Research on Engineering Practice Teaching in Universities Based on AR Technology

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Abstract. Under the background of new engineering, the application research of AR technology to college engineering practice teaching is helpful to find more effective engineering practice teaching methods. At present, engineering practice teaching in universities mainly relies on laboratory experimental equipment and traditional experimental topics, and there are some problems such as limited experimental resources, poor experimental results, and high operating costs. Virtual simulation engineering practice teaching using AR technology can make up for the problems of traditional engineering practice teaching. Therefore, through the combination of AR technology and traditional experimental devices, students can not only watch the internal 3D model and 3D animation of the experimental device through AR projection, AR glasses, tablet computer, mobile phone, and other mobile terminals, but also realize the interactive operation of engineering practice projects. By integrating AR technology and practical projects, engineering practice teaching resources can be greatly increased to meet the changing learning needs. At the same time, the integration of AR technology and practical engineering teaching can improve students' learning interest and enthusiasm for engineering practice courses, and effectively improve students' learning results.

Keywords: Engineering practice teaching; AR technology; Visualization; Interactive operation

1 Introduction

Engineering practice teaching occupies a very important position in higher education, especially under the background of the Ministry of Education actively promoting the construction of "New Engineering", the state advocates new engineering education, emphasizing the combination of engineering practice education with practical problem solving and innovation ability training. Engineering practice teaching not only helps students master skills and experience, but also provides a solid foundation for their future career and personal growth, and improves students' practical ability and comprehensive quality to adapt to the needs of The Times and practical

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development. Engineering practice teaching is a key way to translate theoretical knowledge into practical applications, helping to train future engineers and the ability to solve real-world problems. Information technology provides strong support for engineering practice teaching, which can enhance the effect of practical education, enhance the learning experience, and provide students with a wider range of learning opportunities. Augmented Reality (AR) technology also plays an important role in practical teaching, which can superimpose virtual information into the real world. Superimposing computer-generated virtual objects on top of real-world scenes enables enhancements to the real world and provides a rich learning experience. AR technology will promote the reform of engineering practice teaching in colleges and universities to a large extent. AR technology assists engineering practice teaching and applies to teaching management, which has the advantages of visualization, real-time, and high efficiency, and provides new ideas and forms for practical teaching in colleges and universities. The content presented by AR is all immersive, vivid, intuitive, and image, which helps to deepen students' understanding and memory and achieve the immersive effect. The organic integration of AR technology and engineering practice teaching can provide a richer and more immersive learning experience, help students better grasp the theoretical knowledge and practical skills of the course, help improve students' learning motivation and interest, improve students' learning outcomes, and further enhance their future career and life ability.

2 Application Status of AR Technology in Education

With the continuous development of science and technology, AR technology is gradually applied to various industries. In the field of education, AR technology integrates digital content into the real world to provide a new education model for education and teaching. Dunleavy et al. proposed that AR technology can improve users' participation in interaction, cooperation, and exploration[1]. Bujak et al. studied the application of AR technology in mathematics teaching, analyzed the feasibility of AR technology in mathematics teaching, and evaluated the application effect of AR technology in mathematics teaching[2]. Kamphuis et al. realized the teaching examples of human anatomy through AR technology, indicating the great application potential of AR technology in medical learning[3]. Professor Christopher J. Dede developed a new teaching model based on AR technology and applied it to the science curriculum to improve the impact of learning on students[4]. According to the study of Sirakaya et al., AR technology-supported learning environment has a positive impact on changing students' learning attitudes and improving students' academic performance, which is fundamentally different from a traditional learning environment[5]. The research of Giasiranis et al. pointed out that the application of AR technology in teaching can increase students' immersion experience, which is of great help to the improvement of students' academic performance[6]. Through the above analysis, it can be seen that the application of AR technology in teaching can significantly improve the learning effect of students [7-9]. China's research on AR technology in the field of education started late. Early domestic research on education

mainly focused on children's education, and its research failed to take into account the psychological development of college students, school hardware facilities, curriculum standards, and other factors, so the early research results were not promoted and popularized[9-13]. Therefore, in the situation that AR technology is becoming increasingly mature and the teaching effect is constantly verified, it is necessary to transfer the application research of AR technology in higher education teaching from the laboratory to the real classroom, to give full play to the educational advantages of AR technology[14-16]. Therefore, The paper mainly studies the application of AR technology in the teaching of engineering practice courses in colleges and universities.

