

# Exploration on Virtual Simulation Practical Teaching Platform of Hydraulic Engineering

Yan Li<sup>1</sup>

<sup>1</sup>College of Water Conservancy Engineering, Tianjin Agricultural University, Tianjin, China

**Keywords:** Hydraulic engineering, Experimental teaching, Virtual simulation, Green practice teaching

**Abstract:** Due to the characteristics of the hydraulic engineer discipline, there are many real experimental teachings which are not difficultly carried out in the laboratory. Aiming at the deficiency of the traditional practice teaching of the hydraulic engineer in Tianjin Agricultural University, combined with the construction of the modern hydraulic engineer construction and management on the virtual simulation experiment teaching center in Tianjin Agricultural University, this paper introduces the exploratory work in the virtual simulation practice teaching of the hydraulic engineer. The practice shows that the open and autonomous virtual simulation experiments can promote the students' autonomous learning. It can form the connotation of the "green practice teaching" which can expand the real experiment with the simulation experiment and a virtuous circle of "the production, learning and research". According to the virtual simulation experiment teaching platform, the students can not only design the experiment independently but also experience the results of the experiments, which promote the students' independent learning.

## 1. Introduction

The hydraulic engineer includes the hydraulic and hydropower engineering and the agricultural water and soil engineering, it has the characteristics of the strong practicality and the wide specialty [1]. In order to meet the needs of the rapid development of the national economy and the practical and skilled personnel training mode in the hydraulic engineer universities, the teaching methods in the universities is gradually being changed from the teaching of the basic theories and the professional knowledge to the training of the engineering practice skills and the innovation awareness [2]. But, because of the limitation of the site, the shortage of the funds, the outmoded experimental equipment and the insufficient quantity of experimental equipment, there are many problems, such as the more experimental items of the basic theory research, the verification and the less experimental items of the design, the comprehensiveness and innovation in the process of the practical teaching [3-6]. So, the reform of the practical teaching in the universities is imperative.

## 2. The Role of The Virtual Simulation Technology in The Practical Teaching of the Hydraulic Engineer

### 2.1. Serve for the construction of the Whole Process, the Multi-Level and the Systematic Virtual Simulation Experiment Teaching of the Related Engineering Majors

Three levels of the virtual simulation experiment system, the professional basis, the professional application and the independent innovation are systematically constructed in the virtual simulation experiment teaching center of the modern hydraulic project construction and management in Tianjin Agricultural University (Abbreviation Center) with the strong technology R & D ability of the relevant enterprises and the good cooperation platform of the production, the learning and the research. According to the teaching rules and the requirement of the various disciplines, eight virtual simulation experiment teaching systems have been built up at present. The real experimental teaching function that is difficult to be completed is realized. The safe, reliable and economic experimental teaching is provided and the real experimental teaching is expand in case of the

high-risk or extreme environment, the inaccessible or irreversible operation, the high cost, the high consumption, the large-scale or comprehensive training, etc.

## **2.2. Carry Out the Explorative Virtual Simulation Experiment, Stimulate the Students' Interest**

Because of the danger of the various experiments and the limitation of the experimental resources in the hydraulic engineer, the traditional experiment teaching can be only carried out according to the content of the experiment instruction step by step. Because the students have known the experimental results before, the cultivation of the students' innovation ability is greatly limited. The teachers and the students don't have to worry about the danger in the experiment of the virtual simulation teaching system. The students' attention is attracted with the vivid animation demonstration in the virtual simulation experiment teaching system. This can quickly integrate the students into the virtual simulation experiment teaching system. The students actively participate in the whole process of the experiment. The students' enthusiasm of the learning is stimulated. This can guide the students to carry out the innovative and designing experimental research and cultivate the students' innovative spirit. This construction of the virtual simulation experiment teaching management platform is based on the concept of the large-scale open network course (MOOC). The whole process of the online learning assistance and the classified acquisition of the teaching resources is fully reflected. This includes the resource base management, the account management, the assessment management and other functions. The platform is equipped with all-round auxiliary teaching functions such as the virtual simulation experiment teaching, the experiment principle introduction, the independent learning, the independent assessment, etc.

