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The Innovation Path of Experimental Teaching in Built Environment Disciplines Driven by AI Technology

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Abstract: This paper focuses on the application of AI technology in the experimental teaching of building environment majors, and takes DeepSeek as the entry point to deeply discuss how it drives the innovation of experimental teaching. By analyzing the cognitive reconstruction and ethical framework under its empowerment, as well as the specific practice in teaching content, form and efficiency improvement, this paper reveals the core value of experimental teaching of built environment under the reconstruction, proposes the development model of teachers' intelligent ability, and looks forward to the potential impact of the integration of AI, Internet of Things and digital twin technology on professional experimental teaching in the future. The research aims to solve the "last mile" problem of intelligent technology landing in the experimental teaching of built environment majors, and provide reference teaching reform ideas for college teachers.

Keywords: AI Teaching Integration; Building Environment Experiment; DeepSeek; Virtual Simulation; Teaching Ethics; Personalized Learning

1. Introduction

1.1 Research Background and Policy Driving

In the field of global education, AI technology is penetrating and changing traditional teaching models at an unprecedented speed [1]. DeepSeek, an emerging AI technology, has demonstrated outstanding performance in multiple evaluations [2], achieving 88.5 points in the MMLU-Pro test, while its code generation capability surpasses that of GPT-4o [3].At the policy level, the White Paper on the Development of AI Empowered Teachers released by the Ministry of Education clearly points out that college teachers should actively embrace AI technology and improve their AI literacy to meet the needs of educational development in the new era [4,5]. At the same time, the "14th Five-Year Plan" teacher assessment KPI has also put forward specific requirements [6] for the AI ability of college teachers, which has prompted more and more colleges and universities to launch intelligent transformation. According to statistics, driven by policies, 89% of the double first-class colleges and universities have started intelligent transformation, but there are still 87% of teachers facing the practical dilemma of "technology can not be used to make good use of teaching", and it is urgent to solve the problem [7].

The application cases of DeepSeek in the field of education continue to emerge, providing new ideas and methods for education and teaching. For example, DeepSeek has greatly reduced the need for computing power, input data and corpus, thus greatly reducing the cost of training and reasoning, which provides the necessary conditions [8]. At the same time, DeepSeek adopts multiple potential attention (MLA) and load balancing technology, which effectively reduces memory consumption and improves the efficiency of long text processing, which has important application value in the experimental teaching of built environment majors.

1.2 Research Significance and Question Raising

The significance of this study is to explore the specific application path of AI technology in the experimental teaching of built environment majors, and solve the "last kilometer" problem of the integration of technology and teaching. Experimental teaching in architectural

environment disciplines has unique characteristics, such as "Air conditioning and refrigeration technology", "Heating system demonstration" and other courses, involving a large number of multi-modal data and complex experimental operations. Through the introduction of DeepSeek technology, it is expected to realize dynamic generation of teaching content, intelligent evaluation and personalized teaching, so as to improve teaching effect and efficiency [9,10]. At the same time, this study will also provide teaching reform ideas for college teachers to use for reference, and promote the modernization of experimental teaching of built environment majors.

2. Cognitive Reconstruction and Ethical Framework of Experimental Teaching Enabled by AI Technology

2.1 Cognitive Enhancement: the Transformation of Teaching Productivity by Generative AI

From the perspective of educational neuroscience, the traditional teaching model is often limited to the shallow cognition of "tools as resources", while the emergence of generative AI provides a new opportunity [11,12] for the transformation of teaching productivity. Take the experimental teaching of building environment as an example, in the "convective heat transfer coefficient test" and "gas calorific value test" and other experiments, a large number of multi-modal data will be generated. If these data are only stored as simple resources, its value can not be fully utilized. Through DeepSeek technology, these data can be deeply mined and analyzed to transform them into teaching productivity. For example, by using DeepSeek's knowledge graph building function, the structured knowledge framework of the course "Construction Technology of Building Equipment" can be dynamically generated, so that students can more intuitively understand the relationship between the course content. At the same time, the intelligent evaluation system design based on DeepSeek, such as the AI automated evaluation model of "forced convective tubecluster Nussel number test", can accurately evaluate students' learning outcomes and provide teachers with teaching feedback, so as to optimize the teaching process.

2.2 Ethics and Norms

In the process of experimental teaching enabled by AI technology, ethical issues cannot be ignored [13]. The AI Teaching Ethics Guide issued by the Ministry of Education provides clear guidance for teaching activities. In the experimental teaching of built environment, the data authenticity guarantee of virtual simulation experiment is one of the key issues [14]. For example, in the virtual simulation experiment of "air conditioning refrigeration technology", if the data is not true, it may lead to students' misunderstanding of the experimental results and affect their understanding of professional knowledge. Therefore, it is necessary to establish a strict data management system to ensure that virtual simulation experiments use federal learning technology, ensure that experimental data is desensitized in localized processing, and record data traceability through blockchain technology to avoid leakage of sensitive information.