3 The Significance and Practical Problems of AR Technology Engineering Practice Teaching Application

3.1 Significance of Engineering Practice Teaching and Research of AR Technology

The application of AR technology in engineering practice teaching can improve the effect of practical teaching. Students can be immersed in the AR teaching environment through the virtual environment with realistic visual, auditory, force, touch, and motion sensations, so as to realize the direct and natural interaction between students and the practical teaching environment, which makes it easier to achieve the established teaching objectives and the teaching content is easier to be accepted by students. The specific research significance includes the following aspects.

Improve the Experimental Teaching Effect

AR technology provides a real learning experience and rich learning scenes for engineering teaching. The content presented by AR has a 3D three-dimensional effect, which is very vivid, intuitive, and image, which is helpful for students to understand and remember. The experimental guidance and simulation of the virtual and real superposition in the practical teaching of AR technology engineering can allow students to enter the immersive learning experience while wearing the device, and the experimental tools and usage methods will appear in front of them, so that students can get the experience of human-computer interaction. For example, in the hardware practical teaching of the principle of computer composition, when learning the hardware composition of computer, most schools are not equipped with a computer for each student to disassemble and assemble, and if the traditional teacher prototype demonstration and PPT teaching cannot achieve the purpose of practical teaching, students have no practical operation. It can not fully grasp the details that need to be paid attention to in the process of disassembly and assembly of hardware, and the understanding of related knowledge points of hardware composition is not deep and comprehensive enough. If AR technology is used in some hardware practice teaching, 3D models of various types of computer hardware are stored in the system through

system modeling, which not only increases practical teaching resources, but also provides a new teaching method. Students can see 3D models by wearing AR glasses and interact with sensing devices so that they can better understand the composition of each part of the computer hardware and the assembly and disassembly process of each part.

Reduced the Cost of the Experiment

Experimental resources based on AR technology can be stored in the server, the request is received by the AR application client, and then the virtual object resources are retrieved from the server and sent to the client application. Therefore, the virtual mapping data based on AR technology does not have physical loss, and the hardware will not appear hardware loss during the experiment operation in the experimental room. The use of AR technology teaching can greatly reduce the cost of purchasing hardware and maintaining hardware, especially the large hardware equipment of computers and machinery, which can avoid the expensive purchase of hardware equipment.

Optimize the Cultivation of Students' Innovative and Entrepreneurial Talents

Through AR technology, students can be guided to make innovative and entrepreneurial design practice projects. Innovation and entrepreneurship courses with the support of AR technology, teachers can easily create AR courses through course editing and publish them to AR devices, customize the content of innovation and entrepreneurship practice courses, flexibly realize the expansion of innovation and entrepreneurship course cases, and expand the knowledge points covered by cases. Through the virtual and real superimposed AR practical teaching training, teachers can quickly create AR operations to release training tasks, and students use AR induction reminding operations after wearing AR equipment, which enhances the fun and experience of training and improves the efficiency and effect of training. The application of AR technology in innovative practical courses can help students enhance their more visualized cognition and reduce the huge investment in human and material resources of traditional practical training. Students can also design and realize entrepreneurial projects more conveniently through AR equipment.

3.2 Research the Practical Problems of Engineering Practice Teaching in Universities

Through research and analysis, it is found that although informatization technology has been introduced into the engineering practice teaching in colleges and universities, there are still some problems in the actual implementation process.

