

Research on the Practical Path of Flipped Classroom in Colleges and Universities Based on Artificial Intelligence

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Abstract: In today's digital era, higher education faces the urgent need for innovation and change. The rapid development of Artificial Intelligence (AI) technology has provided a powerful impetus for the innovation of teaching mode in colleges and universities. Flipped classroom, as a student-centred teaching mode, has been gradually promoted in colleges and universities. Combining artificial intelligence with the flipped classroom in colleges and universities can give full play to the advantages of both, effectively improve the quality of teaching, cultivate students' independent learning ability and innovative thinking, and meet the cultivation requirements for high-quality talents in the new era.

Keywords: Artificial intelligence, flipped classroom, practical path.

1. Background to the Study

For a long time, the traditional teaching mode has dominated teaching in colleges and universities. Teachers unilaterally output knowledge to students on the podium, and students can only passively accept it, lacking the opportunity for active thinking and exploration. However, in today's fast-changing information dissemination speed and more and more diversified ways of knowledge acquisition, this traditional teaching mode is gradually difficult to meet the diversified and personalised learning needs of students in the new era. New-age students are growing up in the era of information explosion, they are active and curious, eager to explore knowledge on their own, and pursue a more interactive and innovative learning experience. Artificial Intelligence (AI) educational tools are attracting a lot of attention and are becoming increasingly popular

Traditional teaching favours a teacher-driven approach. In a class lesson, the teacher always teaches the whole class in a day-to-day, planned and organised manner, it ensures that every student is under the direct guidance of the teacher from the beginning to the end of the lesson, and the teacher is the source of knowledge. (Qader & Arslan, 2019). Traditional teaching is based on a series of activities previously planned by the teacher that the student must perform, which take place in different physical and virtual scenarios, and the student must acquire knowledge by listening (Blanco, Echaluze, & Peñalvo, 2019). It is all a more economical and effective form of teaching and learning that allows students to learn in a shorter period of time the rich body of knowledge that humans have accumulated over time.

However, traditional classroom teaching does have limitations. In traditional classroom teaching, the teacher is the main source of information, the main teaching method is continuous lecture, and the teacher is usually the leader of the lesson and the focus of attention (Hashemi et al., 2022). Although teachers can adapt the content based on students' feedback, some students will find the pace fast and

others slow because there is a gap in students' receptivity (Abedi, Keshmirshakan, & Namaziandost, 2019). Personalised Adaptive Learning has to be adapted to the characteristics of the learner to promote the personalised development of the student (Cheung, Phusavat, & Yang, 2021). In such an instructional model, although some active learning strategies can be introduced into the classroom to promote classroom interaction through student reflection and sharing, there is a risk of making the classroom restless and taking up a lot of class time (Bhat et al., 2020).

Technological advances in the twenty-first century have allowed students to access resources online that are useful for teaching and learning (Kevser, 2021). By creating a sharing platform on the Internet, teachers around the world began to share knowledge, which could then be reused and utilised by all (Rodríguez et al., 2019). In order to adapt to the needs of the times, a new teaching methodology emerged as the flipped classroom, which was created by transforming the traditional learning environment by making it possible to make learning content available on the Internet before the class starts (Susanti & Pitra 2019), and students strongly expressed their expectations of university learning (Tomas et al., 2019). As a result of the massive rise of open online courses, a large number of micro-courses have ensued, which can offer quality courses from top universities to any learner in the world (Wang & Zhu, 2019). This has led to a general realisation of the value of OERs around the world, breaking away from the traditional ideology that the only way to access university courses is to pay university fees, and providing free access to learners who are blocked from accessing universities and colleges, and extracurricular videos can be viewed as the initial stage of instructive re-creation, laying the groundwork to provide the basis for students to engage with tasks in contextualised and referenced activities (Fredriksen, 2021).