## **2.3. Form a Sharing Platform of the Smooth Network Information Resource with Connecting the LAN and the Campus Network**

A unified information management platform for the experimental teaching center in the virtual simulation experiment teaching center of the hydraulic project construction and management is established. The informatization of the curriculum management, the teacher-student communication and the teaching evaluation are promoted. The ability of the information technology of the experimental teaching team can be continuously improved. On this basis, the "four information construction" of the center is realized. That is the informatization of the teaching resource management, the informatization of the open experimental teaching, the informatization of the laboratory instrument management and the informatization of the student performance assessment management.

## **3. Based on the Hydraulic Engineer Practice Teaching of the Virtual Simulation Technology**

Due to the characteristics of the hydraulic engineer discipline, there are many situations in the laboratory where the real experimental teaching function is not available or difficult to be carried out. Because of these problems, based on the municipal experimental teaching demonstration center of the hydraulic project and Tianjin Agricultural Water Saving Research Center, the virtual simulation experiment teaching center of the modern hydraulic project construction and the management of Tianjin Agricultural University is established in 2014. Several sets of the virtual simulation experimental teaching systems have been developed successively, such as the hydraulics, the topographic in small areas, the engineering elevation survey, the construction and operation management of the concrete gravity dam, the flow velocity and the flow monitoring of the river section. The virtual simulation technology is applied to the practical teaching.

### **3.1 Construction of the Virtual Simulation Experiment Platform**

The two-level management is implemented in the center. The teaching and the daily management are given the first place to the college. The investment and the construction are given the first place to the universities. The director responsibility system is implemented in the experimental teaching center. The management mechanism of the competition and the regular

assessment are implemented for the teachers and the experimental technicians. The professors and the subject leaders of the relevant disciplines are responsible for each laboratory. The "center" takes the "student-oriented" as the experimental project setting. Pay attention to training the students' innovation ability and the practice ability, cultivating the students' engineer quality. Play the main role of the students. The scientific and technological innovation activities of the students are actively carried out and the remarkable results have been achieved. The scientific research results are transformed into the teaching contents of the students' experiments through the virtual simulation teaching experiment platform. The students' interest in the learning is stimulated and the students are taught of the latest theories and the methods of the scientific research achievements through the training of the scientific research projects. The students can master the latest scientific research trends and the scientific frontier background. The students' innovative ideas and the scientific research innovation ability can be trained. The typical system cases include the "hydraulic virtual simulation platform", the "engineering measurement virtual simulation platform", the "hydraulic structure virtual simulation platform", the "hydraulic construction virtual simulation platform", etc.

### **3.2 The Application of the Virtual Simulation Technology in the Practical Teaching**

With the strong technology R & D ability of the related enterprises and the good cooperation platform of the production, the learning and the research, a virtual simulation experiment system with three levels of the professional basis, the professional application and the independent innovation the center have been systematically built. Eight virtual simulation experiment teaching systems have been built up at present according to the teaching rules and the requirements of the various disciplines. These virtual simulation experiment courses have been used as the comprehensive and designing experiments in the engineering hydrology, the hydraulic engineer construction, the river dynamics and other professional courses. The students' teaching has been carried out simultaneously. And now it has become the project training of the scientific research content of the undergraduates and the research content of the graduation thesis of the hydraulic engineer major.

For a virtual simulation experiment course of the gravity dam section stress example, the gravity dam itself is a large building. It is difficult and dangerous to monitor the stress and the strain of the gravity dam surface in the practical engineering. Therefore, it is an important content for the operation and management of the hydraulic projects that are calculated and predicted the stress and the strain of the gravity dam surface. It plays an important role in the daily maintenance and management of the gravity dam and it can also reduce the economic loss caused by the dam break. However, the prototype size of the reservoir and the solid gravity dam is huge, so it takes a long time to do the micro model experiment and the cost is high, which is not conducive for the students to carry out the solid experiment of the stress and the strain of the gravity dam.