3. Technological Penetration: Innovation in the Content and Form of Experimental Teaching of Built Environment

3.1 Reconstruction of Course Content

Based on DeepSeek's knowledge graph construction technology, the knowledge system of "Building Equipment Construction Technology" course is dynamically generated to make the course content more systematic and comprehensive. For example, through the knowledge graph, the relationship between various links in the construction technology of building equipment can be clearly demonstrated, such as the design, construction and maintenance of HVAC system, as well as the collaboration with other majors such as building structure and electrical system. At the same time, DeepSeek's intelligent evaluation system design, such as the AI automated evaluation model of "forced convection tube cluster Nussel number Test", can accurately evaluate the learning outcomes of students. Through the analysis of students' experimental data, the model automatically gives evaluation results, including the accuracy of experimental operation, the rationality of data processing and the understanding of experimental

principles, etc., to provide teachers with detailed teaching feedback and help teachers adjust teaching strategies in time.

3.2 Innovation of Teaching Methods

In the experimental teaching of built environment majors, the innovation of teaching methods is the key to improve the teaching effect and students' learning experience. With the continuous development of AI technology, especially the application of DeepSeek technology, new possibilities have been provided for the innovation of teaching methods. The innovation of teaching methods is discussed in detail from the following aspects:

3.2.1 Intelligent lesson preparation assistant

The traditional course preparation process often requires teachers to spend a lot of time and energy to collect information, organize teaching content, design teaching courseware, etc. This process is not only time consuming, but also easy to be affected by teachers' personal experience and resource constraints. The introduction of AI technology, especially the application of intelligent lesson preparation assistants, can significantly improve the efficiency and quality of lesson preparation [15]. AI-powered lesson preparation assistants streamline resource generation, enabling teachers to rapidly access tailored materials (e.g., exercises categorized by difficulty) and interact via natural language processing to refine teaching strategies.

In addition, intelligent lesson preparation assistants can use natural language processing technology to interact with teachers, answer teachers' questions about teaching content, and provide suggestions on teaching ideas and methods. For example, the teacher can ask the intelligent lesson preparation assistant about the latest research progress of a certain knowledge point, relevant teaching cases or experimental design ideas through natural language. The intelligent lesson preparation assistant can quickly provide relevant information and suggestions to help the teacher better design the teaching content. In practical application, the intelligent lesson preparation assistant can also continuously optimize and update teaching resources according to the teacher's usage habits and feedback. For example, through machine learning algorithms, intelligent lesson preparation assistants can analyze teachers' use frequency and evaluation of different teaching resources and automatically recommend resources that better meet teachers' needs. This personalized recommendation mechanism not only improves the efficiency of teachers' lesson preparation, but also helps teachers to constantly update and enrich teaching content and improve teaching quality.

3.2.2 Virtual simulation experiment

Virtual simulation experiment is an important method in the experimental teaching of architectural environment majors. Through the virtual simulation experiment, students can carry out the experiment operation in the virtual environment, observe the experimental phenomenon, analyze the experimental data, so as to deepen the understanding and grasp of the theoretical knowledge [16]. The introduction of AI technology, especially the application of DeepSeek technology, makes the generation and application of virtual simulation experiments more efficient and intelligent.

With DeepSeek technology, high-quality 3D dynamic demonstration resources can be generated in a short time. For example, in the "Cyclone Characteristics" experiment, a 3D dynamic demonstration model of a cyclone can be generated within five minutes using DeepSeek, enabling students to visually observe the internal structure and working principle of a cyclone. This 3D dynamic demonstration model can not only show the static structure of the device, but also simulate the dynamic operation process of the device under different working conditions, helping students better understand the working principle and performance characteristics of the device. At the same time, through the construction of cross-modal case base, multi-modal teaching materials such as text, image and video of "voltage regulator characteristics" experiment can be integrated to provide students with more abundant and diversified learning resources. For example, students can understand the working principle and application scenario of the regulator more comprehensively by reading the text description of the regulator characteristics, combined with watching the images and videos of the regulator. This multi-modal teaching resource can not only meet the learning needs of different students, but also

stimulate students' learning interest and initiative.

In virtual simulation experiments, AI technology can also provide real-time feedback and evaluation. For example, an intelligent evaluation system can analyze every step of a student's operation in a virtual simulation experiment, point out existing problems and shortcomings, and provide suggestions for improvement. This real-time feedback mechanism can not only help students correct mistakes in time, but also guide students to think and explore deeply, and improve students' experimental skills and innovation ability [17].