In this context, the flipped classroom teaching model was born. The definition of flipped classroom is the reversal of roles in the classroom, where students get the leading role in

the learning process (including the three segments of before-, during-, and after-class), and the teacher acts as a guide (Bergmann & Sams, 2012). It breaks the time and space limitations of traditional teaching and constructs a brand new teaching process with students as the centre. Students learn the basics independently before class with the help of various learning resources, such as teaching videos and electronic textbooks, to form a preliminary knowledge of the course content in advance. The classroom is transformed into an important place for teacher-student interaction, knowledge deepening and problem solving, where students can engage in in-depth discussions with teachers and classmates to solve doubts encountered in the process of independent learning and further deepen their understanding and application of knowledge. With the continuous updating of educational concepts and the continuous development of educational technology, the promotion of flipped classroom in colleges and universities is becoming more and more widespread, and more and more college and university teachers have begun to try to use this teaching mode in order to improve the quality of teaching and the learning effect of students.

Currently, the flipped classroom model is a hot topic of research in the international higher education field and education theory. Due to the rapid development of Internet technology, the efficiency of learning has been improved through online learning and e-learning between teachers and students. Flipped learning is unthinkable without the use of technology (Birgili, Seggie, & Oğuz, 2021). The introduction of e-learning tools in the educational process is essential and educators should consider the specificities of their implementation in order to master the conceptual strategies of teaching and learning in online learning environments (Abdula et al., 2020). This open learning opportunity has contributed to the development of MOOC, which is growing in size and scope (Mahajan, Gupta & Singh, 2019).

It is very different from traditional teaching methods, which can motivate students to learn (González et al., 2020), and can break through the spatial constraints of conventional teaching venues such as schools and classrooms, and the constraints of fixed teaching hours, with classroom time for more student-centred learning activities (Låg, & Sæle, 2019). There is an increase in student engagement and a shift from passive to active learning (Angadi et al., 2019). The introduction of information technology has played a key role in terms of open services, quality improvement, customised conditions and learning flexibility (Gutiérrez et al., 2019).

Although students participating in flipped classrooms are free to choose the space and time for their learning, the pedagogical content of online learning is still part of the course provided by the instructor and is often the condition and basis for subsequent face-to-face classroom instruction, so there are also requirements to be met by the online learning before the class, and the students are expected to prepare for the course outside of the classroom (Öztürk & Çakıroğlu, 2021). Time management is an important part of regulating learning behaviour (Jovanović et al., 2019). More and more educational software is used in higher education (Zhao, 2019). The basic way is a new teaching methodology through teacher-developed videos and content-based teacher-student activities (Tekin et al., 2020). Through the careful design of the teacher, it can support the learning objectives and ensure that the students acquire knowledge, which can lead to active learning and team learning (Dooly & Sadler, 2020). Most importantly it can be tailored to the problem itself and the type

of project to be learnt, and the good feelings and positive impacts generated by the flipped classroom can help to increase students' self-efficacy (Fisher, Perényi, & Birdthistle, 2021).

In education, ICT can provide huge amount of learning resources for students to learn. Flipped classroom teaching opens the era of blossoming and flourishing in the educational arena in all its glory and higher education is embracing change (Yusuf, Walters, & Sailin, 2020). The introduction of computers in education is positive and effective, and this new information technology-based teaching tool is highly relevant to support independent and self-directed learning in the flipped classroom model (Tejedor et al., 2020). At the same time, the development of technology has made it convenient to open and share educational resources. Convenient open sharing of resources provides a material foundation for the flipped classroom to improve global education, form the cornerstone of curriculum design, and provide students with learning opportunities that were previously impossible or inaccessible. Students have a new learning environment that is not limited by time and space (Girmen & Kaya, 2019). In order to be able to carry out the online combined with offline learning model well, it is necessary to formulate appropriate policies, implement plans, rationally allocate resources (e.g., manpower allocation, technological conditions, machines and equipment), make a timetable, and come up with specific measures to support the system so that it can be successful.

The deep integration of artificial intelligence technology into the flipped classroom in colleges and universities is like loading a powerful 'wisdom engine' for the traditional teaching mode. The organic combination of the two can give full play to the synergistic advantages and improve the quality of teaching in an all-round way from multiple dimensions. Through accurate analysis of the massive amount of data generated by students in the learning process, it is possible to tailor-make personalised learning programmes for each student to meet the learning pace and needs of different students. This personalised learning support helps to develop students' independent learning ability in an all-round way, so that students can learn to actively explore knowledge, freely learn at their own pace, and develop the habit of independent thinking. At the same time, the diverse learning environments and rich learning resources created by AI can stimulate students' critical thinking, so that they can no longer blindly accept knowledge, but can think deeply and question what they have learnt. In addition, AI can provide students with more opportunities for innovation and practice, cultivate students' innovative thinking, encourage students to break through the traditional thinking stereotypes and put forward unique insights, so as to provide the society with a steady flow of high-quality talents adapted to the needs of the new era, and to meet the society's urgent desire for innovative and complex talents.

