

Exploration of Virtual Simulation Experiment Construction in Application-Oriented Undergraduate Universities

Jia-Qing Song¹, Jiyan Wang², Jing Lei²

Office of Educational Administration, Taishan University, Tai'an 271000, China ¹

School of Mathematics and Statistics, Taishan University, Tai'an 271000, China ²

Abstract—Virtual simulation experimental teaching relies on virtual reality, multimedia, human-computer interaction and other technologies to build a highly simulated virtual experimental environment and experimental objects, and students can carry out training in the virtual environment, which can better improve students' practical ability and innovation ability. This paper summarizes the existing problems of virtual simulation experiment construction in China, and explores the concept, advantages and disadvantages, construction and teaching of virtual simulation experiment.

Index Terms—Virtual simulation; Experimental teaching; Higher education

I. INTRODUCTION

With the vigorous development of information technology such as the Internet, big data, artificial intelligence, and virtual reality, virtual simulation experiments came into being. Through virtual simulation to simulate physical experiments, show invisible structures or principles, complete various preset experiments, can be virtual complementary, virtual verification, virtual reality, virtual reality, virtual reality, so as to quickly respond to the needs of experimental teaching, narrow the distance between experimental teaching and engineering practice, scientific and technological frontiers, promote students' independent learning, inquiry-based learning, paperless learning, and solve the problem that the current experiment cannot be done and cannot be done.

Virtual simulation experiment teaching relies on virtual reality, multimedia, human-computer interaction and other technologies to build a highly simulated virtual experimental environment and experimental objects, and students can carry out training in the virtual environment, which can better improve students' practical ability and innovation ability, and can evaluate the experimental effect. However, at present, there are fewer virtual simulation experimental teaching conditions in colleges and universities, especially in most application-oriented undergraduate universities, especially there are fewer really easy-to-use, comprehensive virtual simulation training systems, or lack of application conditions. Under such a premise, it is very important to carry out the

reform of virtual simulation experiment teaching.

This paper summarizes the existing problems of virtual simulation experiments, and explores the concepts, advantages and disadvantages, construction and teaching of virtual simulation experiments.

II. THE DEFINITION OF VIRTUAL SIMULATION EXPERIMENT TEACHING AND ITS ADVANTAGES AND DISADVANTAGES

Virtual simulation technology is a kind of technology that imitates real systems with virtual systems, integrating computer technology, image processing and pattern recognition, intelligent technology, sensing technology and other fields. Through special equipment to achieve interactive operation with experimental objects in the virtual scene, the feeling and experience of visiting the real scene is generated, which has the characteristics of immersion, interactivity and realism. At present, virtual simulation technology has been widely used in online games, military training, online education and other fields.

Virtual simulation experimental teaching in the experimental teaching of application-oriented undergraduate professional talent training has the following three comparative advantages. First, from the perspective of experimental content, through the construction of virtual simulation experiments or training scenarios, some experimental projects that lack the support of realistic conditions can be flexibly applied to professional simulation training and teaching, which has high scale cost-effectiveness and advantages. Second, from the perspective of the experimental process, because it's object-oriented, time and place are relatively flexible, students can deeply participate in the whole process and link of experimental teaching or training subjects, and can explore and try according to different processes, which is conducive to cultivating students' professional comprehensive ability and innovative thinking. Third, from the perspective of experimental management, virtual simulation experimental teaching belongs to the in-depth comprehensive application of information technology, giving full play to the advantages of a variety of media support, can timely update experimental teaching resources, improve the level and efficiency of experimental teaching management.

Of course, virtual simulation experiment teaching also has its limitations. First of all, the realism, operation and on-site sense of physical experiments cannot be replaced by virtual simulation experiment teaching, and the specific environment and conditions of practical application are not equivalent to the environmental conditions of virtual simulation. Secondly, the resources of virtual simulation experiment teaching need to be jointly developed by professional and technical personnel, teaching design professionals, information technology personnel, etc., which are difficult to develop, high in cost and long in cycle.

