, teachers can also carry out personalized guidance. In the classroom, teachers can carry out personalized guidance based on students' learning situation and feedback, according to the basic knowledge mastered by the students before class, teachers can carry out targeted tutoring in the classroom by understanding the students' problems and needs, and during the guidance process, they can learn about the students' learning styles and interests through observing the students' performances and exchanging views with the students. points, so as to provide students with more personalized teaching services. Finally, the flipped classroom can use technology to support personalized learning. For example, through the online learning platform, teachers can provide students with personalized learning resources and learning paths; through data analysis tools, teachers can understand the learning situation and needs of students, so as to provide students with more accurate teaching feedback.

3. Challenges of Flipped Classroom Model in the Digital Era

3.1 More Data Security and Privacy Protection Issues

In the flipped classroom model, sensitive data such as students' learning data and personal information will be widely collected and stored. These data include, but are not limited to, names, student numbers, learning progress, online behavior records, etc. If educational institutions or platforms fail to take effective data encryption and protection measures, these data may be at risk of being leaked by hacking, internal staff misconduct, or third-party partners' negligence. Once the data is leaked, it not only poses serious privacy risks to students, but may also lead to identity theft, harassment and other social problems. For example, some educational institutions or teachers may use students' personal information for unauthorized marketing activities or sell the data to third parties for profit. Such misuse not only violates students' right to privacy, but may also damage the reputation and trustworthiness of educational institutions. In addition, flipped classrooms usually rely on online learning platforms and digital teaching tools for implementation. However, these platforms and tools themselves may have technical vulnerabilities, such as unfixed security patches, insecure API interfaces, etc. These vulnerabilities may be exploited by hackers for data theft, tampering or destruction, and if the platforms or tools are not updated in a timely manner, it may also result in known vulnerabilities not being fixed, thus increasing the risk of data security.

3.2 Technology Update and Teacher Training to be Improved

On the one hand, the successful implementation of the flipped classroom model cannot be separated from the strong technical support, such as the purchase of advanced teaching equipment,

updating the software platform, optimizing the network environment, etc. Problems with these technologies will directly affect the implementation of the flipped classroom, and even lead to the interruption of the teaching process. The common technical problems are mainly the incomplete network coverage and insufficient bandwidth in the network environment, which lead to some teachers and students not being able to access online teaching resources smoothly, and at the same time, the network security problems are also endless, such as network attacks and virus propagation, which bring great threats to the information security of teachers and students. On the other hand, the flipped classroom model requires a large number of digital teaching resources to support it, but the development of these resources is not an easy task, and it requires a lot of human, material and financial resources, and the updating speed of the teaching resources needs to keep up with the development of the times to ensure the timeliness and accuracy of the teaching content, which is a considerable challenge for many educational institutions. At the same time, the flipped classroom model also requires teachers to have a high level of informatization literacy and be able to skillfully use digital teaching tools and methods for instructional design. However, at present, the informatization literacy of many experienced teachers still needs to be improved, and they may lack the necessary digital teaching skills or have an insufficiently in-depth understanding of the new teaching mode, which leads to difficulties in giving full play to the advantages of the flipped classroom in actual teaching, so enhancing Teacher training is also crucial.

3.3 Educational Equity and Uneven Distribution of Resources

In the digital era, the phenomenon of digital divide between different regions and different groups is increasingly significant. In the actual teaching process of flipped classroom, economically underdeveloped areas, remote areas and disadvantaged groups are often difficult to access high-quality digital educational resources, resulting in increased inequality of educational opportunities, and the flipped classroom model is highly dependent on digital resources and network environment, which undoubtedly exacerbates the phenomenon of educational inequity. Moreover, the flipped classroom model requires a large amount of high quality digital teaching resources to support it, including high quality teaching videos, interactive courseware, online tests, etc. However, some regions or schools are unable to obtain enough high quality resources due to the limitations of funds, technology, etc., which affects the implementation of the flipped classroom model, and this imbalance of educational resources is an important problem faced by the development of flipped classroom abandonment.