2. Changes in Teaching and Learning

The integration of artificial intelligence chatbots with flipped learning is an emerging field of research, (Lo & Hew, 2023). Artificial Intelligence, relying on its powerful data analysis capabilities, has the power of accurate observation, and is able to deeply mine and accurately analyse the huge amount of data left by students on various learning platforms. These data dimensions are extremely rich, covering all aspects of students' learning life. From the dimension of learning time, by analysing the time students spend on

different courses, we can clearly understand the degree of students' commitment to different courses, and determine which courses students are more interested in and which courses may have difficulties in learning. In terms of course participation, it not only includes the number of times students speak in classroom discussions, but also covers the frequency of participation in online learning activities, the enthusiasm of interaction, etc., so as to comprehensively judge students' motivation and enthusiasm for learning.

In terms of detailed analysis of homework completion, the system not only records the time spent on answering questions, but also analyses the reasonableness and uniqueness of students' thinking with the help of advanced algorithms. For example, in mathematics homework correction, the system can identify students' problem solving steps, determine whether students use conventional methods or innovative ideas to solve problems, provide encouragement and further guidance to students with unique ideas, and provide targeted guidance to students with deviations in problem solving ideas. The question-by-question analysis of test scores can pinpoint the students' mastery of each knowledge point and identify their weaknesses and strengths.

What's more, with the help of advanced emotion monitoring technology, such as capturing students' facial expressions through cameras, voice tone analysis and other means, it is able to capture students' emotional changes in the learning process and determine whether their learning state is positive, negative or burnout. When the system detects students' negative emotions, it can push some light and interesting learning resources or give encouraging tips to help students adjust their learning state.

Through the comprehensive analysis of these multi-dimensional data, teachers can more clearly observe the dynamics of students and gain precise insight into the learning status of each student. For example, for students who learn slowly in the mathematical analysis course and make frequent mistakes in the function chapter, the system can intelligently filter and accurately push the videos of intensive explanation of function basics for them based on the results of data analysis. These videos are specially recorded by experienced teachers to provide students with detailed analyses of easy-to-error and difficult points, and use animation, examples and other methods to help students better understand abstract function concepts. At the same time, with the targeted practice problem sets, the difficulty of the questions is gradual, from basic consolidation to ability enhancement, and gradually help students master the knowledge points. The practice problems are also accompanied by a detailed analysis of the solution to guide students to learn the correct method of solving the problem, and develop students' logical thinking ability. For students who have the ability to complete basic assignments in computer programming courses, the system will recommend extended learning resources such as algorithm optimisation and application of cutting-edge programming frameworks. These resources come from the latest research results and actual project cases in the industry, which help students keep up with the technology frontier and broaden their technical horizons, thus truly realising teaching according to students' abilities.

The intelligent tool can accurately plan the teaching objectives, content framework and teaching progress of the course based on education and teaching theories and curriculum standards, ensuring the scientific and rational nature of the course syllabus. In the creation of text content

for teaching courseware, it can elaborate complex knowledge points in simple and clear language, transform abstract concepts into vivid and easy-to-understand expressions, and at the same time, it can also reasonably design the presentation of content according to the key points and difficulties of teaching, so as to enhance the attractiveness and readability of teaching courseware. In the preliminary conception of academic papers, intelligent tools can provide relevant research ideas and literature review, integrate a large number of academic resources, and provide strong support for teachers' research work.

The combination of image recognition and intelligent mapping technology provides great convenience for teachers to create teaching resources. Teachers only need to simply describe their teaching needs, such as wanting a schematic diagram to show the principles of physical circuits, or a chart to illustrate an economic growth model, and then they can generate intuitive and visual teaching charts, professional schematic diagrams, and vivid teaching illustrations. These graphics not only accurately convey the main points of knowledge, but also choose the appropriate colour, style and labeling according to the teaching content and students' characteristics, attracting students' attention and helping them better understand and remember their knowledge.

