

VR Simulation Teaching and Practice of Transformers and other High Voltage Equipment

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Keywords: Virtual reality, simulation teaching, high voltage equipment, transformers

Abstract: Taking engineering education certification as the starting point, this paper discusses the virtual reality (VR) simulation teaching of high voltage equipment represented by transformers. The course is constructed into a distinct curriculum system with engineering basic knowledge, technical knowledge, and ability module, which provides a reference for the future high voltage technology experimental teaching.

1. Introduction

Strengthening engineering application background and high-quality engineering and technology talents become important cultivation goals in the development of higher education institutions in China^[1-3]. Engineering certification has developed extensively in various disciplines^[3-11] such as Civil Engineering, "Power System Analysis" and Mechanical Professional Practice Teaching. The Engineering Certification integrates the advanced education concept into this system, which is an important guarantee to improve the cultivation of engineering and technology talents and a platform and important foundation for domestic university education to participate in international competition. The cultivation goal of our university's electrical engineering and automation major is: "to cultivate qualified socialist builders and successors who can meet the needs of national and regional energy strategy development, engineering practice development in electric power industry, and comprehensive development of moral, intellectual, physical, and aesthetic skills, and can be competent to meet the requirements of engineers in electrical engineering fields such as power system and its automation, electrical automation, electrical energy conversion, etc. The senior applied engineering talents who can carry out planning and research, production operation and maintenance, design and development, information processing and testing, engineering project construction and management of power systems and electrical equipment. "High Voltage Technology" is one of the major courses of the major of "Electrical Engineering and its Automation", which is a course with strong theory and practicality.

This course is the main way for electrical engineering students to master the theory and practice related to "high voltage and insulation technology". This course is an important part of the engineering certification of electrical engineering and automation in our university. High-voltage electrical equipment is the main component of the electric power system, which is related to the safe operation of the whole electric power system. High-voltage testing is the main means to obtain the insulation status of high-voltage electrical equipment, and high-voltage testing technology is a highly practical

technology, which often requires high voltage and high current to carry out the relevant tests. In the teaching process generally choose 2-3 of them, easy to carry out the project for the test teaching, cannot make students a comprehensive grasp of the relevant practical knowledge. In order to obtain better teaching effect, we need to build a comprehensive three-dimensional ecological teaching, try to avoid boring lecture theory, enhance students' hands-on practical ability and serve engineering practice.

2. Methods

The team takes high-voltage electrical equipment as the main teaching line, relying on the courses of high voltage "High Voltage Technology" and "Electrical Part of Power Plant", and carries out VR experimental practice teaching and simulation analysis for the main electrical equipment in them. Using advanced information technology and simulation means, the team establishes a virtual simulation experiment platform for high voltage, using the experiment platform to provide students with safer and more efficient learning opportunities, expand students' horizons, enrich their knowledge structure, improve their innovation and practice ability, and provide a platform for innovation and entrepreneurship training for college students, while it can provide a platform for scientific research practice and innovation for teachers and students in the field of electrical engineering.

Under the guidance of "result-oriented education" and "student-centered" education concept of engineering education professional certification, we complete the reform of the existing curriculum teaching system of high voltage technology experimental teaching, develop the implementation plan to support the certification system, so that students can improve their comprehensive ability. The course is oriented to engineering practice. At the present stage, students manually complete the entire experimental project of relevant high voltage equipment, experimental conditions that to meet the huge investment in equipment, time-consuming, experimental observation effect and high voltage safety is difficult to control. Therefore, the teaching mode of virtual simulation is adopted, requiring students to simulate the operation through VR virtual software, mastering the basic principles of high-voltage equipment experiments and the operation steps of high-voltage experimental safety norms. Before the experiment, students have mastered the relevant experimental principles through the study of the course, the teacher should adopt the teaching mode of demonstration, guidance and inspiration to carry out teaching, and the student operation, simulation in the form of guidance, inspiration to make students aware of the key to the problem, to train students to identify problems, analysis and problem-solving skills.

In order to achieve the training goal of electrical engineering certification and effectively improve students' ability to solve engineering problems, the teaching of the course "High Voltage Technology" should fully rely on and utilize the scientific research advantages and characteristics of the college's VR platform. The teaching process should take the cultivation of engineering application innovation ability as the main line, and take "optimizing basic theory, emphasizing engineering thinking, strengthening practical ability, and cultivating innovative spirit" as the principle of curriculum construction. At the same time, an engineering oriented curriculum system needs to be established to improve the experimental teaching content in the course of "High Voltage Technology". In this way, "High Voltage Technology" can be constructed into a course with three distinct characteristics: engineering basic knowledge, technical knowledge, and ability modules.