Engineering Practice Teaching Resources in Colleges and Universities are Limited

The limited practical training and experiment resources in colleges and universities, including the limited resources such as venues, equipment, instruments,

projects, and facilities, directly affect the participation of students in engineering practice teaching and lack the help of effective new technical means. Different types of engineering practice education courses, according to the nature of different practice courses have site requirements, such as sports, service, and other courses. Some practical courses have equipment requirements, such as machining, electronic circuits, sensor technology, optical communication, etc. At the same time, practical teaching requires some consumables [13-16]. At present, in the teaching of engineering practice courses in most colleges and universities, the main implementation method is to construct practice and training rooms, select a certain site to arrange in a certain scene according to the actual theoretical learning content needs, and let students carry out engineering practice and training according to the course arrangement. However, this practice mode has high requirements for teaching sites and resources, and engineering practice resources are limited, which can not meet the requirements for students to fully learn engineering practice.

The Application of Information Technology in Engineering Practice Teaching is Insufficient

The teaching of engineering practice courses in colleges and universities is mainly reflected in theoretical teaching and some experimental and practical training courses. The practical teaching resources are limited, and the practical teaching effect is not satisfactory[5-6]. At present, the mainstream educational information means in schools are mainly teaching management information systems, network teaching systems, network examination systems, computer simulation laboratories, multimedia classrooms, etc. These methods only transform the original teaching means such as blackboard teaching and paper management into computer-based information methods, although they improve the efficiency of imparting knowledge. But for the engineering practice course education itself has not played a lot of effect.

The Safety of Engineering Practice Teaching

Many practical projects in engineering practice teaching have certain risks, such as circuit design, laser processing, strong current experiments, hot forging practice, turning processing, and other experimental projects are prone to dangerous accidents, such as hot forging practice prone to scalding accidents, laser processing if not operated by the regulations easy to cause eye damage and other safety accidents. It is difficult for the traditional teaching method to explain the safe operation process to attract enough attention from students, and some students do not pay enough attention to the engineering practice process and cannot skillfully use tools, which also causes certain operational risks. In recent years, safety accidents often occur in the process of engineering practice in some universities, which is not conducive to the development of engineering practice courses and has a great impact on the training of new engineering talents.

4 The Implementation Path of AR Technology Engineering Practice Teaching Application

4.1 Research on the Application Technology Route of AR Technology in Practical Teaching

The application of new technology in a new field requires continuous research, innovation, and experiment. The application of AR technology to engineering practice teaching in universities also requires a complete application process design and integration of AR technology and course resources, so as to achieve good practical teaching effects. The application technology roadmap is shown in Fig. 1.

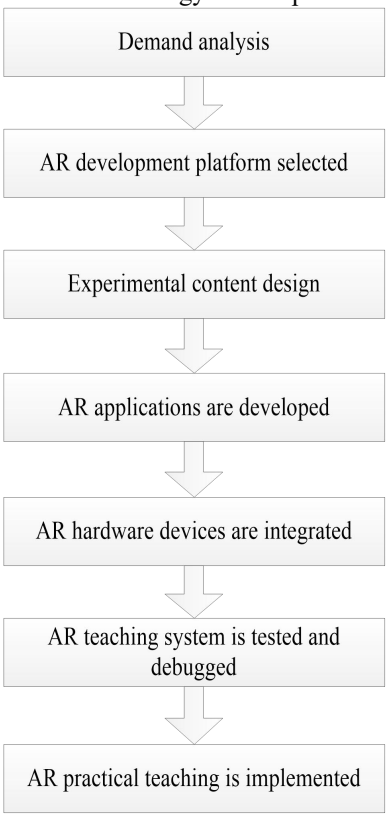

Fig. 1. Application technical route of AR technology engineering practice teaching

As can be seen from Fig.1, demand analysis should determine the functional requirements of engineering practice teaching, students' learning objectives, and engineering practice teaching content, and then meet the practical teaching needs through AR technology application design. Appropriate AR application development platforms are also crucial to AR engineering practice teaching, such as AR Core, Unity 3DARKit, and other development system platforms have provided us with the