More importantly, the virtual laboratory and virtual simulation scenes created by using AI technology make students feel as if they are in a real experimental environment. In the physics experiment course, students can carry out complex circuit construction and optical experimental operations in the virtual laboratory without worrying about equipment damage and safety issues, and they can repeatedly carry out experiments, adjust the experimental parameters at will, observe the results of experiments under different parameters, and explore the laws of physics in depth. For example, in the study of electromagnetic induction phenomenon, students can freely change the strength of the magnetic field in the virtual environment, conductor speed and other parameters, real-time observation of the changes in the induction current, so as to more deeply understand the principle of electromagnetic induction. In chemistry experiments, students can simulate the reaction process of various dangerous chemicals, such as the dilution of concentrated sulphuric acid and the synthesis of explosives, etc., to gain valuable experimental experience in a safe environment. This kind of teaching resources that break through the limitations of time and space greatly enriches the form and content of teaching resources and provides students with a more diversified learning experience.

3. Practical Path

3.1. Pre-course stage

Personalised learning resources are pushed, and university teachers rely on powerful AI learning platforms to customise personalised pre-study packages for each student through in-depth analysis of students' pre-study data. Artificial intelligence can revolutionise education by automating administrative processes, providing timely feedback to students and delivering personalised learning experiences (Ray & Sikdar, 2024). This material is rich and varied and takes into account the learning level and professional needs of the students. The instructional videos are tiered according to the learning level of the students. Students with weak

fundamentals can watch the basic knowledge explanation video, which starts from the most basic concepts and principles, and explains them step by step in depth, with a lot of examples and exercises, to help students consolidate the fundamentals. Students with stronger learning ability can choose more difficult knowledge expansion videos, which cover the cutting-edge knowledge and in-depth application of the subject area, leading students to conduct more in-depth thinking and exploration.

The kit also covers electronic teaching materials, which are convenient for students to access the knowledge points at any time. The electronic teaching materials not only contain the contents of traditional teaching materials, but also incorporate multimedia elements, such as animation demonstrations and video explanations, which make the presentation of the knowledge points more vivid and graphic. Cutting-edge academic literature, on the other hand, allows students to understand the latest research developments in the subject area, broadens their academic horizons, and stimulates their interest in learning and innovative thinking. As well as the actual case study materials related to the course, in the case of finance courses, for example, for students majoring in financial engineering, the pre-prep materials will contain quantitative investment strategy analysis, financial derivatives pricing model of the actual application of the case, etc. These cases come from the real financial market transaction data, such as the actual investment strategy and return analysis of a well-known investment institution, to help students combine the theoretical knowledge with the actual operation, and deeply understand the core knowledge of financial engineering. This helps students to combine theoretical knowledge with practical operation and gain a deeper understanding of the core concepts and application skills of financial engineering. For students majoring in insurance, it will focus on the analysis of insurance market dynamics, cases of insurance product innovation, etc., helping students understand the application of financial theories in practice from the unique perspective of the insurance industry, such as the design ideas and market feedback analysis of innovative insurance products launched by an insurance company.

Intelligent learning guidance on the learning platform, intelligent learning assistant is like a caring private learning consultant, providing students with a full range of services at any time. It will use intelligent algorithms to plan detailed learning paths and recommend suitable learning methods for students based on their learning goals, knowledge reserves and learning habits. For a student, the intelligent learning assistant will plan a long-term study plan for him or her, including the focus of each semester's study, recommended readings and academic papers, as well as how to participate in research projects and academic exchange activities, etc. The AI content delivery system uses machine learning algorithms to provide personalised teaching and learning materials, which can improve student engagement (Ray & Sikdar, 2024). When students encounter problems such as difficulties in understanding a concept or doubts in formulae derivation during the pre-study process, intelligent assistants are able to provide quick and easy-to-understand answers through voice or text responses. For complex formulas in mathematics, the intelligent assistant can show the derivation process of formulas with animation to help students understand intuitively. At the same time, it also dynamically adjusts the learning plan according to the student's real-time

learning progress and feedback, ensuring that the student's learning process is always efficient and orderly. If a student spends too much time on a certain knowledge point, the intelligent assistant will automatically recommend more related learning resources, such as related micro-lesson videos, online forum discussion links, etc., to help students overcome the difficult points.