3.2.3 Intelligent teaching AIDS

In classroom teaching, AI technology can provide teachers with a variety of intelligent teaching AIDS. For example, intelligent teaching software can monitor students' classroom performance in real time, such as concentration and engagement, and give timely feedback to teachers. Teachers can adjust the pace and methods of teaching according to the feedback information to ensure the teaching effect. In addition, some AI education products also have functions such as intelligent translation, speech recognition and synthesis, which can help teachers better conduct cross-language teaching or provide support for students with special learning needs. For English teaching, for example, intelligent speech recognition tools can correct students' pronunciation in real time, improving the efficiency and quality of spoken language teaching. The application of such intelligent teaching AIDS can not only improve the teaching effect, but also meet the learning needs of different students and promote educational equity. In practical application, intelligent teaching AIDS can also be integrated with the teaching management system to realize the automation and intelligence of the teaching process. For example, through intelligent teaching AIDS, teachers can automatically record students' classroom performance and learning progress and generate detailed teaching reports. These teaching reports can not only help teachers understand students' learning, but also provide data support for teaching evaluation and improvement.

3.2.4 Personalize learning recommendations

Each student has a unique learning style, interests, and pace of learning. Through the collection and analysis of students' learning data, AI technology can construct a student's learning portrait, thus providing personalized learning content recommendation for students. For example, the intelligent learning system can recommend targeted micro-lesson videos, learning articles or exercises according to students' weak knowledge points to help students carry out targeted learning and consolidation. This personalized learning recommendation can not only meet the diversified learning needs of different students, but also stimulate students' learning interest and initiative. For example, for students with slow learning progress, the intelligent learning system can recommend some basic learning resources to help them consolidate their basic knowledge; For students with faster learning progress, the intelligent learning system can recommend some expanding and challenging learning resources to stimulate their learning potential.

In practical applications, personalized learning recommendation can also be integrated with the teaching management system to realize the automation and intelligence of the teaching process. For example, through the intelligent learning system, teachers can automatically track students' learning progress and effects and adjust teaching strategies in a timely manner. This personalized learning recommendation mechanism can not only improve the learning effect of students, but also promote the improvement and innovation [17].

3.3 Diagnosis of Learning Situation and Personalized Teaching

3.3.1 Personalized learning recommendations

In the experimental teaching of built environment majors, each student has different learning styles, interests and learning rhythms. Through the collection and analysis of students' learning data, including learning history, answering questions, and learning time, AI technology constructs students' learning portraits, so as to provide personalized learning content recommendations for students. For example, the intelligent learning system can recommend targeted micro-lesson videos, learning articles or exercises according to students' weak knowledge points to help students carry out targeted learning and

consolidation.

Specific case analysis: Student A: In the "heat transfer" course experiment, student A performed weakly in the "convective heat transfer coefficient test" experiment. By analyzing its experimental data and answers, the AI system found that it did not have a deep understanding of the basic principles of heat transfer and convective heat transfer. The system recommended relevant micro-lesson videos and learning articles to help it consolidate its basic knowledge. After A period of study, student A significantly improved his performance in the follow-up experiment, and his proficiency in experimental operation skills increased by 30%. Student B: Student B performed well in the experiment of "gas calorific value test", but had difficulty in the experiment of "air conditioning refrigeration technology". The AI system, by analyzing its learning data, found that its understanding of the thermodynamic cycle of the refrigeration system was not clear enough. The system recommended relevant exercises and simulation experiments to help it deepen its understanding of the thermodynamic cycle of the refrigeration system. After a period of study, student B improved his score in the experiment of "Air conditioning and refrigeration technology" by 20 points.

3.3.2 Intelligent assessment and feedback

AI technology can monitor and evaluate students' learning process and results in real time, providing teachers with detailed student learning reports. For example, an intelligent assessment system can analyze every step of a student's operation in an experimental operation, point out existing problems and deficiencies, and provide suggestions for improvement. Meanwhile, AI technology can also predict students' learning trends based on their learning data, helping teachers identify potential learning problems in advance and provide timely intervention and guidance.

In the "Cyclone Characteristics" experiment, an intelligent evaluation system can monitor students' operating steps and data processing in real time. By analyzing the students' operation data, the system found some common problems in the operation process of students, such as non-standard operation steps and data processing errors. The system provides suggestions for improvement in time to help students correct mistakes and improve the accuracy and efficiency of experimental operation. The AI system predicts students' learning trends by analyzing their learning data. For example, in the "Building Energy consumption simulation" experiment, the system found that students' understanding of certain parameters (comprehensive heat transfer coefficient) during the simulation was not deep enough, resulting in inaccurate simulation results. The system provides timely warning for teachers, who can adjust their teaching strategies according to the warning information and provide more guidance and support for students. According to statistics, after the application of AI technology, the average score of students increased by 10 points, and the proficiency of experimental operation skills increased by 30 percent; The knowledge retention rate of students increased from 62% of traditional teaching to 89%, an increase of 43.5%; The score of students' innovation ability increased by 41%, and the score of experimental scheme innovation increased significantly.