4. Personalized Learning Path Design Path based on Artificial Intelligence in Flipped Classroom Mode

4.1 Learning Needs Analysis

Before carrying out learning needs analysis, it is necessary to first clarify the goal of learning needs analysis, understand the learning background, interest, ability and needs of different students in order to provide them with customized learning resources and paths, and also adjust teaching strategies and methods according to the needs of students in order to improve teaching effectiveness and learning satisfaction. In addition, all-round collection of information on students' needs is also a crucial part of carrying out personalized learning. On the one hand, questionnaires can be designed to collect information on students' interest in learning content, learning styles, learning goals, etc. On the other hand, student learning profiles can be set up to record information on students' learning histories, grades, interests, specialties, etc., in order to have a more comprehensive understanding of students' learning needs. One-on-one interviews can also be conducted with students to understand their learning confusions, expectations, and personalized needs, and finally, AI technology can be used to collect and analyze students' behavioral data, outcome data, and feedback data during the learning process in order to discover the students' learning patterns and potential needs, such as the figure

reflecting the biology of a student in a certain class, and such transparent learning needs analysis makes it possible to see whether the student has reached his or her learning goal becomes obvious.

The final step in needs analysis is to carry out data analysis. It is necessary to first classify the information collected on students' needs, such as learning content needs, learning resources needs, learning methods needs, etc. Students are then ranked according to the urgency and importance of their needs in order to determine which needs are to be met as a matter of priority, and then the differences in needs between different students are analysed so that personalized learning resources and paths can be provided for them. Note that in designing personalized learning pathways, it is important to fully respect students' learning styles, interests and differences in needs and avoid a one-size-fits-all approach to teaching. For example, Changsha Mingde Wangcheng School is committed to educational innovation and actively explores the design of personalized learning paths based on artificial intelligence, introducing a "unit-based holistic teaching based on consistency of teaching and learning assessment" model (Figure 2) and combining it with artificial intelligence technologies such as the Big Data Precision Teaching System to achieve personalized learning in large-scale education. Teachers upload the unit analysis files to the AI system, which will evaluate them and make suggestions for improvement. During the learning process, the AI system will collect and analyze their learning data in real time, accurately identifying learning difficulties and weaknesses, and based on the learning data of the students, the AI system will intelligently recommend suitable learning resources and practice questions, and provide personalized learning suggestions, and through the use of this teaching mode, the learning effect of students has been significantly improved. Through the use of this teaching mode, the learning effect of students is significantly improved, especially in the mastery of difficult points and weaknesses, and teachers are able to more accurately understand the learning situation of students, so as to conduct more targeted teaching.