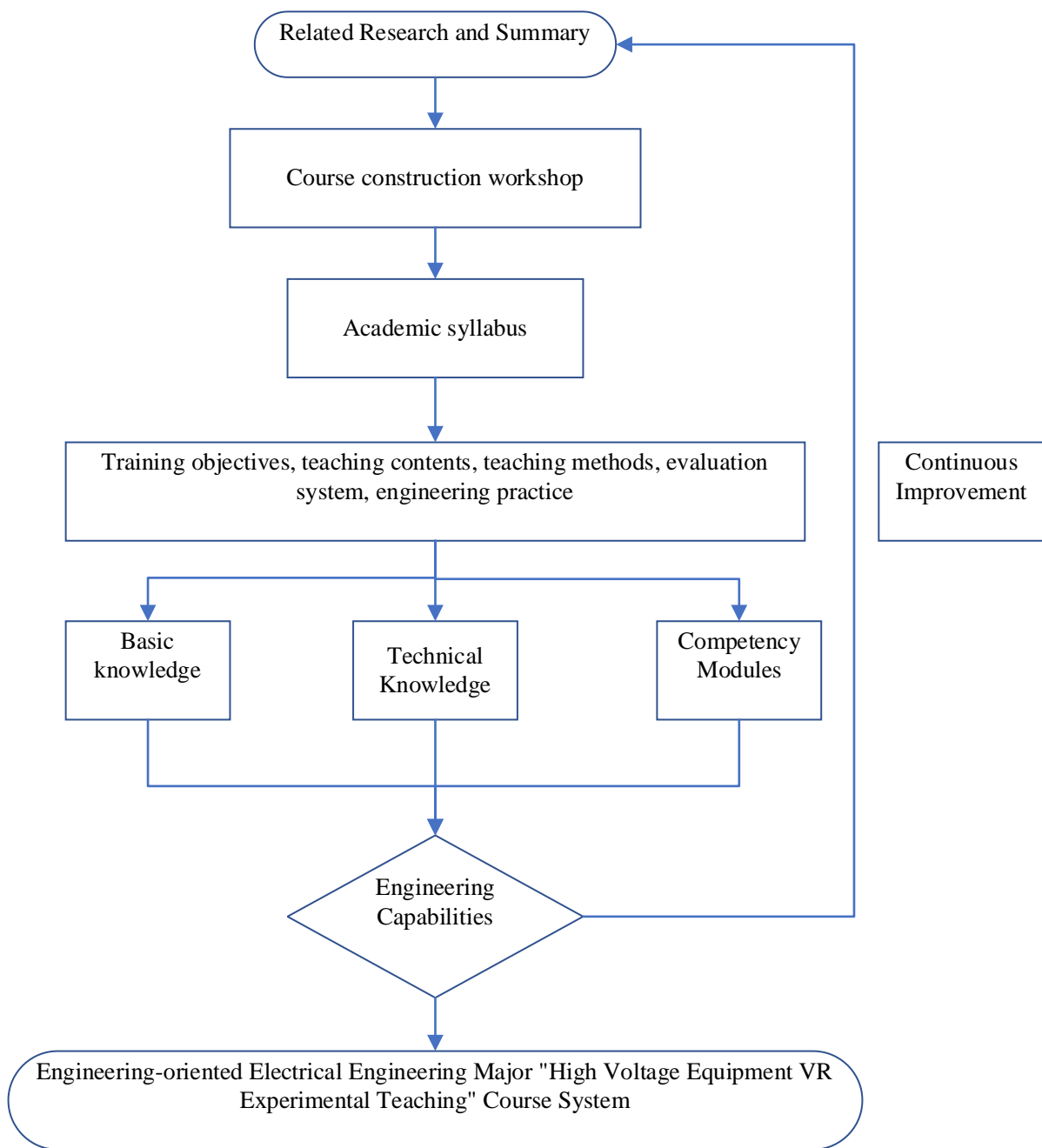


Figure 1: Overall study block diagram

The research contents include the follows:

(1) Conduct research and analysis: including interpreting engineering certification system, analyzing teaching objects, teaching system to identify gaps and locating problems.

(2) Relying on engineering education professional certification, taking the specific requirements of engineering education professional certification for electrical engineering majors as the guide, clarifying cultivation objectives, reforming teaching contents, reasonably allocating credit hours and improving teaching syllabus.

(3) To optimize teaching methods and experimental contents in the practice of teaching reform and form a complete teaching quality evaluation system in response to the professional certification of engineering education.

(4) Drawing on the concept of CDIO education to improve students' engineering practice ability. Specific steps shown in Fig.1 and the details are as follows:

- 1) Relevant research and self-summary.
- 2) Seminar on the construction of high-voltage electrical equipment testing curriculum system for engineering-oriented electric self-professional.
- 3) Determine the teaching program: including training objectives, teaching content, teaching methods, evaluation system, development of engineering practice.
- 4) Evaluate students' basic knowledge, operation level and engineering practice ability through the assessment program.
- 5) Carry out teaching reflection and continuous improvement of the existing teaching program.