development tools and system resources needed to create AR applications. The design of engineering practice course content is to apply AR technology to develop design practice content, including the need to design virtual objects, scenes, and interactive elements to meet the teaching objectives and organically integrate with actual engineering practice activities. Developing practical courses based on AR technology uses the AR development platform to design virtual models, write code, develop AR applications, configure interactive elements, and other steps to ensure that applications run normally on different AR devices. Integrating AR hardware equipment is mainly to ensure that teachers and students have the appropriate hardware equipment, such as AR projection, AR glasses, smartphones, tablets, and other hardware devices. AR teaching system testing and debugging refer to the comprehensive testing and debugging of AR applications before the system is formally used to ensure that the application system programs can run normally on different devices. The implementation of AR practice teaching means that the AR teaching system provides teachers with a new way of engineering practice teaching, and can effectively use AR applications for engineering practice teaching. AR practice teaching technology route provides a basic AR technology application framework, which can be customized according to different educational environments and specific engineering practice teaching subject needs, effectively integrates AR technology and engineering practice teaching resources, solves the teaching objectives and students' learning needs, and provides theoretical guidance for the application of AR technology in engineering practice education.

4.2 Research on Innovative Models of AR Technology and Engineering Practice Teaching

The application of AR technology in college engineering practice teaching will change the traditional teaching methods, not only blackboards, books, computers, and other facilities. AR technology uses visual three-dimensional interactive simulation to present knowledge that is difficult to express in language to students, to deepen the understanding of boring knowledge. AR technology is interactive, allowing students to see, hear, think, do, and participate in the construction of knowledge. Apply AR technology in engineering practice teaching, create a new teaching model of AR smart classroom, integrate AR into teaching, break down abstract concepts step by step, and create a wisdom practical training classroom that integrates immersion and interaction. AR technology is used to virtual a simulated equipment practice scene, so that students can intuitively feel the three-dimensional simulation scene, and can observe and learn each piece of equipment in 360-degree rotation. AR technology engineering practice education can be used in high-risk and practical fields, and students can effectively master relevant skills through AR technology teaching, and can achieve "learning to apply". Combine AR technology with engineering practice education, deeply integrate it into practical training teaching, create an immersive and interactive teaching situation, apply "AR interactive motion sensing technology" to improve practical engineering practice teaching, and the content presented by AR technology has a 3D three-dimensional effect, intuitive, vivid and graphic, which is

conducive to students' understanding and memory. It not only reduces the cost of practical teaching, but also achieves better teaching effect. To realize the direct and natural interaction between students and the practical environment, it is easier to achieve the established teaching objectives, and the teaching content is easier to be accepted by students.

At present, AR technology has been tentatively applied in some university laboratory teaching. The research shows that the practical teaching of AR technology can effectively improve students' learning interest and learning effect. In order to realize the application goal of engineering practice teaching based on AR technology, AR technology is mainly organically integrated with experimental projects, experimental teaching instruments, and engineering projects to cultivate students' engineering practice ability and meet the goal of new engineering construction in colleges and universities. The following will further study the application model of AR technology in engineering practice teaching combined with the application case study of AR technology in engineering practice education.

Construct a Practical Training Teaching Model With AR Technology

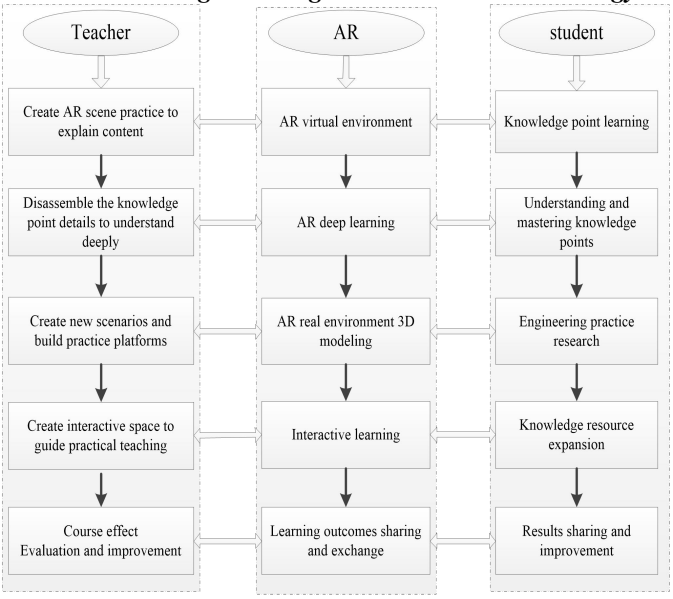

Fig. 2. Schematic diagram of engineering practice teaching mode

In order to realize the integration of AR technology and engineering practice teaching and realize the high quality and effective realization of engineering practice teaching courses, an engineering practice environment suitable for AR technology teaching is designed to stimulate students' learning thinking and visual learning to the maximum extent, so as to realize the effect of AR technology and engineering practice integration education. Therefore, a new model of engineering practice teaching based on AR technology is designed, as shown in Fig. 2. As can be seen