3.2. Classroom interaction and collaboration phase

Intelligent grouping and collaborative learning, using advanced artificial intelligence grouping algorithms, take into account various factors such as students' learning ability, teamwork ability, personality traits and past performance in group cooperation, and carry out scientific grouping for classroom discussion and project practice. For example, in the group project of the management course, students with strong organisational and coordination skills and students with active thinking and innovative spirit are divided into a group, and at the same time, students who are good at data analysis and copy writing are paired together to ensure that the group can conduct in-depth research from different perspectives when completing the case study project of enterprise management, give full play to their respective advantages, and realise the complementarity of strengths. During the implementation of the project, group members communicate and collaborate in real time through the online collaboration platform, sharing documents, discussing ideas, assigning tasks, and overcoming problems together. Flipped classrooms incorporating AI technology may become more inclusive and accessible to a wider range of students (Ray & Sikdar, 2024). The platform also provides task progress tracking and evaluation features to make it easy for group members to understand the progress of the project and each other's contributions. Each group member can record his or her work progress and problems encountered on the platform, and other members can provide timely help and advice to facilitate efficient group collaboration.

The advantage of digital self-testing is that it allows immediate feedback to students (Bye, 2018), and teachers are able to collect data on the full range of students' performance in class in real time with the help of intelligent teaching devices, such as smart classroom systems and interactive teaching tablets. These data include the number of students' speeches, quality analysis of the content of their speeches, the depth and innovation of their speeches through semantic analysis; the enthusiasm of participating in classroom activities, counting the frequency of students' participation in activities such as voting and quizzing; the correct rate of answering questions as well as the time of answering questions, so as to assess students' mastery of knowledge and reaction speed. Based on these real-time data, teachers can quickly judge students' mastery of knowledge and adjust the teaching rhythm and method in time. For example, when most students are found to have deviations in their understanding of a certain knowledge point, teachers can immediately adjust the teaching strategy, focus on explaining or organising group discussions; at the same time, students can also ask teachers questions, submit assignments, participate in classroom polls, and share their own views and ideas conveniently and quickly through intelligent terminal devices, such as mobile phones and tablet PCs, which greatly enhances classroom interactivity. Teachers can also push relevant learning materials and extension exercises through

intelligent teaching devices to meet students' personalised learning needs. For students with faster learning progress, teachers can push some extended learning materials, such as academic research reports, industry dynamics analysis, etc., to encourage students to carry out more in-depth learning and exploration; for students with slower learning progress, teachers can push some basic knowledge consolidation exercises and counselling materials, to help students to check the gaps and make up for the deficiencies.

3.3. Post-course consolidation and expansion stage

Intelligent homework correction and tutoring, the homework assigned by the teacher is automatically corrected by the advanced artificial intelligence homework correction system, which can not only quickly and accurately give homework grades, but also provide in-depth analysis of the students' answers. It will point out in detail the reasons for students' mistakes, whether they are conceptual misunderstandings, calculation errors or deviations in problem-solving ideas, and provide detailed knowledge point explanations and corrective suggestions for each mistake. For common problems in students' homework, teachers can focus on explaining them in class; for individual students' personalised problems, the system will recommend personalised tutoring materials, such as micro-lesson videos of related knowledge points and special practice questions, according to students' knowledge weaknesses, so as to realise precise tutoring. For example, for students who frequently make grammatical errors in English writing, the system will recommend special micro-lessons on grammar and targeted writing exercises to help students improve their writing skills. The micro-lesson videos are recorded by professional English teachers, providing detailed explanations of common grammatical errors and a large number of example sentences and exercises to help students deepen their understanding and application of grammatical rules.