III. CURRENT PROBLEMS

In recent years, the construction of virtual simulation experiments has developed rapidly, but there are still some problems in this process. As:

- (1) The quality of construction needs to be improved. At present, some virtual simulation projects only virtualize physical experiments and make three-dimensional animations, which lack immersion. The experimental process design is too programmatic, only the prescribed experimental steps and experimental options, and the lack of students' independent exploration links, which is not conducive to students' thinking training and comprehensive ability improvement. In general, the current quality of virtual simulation experiment construction is uneven, and many of them have not achieved the purpose of broadening the breadth and depth of teaching content, extending the time and space of experimental teaching, and improving the quality and level of experimental teaching.
- (2) Duplication of resource acquisition. With the strong support of the state, many universities have carried out the construction of virtual simulation experiments, due to the long design cycle of virtual software, and the need for repeated modification, improvement and testing, coupled with the imperfect sharing mechanism, the construction of information is blocked, many universities for the same experiment repeated purchase, resulting in waste of resources.
- (3) The compatibility and scalability of virtual simulation experiments need to be improved. Virtual simulation experiment construction is expensive, how to improve the compatibility and scalability of each experimental module, reduce the cost of comprehensive experiment, and improve students' innovation ability is an urgent problem to be solved.
- (5) Unable to meet construction requirements. The instruments and equipment used in practical teaching are many and miscellaneous, some equipment is large and expensive, it is necessary to invest large financial resources to purchase equipment, and it is necessary to build a large-scale experimental center to meet the basic teaching and scientific research needs, which cannot be fully met by the school at present.
- (5) The teaching method based on virtual simulation experiment needs to be explored. At present, many colleges and universities are busy with the construction of virtual simulation experiments, but they have less exploration of how

to improve the teaching effect based on virtual simulation experiments, and lack in-depth research on the role of teachers in virtual simulation experiments, what teaching methods are adopted, and how to combine virtual and real diseases.

IV. VIRTUAL SIMULATION EXPERIMENT CONSTRUCTION

The construction of virtual simulation experiments can be explored from the aspects of organization, construction, and teaching.

(1) Teachers

Set up a R&D team composed of professional teachers, experimental teachers and technical personnel of different types of colleges and universities to provide guarantee for improving the quality of projects and increasing the compatibility between projects and students. Among them, professional teachers from different universities such as academic and applied universities cooperate with each other to design experimental content and construction plans according to teaching experience and knowledge characteristics, and design thinking points, feedback points, prompt content, etc. in different modes; Experimental teachers provide a large amount of experimental data, and combined with the understanding of students' practical ability, assist professional teachers to complete the design work and carry out online services in the later stage; The company's technical personnel are responsible for building the technical framework of the project, ensuring the smoothness of the virtual simulation experiment operation, and responsible for the conception of the experimental scene, system style and operation interface, so that the situation is real and reasonably arranged, and the attractiveness of the experimental project is improved.

(2) Construction

In the process of virtual simulation experiment construction, the construction quality should be improved from three aspects: experimental accuracy, depth and breadth; Set up a R&D team composed of professional teachers, experimental teachers and technical personnel of different types of colleges and universities to provide guarantee for the quality of project construction.

1) The purpose is to improve the refinement level of virtual simulation experiments, increase the sense of realism, and cultivate students' rigorous experimental attitude. The virtual simulation experiment should comply with various specifications, the operation steps of the virtual simulation experiment should be consistent with the physical experiment, and the time spent by each step can be shortened or extended in equal proportions. For the preheating, calibration and compensation of the equipment before the experiment, the cleaning and classification of the experimental tools, and the finishing of the experimental bench after the experiment and other details must be required, if a certain aspect of the operation does not meet the requirements, the next step is not allowed, or give a clear warning, pay attention to improve students' attention to the details of the experiment. [5] explains the definition of the term "virtuality." This article discusses the effects of

computer-generated imagery and virtual reality on the contemporary information society using research-based data. The purpose of this section is to shed light on the origins of the concept of virtuality by providing some historical context. Today's views of social life, i.e. virtualized society, virtual realities, virtual images, and their impact on today's social processes are widely explained. The obstacles faced by today's youth when faced with virtual realities are discussed. The issue of the effect of the development of science and technology on the process of turning virtual images into reality on people's worldview was studied. It was deeply analyzed that virtualistics is a new philosophical direction, a new scientific paradigm. The article philosophically analyzes the concept of the combination of virtuality and real life to create a healthy social environment.