3. Discussion

The project team consists of five teachers from the School of Electrical Engineering who have long been engaged in theoretical and experimental teaching of high voltage technology, including: three with senior titles and two with intermediate titles. For several years, the project team members have been engaged in teaching reform practice, guiding students' experiments, and have made certain achievements in teaching methods and experimental equipment development through long-term teaching accumulation and exploration.

The project research materials are complete, the test platform is perfect to complete all the experimental content in the teaching reform, and the teachers are of high level and have strong engineering background on the content related to high voltage technology, which can guide the students' test and simulation research, which provides a strong guarantee for the implementation of this project.

Traditional high voltage experiments are generally taught by teachers and imitated by students in the form of groups, and have high requirements for operators, expensive experiments, and difficult to fully meet the learning needs of students. The virtual simulation experimental project is an important supplement and expansion of traditional teaching methods, with high security, can make each student fully experience the specific steps of each test, increase interest in learning and improve the learning effect. For the electric field simulation experiment of high-voltage equipment, only the most basic operation of the software is trained for students, and a completely open mode is adopted for students to select the simulation equipment, design the program and analyze the results, so as to cultivate students' ability to solve complex engineering problems.

4. Conclusion

Through this teaching reform, students of electrical engineering and its automation can have a more comprehensive understanding of high-voltage electrical equipment and proper operation of high-voltage tests, providing valuable practical opportunities for electrical engineering-related work.

Acknowledgments

This work was supported by the [Teaching reform project of Inner Mongolia University of Technology] under Grant [number 2021250] and the [Scientific Research Project of Higher Education in Inner Mongolia Autonomous Region] under Grant [number NJZY21330].

References

[1] Lin Jian. *The Accreditation, Reformation and Development of Engineering Education. Research in Higher Education of Engineering*, 2015, No. 151(02): 10-19.

- [2] Wnag Ling, Lei Huan. *The Characters of Engineering Education Accreditation of Signatories of Washington Accord and their Impact on China*. *Tsinghua Journal of Ducation*, 2008, No.3
- [3] Jun Xu, Gengmin Jiang, Liying Xing, Wenyu Zheng. *Optimization and Reform of Talent Training Scheme for Engineering Majors under the Background of Engineering Certification*. *Advances in Educational Technology and Psychology*, 2021, 5(7).
- [4] Hualong Cai, Chen Peng, Chengyu Zhu, Ming Ouyang. *The Research of Civil Engineering Certification Information Management System*. *E3S Web of Conferences*, 2021, 252.
- [5] Fengru Sun. *Analysis and Design of Student Training Tracking Feedback System Based on OBE Engineering Certification*. *IOP Conference Series: Materials Science and Engineering*, 2019, 612(3).
- [6] Wang J, Kan H, Meng F. *Research Hotspots and Frontiers of China's Higher Engineering Education Certification//Institute of Management Science and Industrial Engineering. Proceedings of 2019 9th International Conference on Education and Management (ICEM 2019)*. Francis Academic Press, 2019: 506-510.
- [7] Yao X, Xin P. *Research on the Reform and Construction of "Power System Analysis" Based on Engineering Certification//Institute of Management Science and Industrial Engineering. Proceedings of 2019 9th International Conference on Education and Social Science(ICESS 2019)*. Francis Academic Press, 2019: 637-640.
- [8] Qu J, Liang H, Li X. *Teaching Reform of Computer Composition and Structure based on IEET Engineering Certification Environment//Institute of Management Science and Industrial Engineering. Proceedings of 2018 2nd International Conference on Education Technology and Social Science (ETSS 2018)*. Clausius Scientific Press, 2018: 51-55.
- [9] RuoKui C, Yong W, Yuan L, et al. *Discussion on the Teaching Reform of PLC against the Backdrop of Engineering Certification//Proceedings of 2017 International Conference on Economic Development and Education Management. (ICEDEM2017)*, ATLANTIS PRESS, 2017: 220-222
- [10] Yu Y, Li X, Yang P, et al. *Design of Teaching Plan for Measurement and Control Technology and Instrument Professionals Based on Engineering Certification Concept//Science and Engineering Research Center. Proceedings of 2016 3rd International Conference on Advanced Education Technology and Management Science (AETMS2016)*. DEStech Publications, 2016: 58-61.
- [11] Dongya Yang, Tao Shen, Runlan Guo, Xiaozheng Xie, Zhaohui Li. *Study on the Reform of Mechanical Professional Practice Teaching under the Background of Engineering Certification*. *Proceedings of the 2016 International Conference on Advances in Management, Arts and Humanities Science*, 2016.