Learning Outcomes Assessment and Feedback, an AI-based learning assessment system, adopts a diversified assessment method to comprehensively and integrally consider students' pre-course pre-study performance, including completion of pre-study tasks, quality of questions asked, etc.; classroom performance, such as participation, quality of presentation, contribution to group work, etc.; completion of post-course homework, covering the quality of the homework, time of completion, etc.; and examination results, including the examination score, knowledge point score distribution and other factors to provide a comprehensive, objective and fair assessment of students' learning outcomes. The AI-based language learning platform has the function of tracking, monitoring and recording user behaviours, which helps to accurately assess students' learning and thus promotes their external motivation to complete pre-course activities (Li & Peng, 2022). The assessment results are presented to students and teachers in the form of intuitive visual charts, so that students can clearly see their performance in different learning sessions and understand their own learning progress and deficiencies; teachers can also analyse in-depth the problems in the teaching process based on the results of the assessment, adjust their teaching strategies, and provide more targeted help and guidance to students. Teachers can also understand the overall learning situation of the class through the system-generated learning situation report, discover the weak links in teaching,

and carry out targeted reinforcement of teaching. The flipped classroom model can bring more time for teachers and students to interact in the classroom, which will be conducive to the personalised development of students. Teachers also successfully detach themselves from the identity of classroom subjects and become counsellors of students' learning (Wu & Wang, 2021).

4. Implementation Effect

4.1. Improvement of student learning effect

Through long-term tracking of students in multiple colleges and universities that have implemented AI-based flipped classrooms in colleges and universities, the results show that students' learning outcomes have been significantly improved, which is important for both the understanding of the potential to enhance the student learning experience (Lo & Hew, 2023).

Knowledge acquisition deepens and students gain a better understanding of their expertise. In science and technology majors, for example, in physics courses studying quantum mechanics experiments, students are able to accurately control experimental parameters with the help of virtual laboratories created by AI, repeatedly observe microscopic particle motion states, and deeply understand abstract concepts, which is difficult to achieve through traditional teaching. In the field of humanities and social sciences, such as history courses, intelligent teaching resources integrate a large amount of information, students through independent learning and classroom discussion, from multi-dimensional analysis of historical events, no longer limited to a single point of view, a more comprehensive and in-depth understanding of knowledge. Artificial intelligence-driven flipped classrooms have had a positive impact on student engagement, motivation, and learning outcomes (Ray & Sikdar, 2024).

Thinking skills are expanded and critical and innovative thinking is fully stimulated. In class discussions and group projects, the diverse resources and real-time feedback provided by AI motivate students to think deeply and question their knowledge. Chatbots are used as assistants for students and teachers to facilitate the learning and teaching process (Diwanji, Hinkelmann & Witschel, 2018). For example, in economics case studies, students use AI analysis tools to mine market data and come up with unique insights and innovative solutions; art and design students use AI-generated creative inspirations and design references to break out of the traditional constraints of thinking and design more innovative and personalised works.

Practical application ability has been enhanced, and students have performed well in various practical activities and competitions. In the Mathematical Modelling Competition, students proficiently used AI tools to analyse data and construct models, improving modelling efficiency and accuracy, such as using machine learning algorithms to analyse traffic flow data, build prediction models and propose traffic management optimisation solutions. In the Innovation and Entrepreneurship Competition, students conduct market research and product innovation with the help of AI technology, and develop innovative products or services that meet market demand. In the enterprise internship, students can quickly apply what they have learnt to practical work, such as using natural language processing technology to develop intelligent customer service system, using image

recognition technology for product quality inspection, which is highly recognised by enterprises.

Academic performance progressed, and in the case of university English courses, for example, after the adoption of the new teaching model, the flipped classroom actively promoted students' psychology of taking responsibility for their learning, especially in terms of English learning awareness, and it also had a contributing effect on English learning strategy awareness (Wu & Wang, 2021). Students' listening, reading, writing and speaking skills improved significantly. In listening training, the Intelligent Listening Training System provides students with materials of different levels of difficulty according to their level, analyses weak points and carries out targeted reinforcement training; in oral expression, the Intelligent Oral Evaluation System provides real-time evaluation and feedback, helping students to correct their pronunciation and improve their fluency; in reading comprehension, students learn to use critical thinking to extract key information; and in writing, the Intelligent Writing Aid helps to check for grammatical errors, optimize In reading comprehension, students learn to use critical thinking to extract key information.