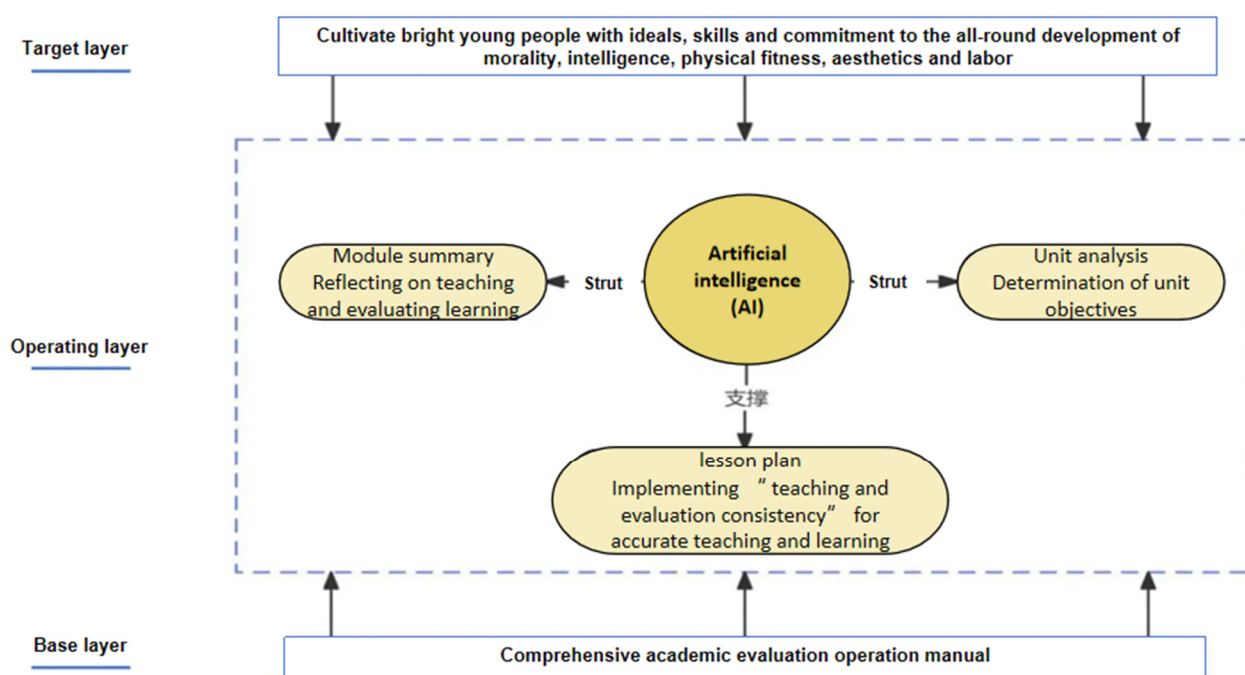


Figure 2. The model of "holistic unit teaching based on the consistency of pedagogical assessment"

4.2 Enhance Resource Recommendation and Optimization

Under the flipped classroom model, the personalized learning path design based on artificial intelligence can provide students with more accurate and effective learning resources by strengthening resource recommendation and optimization. Intelligent recommendation system is the most frequently used resource recommendation method, which mainly uses artificial intelligence technology, such as machine learning, deep learning, etc., to build intelligent recommendation

algorithms, which should be able to accurately recommend learning resources based on students' learning history, interest preferences, learning progress and other information, and in the process, constantly collect students' learning feedback and performance data for optimizing the recommendation algorithm, and through continuous iteration. Through continuous iteration and optimization, the accuracy and satisfaction of the recommendation results are improved. Under the flipped classroom teaching mode, students often need to learn the course content in advance, and with the help of AI, students can be provided with targeted learning resources, customized personalized learning resource packages based on their learning needs and goals, which should include learning resources suitable for the students' current learning level and interests, as well as assistance to help them achieve their learning goals, and provide additional learning resources when students encounter learning difficulties. When students encounter learning difficulties, additional learning resources and support are provided to help them overcome the difficulties (e.g., the figure shows the resource query page in the learning system). In conclusion, by building an intelligent recommendation system, enriching the learning resource base, designing personalized learning paths, evaluating learning effectiveness and collecting feedback as teaching aids, students can be provided with more accurate and effective learning resources and learning paths, which will promote their personalized development and enhance their independent learning ability.

4.3 Real Time Monitoring and Dynamic Feedback Adjustment

Under the flipped classroom teaching model, the application of artificial intelligence to monitor students' learning status in real time, provide personalized feedback and adjustment strategies as well as continuous optimization and iteration can ensure the continuous optimization of students' learning effects and learning paths, so as to improve students' learning satisfaction and learning effectiveness. Teachers can use artificial intelligence technology to collect real-time data on students' behaviors during the learning process, such as the length of time spent on watching videos, correct rate of answering questions, frequency of interaction, etc., and the AI conducts in-depth analysis of the collected data in order to help teachers fully understand the students' learning progress, learning difficulties, and learning effects, and then assess the students' learning status, including learning speed, learning quality, and learning interest, based on the results of the data analysis; and finally, by comparing the students' historical learning data with the current learning data, we can find out the students' learning changes and trends, so as to provide students with personalized learning feedback. After the personalized learning feedback is provided by AI, teachers can communicate with students on a one-to-one basis to understand their learning confusions and needs, and provide them with personalized learning guidance and advice to help students solve the difficulties encountered in their learning and achieve their personalized learning goals. With the help of intelligent learning analytics, the AI system is able to deeply analyze students' learning data, and then provide tailored learning content and paths to help students achieve self-driven learning and comprehensive development. Tsinghua University, for example, has adopted AI teaching assistant systems for some of its courses, which can effectively assist students in overcoming complex knowledge points and provide personalized learning guidelines. Meanwhile, AI technology has also significantly improved students' experimental operation skills and scientific inquiry ability with the help of virtual experiment platforms.

5. Conclusion

In the digital era, the innovation of the flipped classroom model needs to take advantage of the power of artificial intelligence technology. The design of personalized learning paths based on AI provides a new teaching mode and implementation strategy for the flipped classroom. However, to overcome the limitations of technology, teachers and resources, it requires the joint efforts of educators, technology developers and policy makers. In the future, with the continuous progress of

technology and the innovation of education concepts, the integration of flipped classroom and AI technology will be even closer, bringing more profound changes to the field of education.

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