Based on the virtual simulation platform of the hydraulic structures, the students can establish the numerical model of the stress and the strain at different depths of the upstream dam surface of the gravity dam with the background of the Three Gorges solid gravity dam project. Then, by setting the foundation model and the parameters of the different water depth, we can simulate the pressure gauge values at each point of the upstream dam face of the gravity dam under the different water storage conditions of the reservoir and then calculate the stress-strain values at each point of the dam face. On this basis, the displacement value of the gravity dam with the different water storage conditions can be obtained, thus the evaluation index basis for the dam break risk can be provided. Compared with the simple numerical simulation, it can stimulate the students' interest in the learning and improve the learning effect. At the same time, it can also cultivate the students' active ability to solve the practical engineering problems and the innovative thinking.

## **4. Conclusion**

The advantages of the virtual simulation practice teaching in the hydraulic project construction and the management are obvious. Its characteristics and innovation are shown in the following

aspects.

It can innovate the experimental teaching system of "the combination of the virtual and the real" and form the connotation characteristics of the "green practical teaching". Aiming at the problems of the traditional practice teaching, the virtual simulation experiment teaching and the original entity experiment teaching are combined. The practice teaching system of the virtual and the real combination is established. Which can meet the needs of the cognition practice, the professional experiment, the professional training, the professional practice and the innovation experiment. The connotation characteristics of the "green practice teaching" is formed.

The virtual simulation practice teaching can innovate the experimental methods, expand the practice field and highlight the experimental teaching effect of the "interaction experiential autonomy and exploratory". According to the virtual simulation experiment teaching platform and the course requirements and the engineering practice, the students can design the experiment independently and carry out the operation and experience of the whole process of the experiment. The students can also carry out trial experiments and realize the results of the experiments, which promote the students' independent learning.

The application characteristics of the construction mode of the "scientific research feedback teaching" and the "real-time teaching practice" are formed with the advantages of the team technology, the in-depth cooperation between the schools and the enterprises, the innovation of the sharing resource mode. A new win-win mode of the school enterprise cooperation is formed by the center. Dayu water saving (Tianjin) Co., Ltd. and Jinan Keming Digital Technology Co., Ltd. are jointly constructed and operated. The relevant patents have been successively obtained in the center. Many the influential practical engineering projects of the hydraulic planning and design are completed. The scientific research feeds back into the teaching. A virtuous circle of the "production, learning, research and use" is formed.

## References

- [1] Jianhua Yang, Chi Yao, Chenglin Liu, et. al. (2017). Exploration on virtual simulation practice teaching for the major of water conservancy and hydropower engineering. *Journal of Architectural Education in Institutions of Higher Learning*, vol.26, no.5, pp.134-137. (In Chinese)
- [2] Fangfang Dai, Guiqiang Fei, Lei Li, et. al. (2019). Construction and practice of virtual simulation experimental teaching center of chemical engineering majors. *Experimental Technology and Management*, vol.36, no.10, pp. 279-281. (In Chinese)
- [3] Qigui Yang. (2015). Application research on virtual simulation technology in water conservancy projects. *Yangtze River*, vol.46, no.21, pp. 61-64. (In Chinese)
- [4] Jianhua Yang, Chi Yao, Chenglin Liu, et. al. (2018). Construction of virtual simulation experimental teaching center for hydraulic engineering. *Experimental Technology and Management*, vol.35, no.1, pp. 245-248. (In Chinese)
- [5] Shaohua Huang, Min Chen, Youjie Fu, et. al. (2018). Study on application of virtual simulation technique to operation of water resources project. *Water Resources and Hydropower Engineering*, vol.39, no.10, pp. 105-107. (In Chinese)
- [6] Xiaodan Wang, Xiaoye Luo, Shuyi Qiu, et. al. (2018). Application of Virtual Simulation Laboratory Construction in Course Reform of Biotechnology Experiment. *University Education*, no.8, pp. 79-81. (In Chinese)