from Fig. 2, in the AR virtual teaching environment, teachers explain the key points of engineering practice teaching, and students learn the key points of relevant knowledge to gradually enhance their learning ability. Through AR technology disassemble every detail of the knowledge point, so that students can deepen the understanding and grasp of the knowledge point, and then exercise students' thinking ability. Create a new AR practice environment through 3D modeling of the real engineering practice environment, and provide students with AR engineering resources to help students research new problems. Through interactive learning of AR scenarios, students are guided to constantly explore new learning resources and improve their hands-on ability and practical innovation ability. Finally, AR technology is used to exchange learning results and evaluate learning effects, so that students can gain a sense of achievement in engineering practice learning in the process of sharing learning results, and constantly improve learning methods to achieve positive incentives for engineering practice teaching.

AR Technology and Experimental Topics Integrate Practical Teaching Model

The design of the teaching model integrating augmented reality technology and experimental topics is centered on experimental topics, which makes the goal more clear, and can provide students with a more immersive experimental experience and improve their learning interest and participation. Take the experimental topic as the starting point to analyze how AR technology is combined with the experimental topic, and the system model design structure is shown in Fig. 3. It can be seen from Fig. 3 that the AR enhanced experimental environment is to create a virtual laboratory by using AR technology, so that students can enter a virtual laboratory environment through AR glasses or smartphones, and such experience can provide students with a more intuitive experiment process and principle. The experimental steps demonstration module can use AR technology to show experimental steps to students, students can directly observe each step of the experiment through the AR image function, to better understand the details and key points in the experiment process. Through AR simulation experimental equipment, AR technology is used to simulate experimental equipment and devices, so that students can interact with virtual experimental equipment through AR applications. This helps students to better understand the function and use of experimental equipment. Interactive learning experiences use AR technology to create interactive project learning experiences that allow students to interact with elements related to virtual experiments through touch and gesture operations. This interactivity can increase student engagement and deepen their understanding of the content of the experiment. Real-time data visualization is the use of AR technology to visualize real-time data so that students can observe the data changes generated during the experiment in real-time through the AR interface. This can help students better understand the process and results of data analysis. Stimulate interest and creative thinking, use of AR technology to create interesting experimental scenes, to stimulate students' interest and promote their creative thinking, such an experience can help students more in-depth understanding of experimental principles, and stimulate their enthusiasm for scientific exploration. Applying AR technology to practical teaching can improve students' understanding of

experimental principles and experimental instruments. By using AR technology software, students can easily "see" the inside of experimental instruments and have a clearer understanding of their internal working principles. Students' interest and enthusiasm for learning have increased significantly, and the teaching atmosphere in the classroom has become more active. The above experimental teaching results show that the purpose of applying AR technology to physics experiment teaching has been preliminarily realized. The comprehensive use of AR technology and experimental topics can provide students with a more immersive learning experience, deepen their understanding of the experimental content, and improve the participation and effect of learning.