2) According to cognitive theory and behaviorist learning theory, the problem situation is set through the virtual simulation experimental teaching system, forming cognitive contradictions, stimulating students' curiosity and interest in learning, and forming good learning motivation. Formulate assessment methods and standards, introduce the breakthrough of the game process into experimental projects, and stimulate students' curiosity and competitiveness in learning. Set up multiple interactions and result feedback at important steps and key points of virtual simulation experiments to improve students' learning initiative and interest in learning. Students carry out logical judgment, reasoning and association and other thinking activities according to the various feedback information obtained, predict possible problems and phenomena, and understand the deep-seated laws and mechanisms.

3) Design the corresponding learning mode, assessment mode and engineering mode for each virtual simulation experiment to meet the needs of different types of students such as technology-based and research-oriented students in different learning stages such as cognition, mastery and engineering application, and realize the multi-level and individualized teaching of experimental teaching, so as to facilitate the sharing and radiation of experiments. Through breakthroughs at the technical level, the flexible changes of various factors and the mixing and matching between different modules can be realized, so as to improve the scalability, compatibility and forward-looking of experiments, meet the needs of students' comprehensive innovative experiments, and reduce the construction cost of comprehensive experiments.

(3) Organization

According to professional classification, set up a virtual simulation experiment construction team nationwide to share construction information and avoid duplicate construction of projects and waste of resources; Share construction experience, learn from each other's strengths, and steadily improve the quality of virtual simulation experiment construction; Through the unified management of the construction team, the compatibility between different modules is improved, which is conducive to the sharing of virtual simulation experiments and the broadening of experimental content. At the same time, school-level

cooperation is encouraged to promote the established virtual simulation experiments and play a demonstration role. In addition, we fully organize research, actively seek cooperation, jointly build a cooperative virtual simulation platform, and broaden the scope of project application. [6] examined the development and refinement of possible mathematical models for the intellectual system of career guidance. Mathematical modeling of knowledge expression in the career guidance system, Combined method of eliminating uncertainties, Chris-Naylor method in the expert information system of career guidance, Shortliff and Buchanan model in the expert information system of career guidance and DempsterSchafer in the expert information system of career guidance method has been studied. The algorithms of the above methods have been developed. The set of hypotheses in the expert system is the basic structure of the system that determines the set of possible decisions of the expert system. This set, which is crucial in decision-making, should be sufficiently complete to describe all the possible consequences of situations that arise in the subject area. Therefore, it is important to improve the mathematical models of the intellectual system of career guidance

V. VIRTUAL SIMULATION EXPERIMENT TEACHING

After the completion of the virtual simulation experimental project, the virtual effect should not be exaggerated, but should "complement the real with the virtual" and "combine the virtual and the real". The experimental platform with functions such as experiment appointment, pre-class preview, download materials, interactive discussion, upload of experimental reports, system monitoring and other functions is organically integrated with theoretical courses, virtual simulation experiments and physical experiments. Teaching is carried out in combination with the three links before, during and after class and the two major teaching environments of online and offline. Before class, teachers upload learning videos, knowledge questions and answers, thinking questions, etc. to the experimental platform, students conduct online preview, and on the basis of full thinking and exploration, conduct online discussions with teachers to understand the background of experimental engineering, master theoretical knowledge, experimental steps, experimental precautions, etc., and finally pass the preview test to obtain experimental qualifications. In the course, relying on the experimental platform, theoretical learning, virtual simulation experiments, and physical experiments complement and combine with each other. The combination of virtual simulation experiment and physical experiment is to enable students to repeatedly conduct virtual experiments, team discussions, and exchange of experiences according to the characteristics of virtual simulation experiments and the advantages of the experimental platform, and teachers will conduct online guidance synchronously, and then efficiently complete the experimental plan through physical experiments. Finally, based on the questions and thoughts in the process of physical experiment, and then through virtual simulation experiment, discussion is carried out among teachers and students, so as to form a circular