4.2. Optimisation of Teachers' Teaching Experience

Teaching efficiency is improved, artificial intelligence technology greatly reduces the teaching burden of teachers, intelligent homework correction system and performance analysis system quickly complete the correction and statistics, and provide detailed analysis reports. In the future life, the intelligence of AI algorithms will be more and more optimised, and classroom teaching will become more diversified and efficient in the future (Hu, 2021). Teachers will be able to transform their roles by devoting more time and energy to optimising instructional design, innovating course content, and personalising instruction for students.

Teaching decision-making is more scientific. By analysing students' learning data with AI, teachers can accurately understand students' learning status, including knowledge mastery, learning styles and interests. Based on these data, teachers can make more scientific adjustments to their teaching strategies, such as adjusting the teaching progress, adding relevant exercises and explanations to address students' common knowledge weaknesses; and pushing personalised learning resources according to students' interests and preferences to stimulate students' motivation to learn.

4.3. More efficient utilisation of educational resources

Artificial intelligence technology has been strongly introduced into the field of higher education (Montuori et al., 2021), and artificial intelligence achieves personalised push of teaching resources according to students' learning situation and needs. It avoids the problem of single resources in traditional teaching, so that each student can access the most suitable learning materials for him/her, and improves the utilisation rate of resources and learning effect.

Resources are updated and integrated conveniently, and teachers can use artificial intelligence technology to quickly integrate high-quality educational resources on the network and update and optimise them according to the actual needs of teaching. At the same time, the intelligent teaching resource generation tool also facilitates teachers to create rich

and diversified teaching materials, such as teaching courseware, test questions, etc., which enriches the types and contents of teaching resources.

5. Challenges and Strategies to Address Them

5.1. Technology Cost and Infrastructure Construction

The introduction of AI technology means that colleges and universities need to invest huge sums of money in the purchase of hardware equipment, such as high-performance servers to meet the needs of large amounts of data storage and computing; intelligent teaching terminals to provide teachers and students with convenient teaching and learning interaction equipment; and high-speed network equipment to ensure the smooth operation of the teaching platform and the rapid transmission of data. It also needs to bear the development, maintenance and upgrading costs of the software system, including the development of the artificial intelligence teaching platform and the purchase and updating of various teaching software. In addition, a stable and reliable high-speed network environment is the key to ensure the normal operation of the AI teaching platform, while a perfect information security guarantee system is an important barrier to protect the data security of students and teachers against data leakage and malicious attacks.

These high technology costs and complex infrastructure issues (Ray & Sikdar, 2024) are a huge obstacle for many colleges and universities, especially local colleges and universities with relatively scarce funds. Once the technology investment is insufficient, it will not only lead to lagging operation and slow data processing of the teaching platform, which will affect the smoothness and efficiency of teaching, but also may lead to serious problems such as students' privacy leakage due to the lack of information security protection, which will damage the reputation of the university and the rights and interests of the students.

To cope with these challenges, colleges and universities should actively formulate a long-term development strategy for education informatisation and increase capital investment. At the same time, take the initiative to communicate with government departments for policy support and financial subsidies, the government can encourage colleges and universities to carry out AI teaching application pilots through the establishment of a special fund for education informatisation; actively cooperate with enterprises, introduce the technology and capital of enterprises, and jointly build intelligent teaching infrastructure, enterprises can provide advanced technical solutions and equipment, and colleges and universities can provide enterprises with application scenarios and data Support. In order to reduce the burden on schools, it is recommended to develop a shared resource platform through the support of government education funding or co-operation with technology companies (Dai & Kang, 2025). In terms of technology application, colleges and universities should formulate a reasonable technology application plan according to their own actual situation, and promote the application of AI technology in teaching in phases and steps, avoiding blindly following the trend and over-investment. For example, pilot application in some advantageous disciplines and courses first, and then gradually promote it after summing up experience.