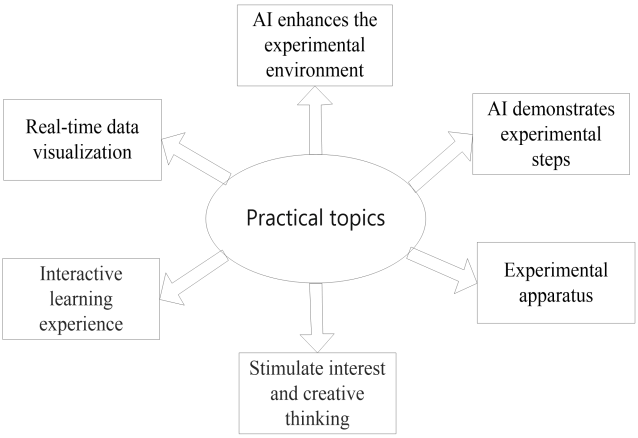

Fig. 3. Combination of AR technology and practical topics

AR Technology and Engineering Project Integration Teaching Model

There are many universities in the country to carry out college students innovation and entrepreneurship engineering education research, combined with augmented reality (AR) technology and engineering projects can bring many advantages, not only improving the efficiency of the project, visualization, and interactive collaboration but also allow students to contact the actual engineering, further training students engineering experience. The following is the case model design of combining AR technology with engineering projects, as shown in Fig. 4. As shown in Fig. 4, engineering projects typically begin at the design and planning stages, with virtual models created through AR technology that allow students to visualize the entire project, including buildings, equipment, and infrastructure. This helps identify potential problems and improve the design. Construction Steps AR design means that during the construction phase, AR technology is used to navigate students or construction personnel, and AR glasses or apps provide real-time engineering drawings, signs, guidance lines, and other information to help construction personnel complete tasks more accurately. Project progress monitoring means that AR technology is used to monitor the progress of engineering projects. Through AR glasses or applications, supervisors can view the progress of virtual projects, compare

the actual project progress with the planned progress, and help to find problems in time and take measures. Safety training and simulation refer to the use of AR technology to conduct safety training and simulation to help students or construction personnel understand potential hazards and learn how to respond, and virtual simulation can be carried out without involving actual risks. Real-time data visualization refers to the use of AR technology to visualize real-time data from sensors and monitoring devices, allowing students to view data trends and alerts through the AR interface to take timely action. Customer presentation and interaction refer to the use of AR technology, and engineering projects more vividly presented to customers or investors, virtual demonstrations can help them better understand the project and provide an interactive experience.

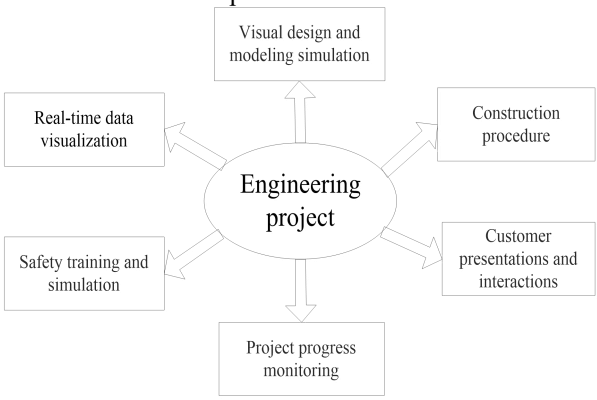

Fig. 4. Combination of AR technology and engineering projects

To sum up, the learning of engineering practice is not a process of passively receiving knowledge, but a process of actively acquiring knowledge. The higher the learning initiative, the better the learning effect. Therefore, the creation of a learning environment and the mobilization of students' learning subjective initiative are more important to the learning effect. Creating teaching situations and giving play to students' subjective initiative has become a major practical problem that teachers need to pay attention to and urgently solve. However, the integration of AR technology and engineering practice can improve the efficiency, safety, and visualization of the project, strengthen collaboration, reduce errors, and provide better engineering practice experience, thus mobilizing students' learning enthusiasm and achieving ideal teaching results.

5 Application Analysis of AR Technical Engineering Practice

In the engineering experiment class, the general engineering experiment principles, experimental devices and experimental instruments and other specific content are abstract and closed, and students can not see their internal physical structure. Experimental instruments and devices are a black box for students. Even if teachers explain how they work, students can't understand well. Only the students understand