learning mode of "theory-virtual simulation experiment-physical experiment-theory", and carry out more inquiry-based and cooperative learning. After class, students can review experiments at any time, consolidate what they have learned, repeatedly chew and absorb knowledge, form abilities, and submit experimental reports online. Teachers should evaluate students' pre-study tests, experimental process, discussion and thinking, and the quality of experimental reports. At the same time, professors can use the fragmented time to reply to students' questions and innovative ideas through the Internet, so that professors can participate in experimental teaching and stimulate students' enthusiasm for innovation.

VI. CONCLUSION

After the introduction of virtual simulation experiments, students' learning forms, learning methods, and teachers' main work contents and working methods have undergone great changes. Therefore, schools should carry out virtual simulation training for teachers in a timely manner, select young backbone teachers to enrich the experimental team, introduce technical talents of various majors according to the characteristics of the post, build a reasonable talent team, and increase rewards and encouragement for experimental teachers to provide guarantee for the efficient operation of virtual simulation experiments.

ACKNOWLEDGMENT

This work was supported by Teaching Reform and Research Project of Taishan University (JG202156).

REFERENCES

- [1] Lu Yanli, Ma Liang, Gao Feng, et al. Research and practice of first-class course construction of virtual simulation experimental teaching [J]. Journal of Higher Education, 2023, 9(25): 34-37.
 - [2] YANG Lei, ZHANG Liang, SHEN Qiaoli. Exploration on the construction of virtual simulation experimental teaching system in vocational colleges [J]. China Vocational and Technical Education, 2023(23): 42-47+75.
 - [3] CAI Yin, YANG Xiaofan, ZHENG Yan, et al. Exploration on the construction of virtual simulation experimental teaching platform in colleges and universities [J]. Education Informatization Forum, 2023(06): 105-107.
 - [4] HAN Yongguang, NIU Le, FAN Xiang, et al. Construction and development of virtual simulation experimental teaching center and project [J]. China Education Technology and Equipment, 2023(04): 8-11.
 - [5] Normamatova Mahsuda, Christo Ananth, Zakirov Farukh, Khaydarov Fakhriddin, Makhmudov Iskandar, and T. Ananth Kumar, "Theoretical and Methodological Foundations of Virtualization of Social Services", 2023 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI) | 979-8-3503-1590-5/23/\$31.00 ©2023 IEEE | DOI: 10.1109/ACCAI58221.2023.10200862
 - [6] Christo Ananth, A.R. Akhatov, D.R. Mardonov, F.M. Nazarov, T. AnanthKumar, "Possible Models and Algorithms for the Intellectual System of Professional Direction", International Journal of Early Childhood Special Education, Volume 14, Issue 05, 2022, pp. 4133-4145
- Jia-Qing Song** received the Bachelor from Shanghai University of International Business and Economics in 1991. He is an experimenter at Taishan University. His research interests include educational administration, teaching management. Email: jiaqing_song@126.com.
- Jiyan Wang** received the Bachelor in Education from Taishan University in 2010. She is now a technician at Taishan University. Her research interests include educational administration, teaching management. Email: wangjiyan1973@163.com.
- Jing Lei** (corresponding author) received the B.S., M.S., and Ph.D. degrees from Ocean University of China, in 2003, 2007, and 2010, respectively. She is a professor at Taishan University. Her research interests include educational administration, teaching management. Email: elizabethia@126.com.