5.2. Teacher Role Transformation and Ability Enhancement

In the AI-based flipped classroom, the role of the teacher has undergone a fundamental transformation, from the traditional knowledge transmitter to a learning guide, facilitator and learning partner. This puts forward higher requirements for teachers' information technology ability, and teachers need to be skilled in the operation of the AI teaching platform and be able to flexibly use the platform for teaching management and student evaluation; master the use of data analysis tools to extract valuable information from massive teaching data to provide a basis for teaching decisions; and the production method of intelligent teaching resources, and be able to use intelligent tools to create high-quality teaching and learning materials that enhance the role of teachers in providing personal support (Suwardika, Sopandi & Indrawan, 2024).

At the same time, teachers' instructional design skills need to be further improved, so that they can design attractive and effective teaching activities according to students' characteristics and learning needs. For example, designing project-based learning activities allows students to master knowledge and skills in the process of solving real-world problems; designing group cooperative learning activities to cultivate students' teamwork and communication skills, and good dialogue among students helps them learn and increases their motivation (Diwanji, Hinkelmann & Witschel, 2018). In addition, in terms of classroom management, teachers need to acquire new management skills to cope with various problems that arise during students' independent learning and group work, such as conflict resolution in group work and supervision of students' independent learning.

However, some teachers are bound by traditional teaching concepts and are difficult to quickly adapt to the role change, and they are intimidated by the application of information technology and have weak instructional design skills, resulting in the implementation of AI-based flipped classroom, which is unable to give full play to its advantages, and may even lead to teaching chaos.

In order to enhance the comprehensive quality and ability of teachers, universities should regularly organise teachers to attend training courses on the application of AI technology, and invite industry experts and scholars of educational technology to give lectures and guidance; carry out teaching seminars and encourage teachers to share their teaching experience and innovative practice results; and set up a special fund for teaching reforms to support teachers to carry out AI-based flipped classroom teaching innovation research and practice. Teachers themselves should also take the initiative to learn and continuously improve their professionalism and information technology skills to adapt to the new changes in education and teaching.

5.3. Student Adaptation Problems

Students have been in the traditional teaching mode for a long time and are used to passively accepting knowledge, with relatively weak independent learning ability and self-management ability. In the flipped classroom based on artificial intelligence, students need to complete the learning tasks independently before class and reasonably arrange the learning time and progress, which is a great challenge for them. Some students may not be able to complete the pre-study task on time due to a lack of self-discipline, resulting in

classroom learning that cannot keep up with the pace; some other students may be overloaded with information and have no way to choose when faced with a wealth of learning resources, which affects their learning effectiveness.

In response to students' adaptation problems, colleges and universities can offer special learning method guidance courses. By adopting AI, many improvements in teaching methods can be obtained (Sanchez-Gonzalez & Terrell, 2023), helping students to master self-directed learning skills, such as how to make a study plan and how to make efficient use of learning resources. Teachers should also strengthen the guidance and supervision of students in the teaching process, regularly check students' pre-study, and give timely feedback and guidance. At the same time, the AI learning platform can be set up with learning reminders, progress tracking and other functions to assist students in self-management.

6. Conclusion and Prospect

Flipped classroom in higher education based on artificial intelligence has opened up a brand new path for the reform of higher education teaching, which effectively improves the quality of teaching and the learning effect of students through such innovative initiatives as accurate learning situation analysis, intelligent teaching resources generation and personalised learning support. Although the implementation process faces many challenges such as the limited functionality and lack of authenticity of the technology (Lo & Hew, 2023), and the difficulty of changing the role of teachers, with the continuous development of AI technology and the continuous updating of educational concepts, the integration of the two will be more in-depth and extensive.

In the future, colleges and universities should unswervingly explore and innovate, fully explore the great potential of artificial intelligence in teaching, and further improve the teaching mode and method. For example, the use of AI technology to achieve more accurate learning predictions, identify students' learning difficulties and potential problems in advance, and carry out preventive interventions; explore the integration of AI with virtual reality, augmented reality and other technologies to create a more immersive learning environment for students. The potential and challenges in the area of flipped learning methods in particular provide a solid foundation, but there is still a need for deeper and broader research in all areas to maximise the benefits of this emerging technology (López-Villanueva, Santiago & Palau, 2024). Through continuous efforts, we will lay a solid foundation for cultivating more high-quality talents with innovative spirit and practical ability, and promote the cause of higher education to flourish in the direction of high quality and intelligence, so as to provide strong talent support for the progress and development of the society.

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