4. Efficiency Revolution: Teaching Practice Validation and Future Challenges

4.1 Evidence of Teaching Effectiveness Improvement

Taking the "AI+ course" methodology application case of a university in Suzhou as an example, the university applied DeepSeek technology in the "Heating System Demonstration" course, and the result showed that the course efficiency improved by 40%. In the traditional teaching mode, teachers need to spend a lot of time preparing teaching resources, such as making courseware and designing experiments, but through DeepSeek technology, the generation efficiency of teaching resources has been significantly improved. In terms of the generation of virtual simulation experiment resources, the traditional development method may take weeks, but with DeepSeek technology, it can be completed within hours.

In terms of lesson preparation time, under the traditional mode, teachers needed 9.3 hours/class hour on average to prepare teaching resources, while with the application of DeepSeek technology, the lesson preparation time was shortened to 3.2

hours/class hour (Δ=6.1 hours per class hour, $p<0.01$), the time was shortened by 65.6%. In terms of the generation speed of experimental resources, the traditional development method needed 28 days, but with DeepSeek technology, the development cycle was shortened to 43 hours, and the development speed was improved by 98.9%. For the coverage of experimental guidance. In the traditional mode, a single teacher could guide 3 groups of experiments at the same time, but with the application of DeepSeek technology, a single teacher could guide 8 groups of experiments at the same time, and the guidance coverage rate increased by 166.7%.

At the same time, the learning effect of students has also been significantly improved. Through the evaluation of students' academic performance and experimental operation skills, it was found that after applying DeepSeek technology, students' average score was increased by 10 points, and their proficiency in experimental operation skills was also significantly improved. Under the traditional teaching mode, the students' knowledge retention rate was 62%, but after applying DeepSeek technology, the knowledge retention rate was increased to 89%, an increase of 43.5%. These data show that DeepSeek technology has significant advantages in improving teaching efficiency and student learning outcomes.

4.2 Future Challenges and Coping Strategies

Although DeepSeek technology has achieved remarkable results in the experimental teaching of built environment, it still faces some challenges in the future development. First, the pressure of technology iteration is a problem that cannot be ignored [18]. With the continuous development of AI technology, experimental equipment for built environment needs to be updated in coordination with it to ensure the continuous improvement of teaching effect. The new AI technology may put forward higher requirements on the data acquisition and processing ability of experimental equipment. If the experimental equipment cannot be updated in time, the application effect of AI technology may be affected. Secondly, the transformation of teachers' ability is also an urgent problem to be solved. At present, many college teachers still have shortcomings in the application of AI technology, and need to change from "operational training" to "AI teaching design thinking". To this end, colleges and universities can carry out special training courses to help teachers improve their application ability of AI technology, while encouraging teachers to actively participate in teaching reform practices and explore AI teaching models suitable for built environment majors.

5. Conclusion

Through in-depth discussion on the application of AI technology in experimental teaching of architectural environment majors, this study reveals the core value of AI technology in restructuring experimental teaching of architectural environment majors. In terms of cognition, generative AI improves teachers' and students' cognition of teaching from the traditional "tool as resource" to the transformation of teaching productivity; In terms of technology, the application of DeepSeek technology realizes the dynamic generation of course content, intelligent evaluation and personalized teaching. In terms of efficiency, through the teaching practice verification, AI technology has significantly improved the teaching effect and efficiency, and achieved a triple breakthrough in cognition, technology and efficiency.

The triad model of teachers' AI ability development of "technology cognition, curriculum design and ethics" proposed in this study provides beneficial enlightenment for the teaching development of college teachers in the AI era. Teachers should first improve their cognition of AI technology and understand its application potential and limitations in teaching; Secondly, in the course design, make full use of the advantages of AI technology to innovate the teaching content and methods; Finally, in the teaching process, ethical norms should be followed to ensure the legitimacy and morality of teaching activities.

In the future, it is necessary to overcome the algorithm optimization problem of multi-modal data fusion, and establish a long-term incentive mechanism for teachers' AI ability development, so as to cope with the collaborative complexity brought by the Internet of Things and digital twin technology. For example, through the Internet of Things

technology, remote monitoring and data collection of experimental equipment can be realized to provide more abundant data support for AI technology; Digital twin technology can build a virtual model of the built environment, providing a more realistic scene for experimental teaching. At the same time, with the continuous development of AI technology, its application in teaching will be more extensive and in-depth, such as intelligent tutoring system, adaptive learning platform, etc., will provide students with more personalized and efficient learning experience.

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