the internal structure of the experimental instrument and the experimental device, and the principle of the engineering experiment can be understood by the students. To solve these problems, AR technology is combined with important experimental instruments or experimental devices in the laboratory. In class, students can get the internal three-dimensional structure diagram and working principle of the experimental instrument by scanning the experimental instrument or corresponding logo through the application software of the mobile terminal, so as to achieve the purpose of all-round understanding of the experimental instrument. For example, in the engineering practice teaching of the course "Principles of Computer composition", the basic knowledge and architecture of computer hardware are studied. The AR virtual center system is designed, equipped with AR glasses and sensing equipment. When teachers explain the basic knowledge and architecture of computer hardware, they enter the AR virtual center system, and students wear AR glasses. According to the input data provided, the AR glasses present a virtual 3D model in front of the students' eyes. students can see that the computer consists of motherboard, CPU, memory, graphics card, hard disk, power supply and other hardware through three-dimensional space. Through AR technology, students can have a more intuitive understanding of the components of computer hardware. At the same time, they can interact with sensing devices to complete the assembly and disassembly of the computer. Through AR practice teaching, students experience and sense of participation are increased, interest in learning is stimulated, and teaching effect is improved.

The application of AR technology in engineering practice teaching has many advantages. The application of AR technology improves students' learning interest and concentration. The "learner-centered" AR motion-sensing interactive teaching method is lively and interesting, both learning and sports, which can fully stimulate students' learning interest and improve their learning concentration. AR technology engineering practice teaching application to improve learning efficiency, AR motion-sensing interactive teaching, the learning content from the plane, into three-dimensional, abstract, profound knowledge through vivid, intuitive, image presented to help students understand and remember, make teachers easy to teach, students learn happy. The application of AR technology can reduce the cost of educational equipment and related consumables. AR motion-sensing interactive teaching can be practiced through virtual simulation in the early stage of teaching and training, and then physical operation and practice can be carried out after students reach a certain level of proficiency, thus reducing the loss of educational equipment and related consumables. AR interactive teaching is a "student-centered" learning model. Before the beginning of learning, the teacher arranged the learning objectives, divided the students into groups, and let the students explore and experience independently, which improved the students' learning initiative.

AR technology is applied to engineering practice teaching, and the students' feedback evaluation is good, and they think that the information provided by AR technology teaching is more vivid and rich than that provided by traditional textbooks, which improves their understanding of experimental principles and experimental instruments, and effectively improves the teaching effect. In the

classroom, through the use of AR application software, it is easy to "see" the inside of the experimental instrument, and its internal working principle is more AR technology is applied to engineering practice teaching, and the students' feedback evaluation is good, and they think that the information provided by AR technology teaching is more vivid and rich than that provided by traditional textbooks, which improves their understanding of experimental principles and experimental instruments, and effectively improves the pre-class preview effect clear. Students' interest and enthusiasm for learning have increased significantly, and the teaching atmosphere in the classroom has become more active. The above practical teaching results show that the purpose of applying AR technology to practical teaching has been preliminarily realized.

6 Conclusion

Under the requirements of new engineering background and new curriculum standards, the application of AR technology to engineering practice teaching in colleges and universities is helpful to develop more effective education methods and promote the development of digital education to adapt to the changing learning needs and technological development. AR technology can realize the superposition and complement of virtual enhanced information and real scene information. Through the integration of AR technology with the physical experimental equipment of traditional laboratories, three-dimensional visualization and interactive operation of hardware such as physical consumables, experimental devices, and experimental equipment can be realized, and it is not limited by the actual hardware resources of the laboratory. The integration of AR technology into engineering practice enhances students' learning experience. AR technology combines virtual elements with the real world to make learning more vivid and interesting. Students can enhance their learning experience by interacting with virtual objects, improve their learning interest and motivation, and at the same time increase students' engineering practice opportunities, especially in engineering practical practice involving high-cost, dangerous, and difficult-to-obtain experimental materials. In addition, AR technology can visualize abstract concepts to help students better understand and remember complex information and AR technology can provide personalized learning content and feedback according to students' needs and progress. AR technology can be used in multiple disciplines, and students can integrate the knowledge of different disciplines into one project, which helps to integrate the innovation of multiple disciplines, to better grasp the connection and practical application of knowledge. The integrated teaching of AR technology and practical engineering can not only improve students' interest and enthusiasm in learning engineering practice courses, but also help improve students' learning effect of engineering practice courses.

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