Constructions and Explorations of Virtual Experiment Platforms for Metal Cutting Tool Experiments

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Abstract. The experimental teaching is an indispensable part of college students' professional knowledge acquisition and skill training. With the help of virtual simulation technology, the experimental teaching center builds a virtual experimental platform for metal cutting tools by using digital, multimedia and networking software and hardware technology. Under the virtual experiment platform, students can complete the cognitive and practical process that is difficult to realize in the real environment, so as to improve students' in-depth understanding and comprehensive application of knowledge.

Introduction

For the implementation of president Xi’s important instruction spirit about strengthening practical education works and spirit of national ideological and political work conference, according to the "Ten-year development plan of educational informatization (2011-2020)" and "key points of education informatization for 2017" and other related requirements, our nation spares no effort to improve the deep combination between the information technology and the experimental teaching of advanced education, and strengthen constructions and applications of high quality resources of education experimental teaching, and strive to improve the level of experiment teaching quality of advanced education and practice-oriented education. The government decides to start demonstrative virtual simulation experimental teaching project in colleges and universities from 2017 to 2020, under the basis of university experimental teaching reform and experimental teaching project.

Under the background that every college and university is increasing the construction of the virtual experimental platform[1-4], with the support of professional professors, East China Jiaotong university mechanical engineering experimental teaching center starts the construction of the virtual experimental platform of surveying and mapping the mechanism motion diagram in the experimental teaching contents, virtual experimental research and development technology, the system of experiment openness and other aspects.

The Experimental Teaching Contents

The Basic Principles

We should adhere to treat problem as orientation and focus on solving problems such as the lack of actual experimental conditions or difficulties in actual operations, the high-risk or extreme environments, high costs, high consumptions, irreversible operations and large-scale comprehensive trainings. we should also insist on the guidance of demands, in close connection with the demand of economic and social development for talents’ training in colleges and universities, professional features and latest achievements of industrial developments, the university’s orientation and the characteristics of talent training. The virtual simulation experiment teaching project will be developed whose principle is accurate, content is compact, length is reasonable and difficulty is appropriate.
Aims of the Experimental Teaching

For students majoring in machinery, the principle of metal cutting is a main course, which mainly studies the interaction between the cutter and the workpiece in the metal cutting process and their respective laws of change. In the process of the design of machine tools and tools, the formulation of machine parts cutting process and its quota and the rational use of tools and machine tools and the control of cutting, we should use research results of metal cutting principles in order to let the machining of machine parts become cost-efficient, high quality and high efficiency. This subject mainly studies the interaction between cutters and workpieces and their respective laws of change during metal cutting. Therefore, the experiment of metal cutting tools arranged in class will play a role as practical guiding. Through the measurement experiment of cutter angle, students can deepen their understanding of cutters’ geometry and consolidate and verify the design method of cutters.

(1) Problems of Traditional Experiments. In the traditional experimental teaching, students enter the laboratory to measure the cutter angle for every three people. In this experiment, students can only touch three to five kinds of cutters, which is not only limited in number but also limited in type. Therefore, it is difficult to achieve the requirement of experiment.

(2) Advantages of Combining Virtuality and Reality. Compared with the traditional experimental teaching, the virtual combined experiment increases the students' understandings of structures of different cutters through the network and solves the problem that types of cutters students can touch are limited. Students can repeatedly measure the tool angle before, during or after the experiment.

Virtual Experimental Researches and Development Technologies

Basic Principles

Researches and developments of virtual simulation experiment teaching projects aim at completing the teaching requirements and contents, and the comprehensive application, which involves multimedia, big data, 3 D modeling, artificial intelligence, human-computer interaction, sensors, supercomputing, virtual reality, augmented reality, cloud computing, networking, digital, intelligent technology, enhances the attraction of experimental teaching programs and teaching effectiveness. We should strengthen the research on the reliability of related technologies, pay attention to all-round and multi-level protections of students who are using virtual simulation experimental teaching projects, in order to protect the health of students effectively.

Virtual Experiments’ Development

The virtual experiment system for metal cutting tools is built by integrating 3D modeling technology, virtual reality technology and Internet technology machine, as shown in figure 3.
Figure 3. The construction process of the virtual experiment system for metal cutting tools.

(1) **3D Modeling of Cutters.** The 3D model of the cutter is the core of the virtual experimental system and the most basic data. The 3D model was created by using Pro/E 3D drawing software developed by us PTC, whose main functions include modeling of 3D entities, assembly design, NC addition, etc. Figure 1 shows the CAD model of the tool.

(2) **Productions of Interactive Animation.** The virtual experiment system uses Solidworks Composer software to produce 3D interactive animations of the model. In the animation, text annotation, pictures, scenes and other contents can be added, and block animation can be played. The production method is simple and easy to use, and the materials can be uploaded to the Internet.

Figure 4. Productions of interactive animations.

(3) **Network platforms’ construction.** In the process of making the materials required by the virtual experiment system, the website of the virtual simulation experiment system is established and released by using Dreamweaver, and then the existing explosive animations will be published on the web page prototype, and finally published on the Internet.

Figure 5. The release of virtual experiment system network.
The Mechanism of Experiment Openness

In order to guarantee the high efficiency of the laboratory and the quality of the experimental teaching, the experimental teaching center has established a set of advanced and flexible operating mechanisms by combining the virtual and the real.

1. Theoretical knowledge learning: professors explain the theoretical knowledge of metal cutting tools in class, and explain the purpose, principle and content of the experiment.

2. Experimental preview: students use their free time to log on to the Internet website of the virtual experiment system, get familiar with various metal cutting tools according to the requirements of the experiment, and finish the preview of the experiment.

3. Experiment course opening: apply to the laboratory through the experiment appointment system, and complete the implementation of experiment under the guidance of teachers.

Results of Virtual Experimental Platform Practices

1. Virtual simulation experiment teaching has a significant effect and benefits more students. Mechanical engineering experimental teaching center will supply metal cutting tool experiments for five classes of mechanical manufacturing and automation specialty, more than 150 students. Students realize the integration of theory and practice, which greatly helps the students' understanding of the concepts of knowledge by using theoretical knowledges learned in the classroom, network virtual experiment preparations, and laboratory experiments.

2. Students have a strong interest in experiment, and their independent learning ability and practical innovation ability have been greatly enhanced. The experimental teaching center uses professional simulation software and adopts multimedia technologies and network communication platforms to build a virtual simulation experimental teaching platform with high sense of reality, directness and accuracy. Students are more interested in learning under the realistic experimental environment, and they can complete the experimental study independently under the drive of interests.

Summary

Experimental teaching is an indispensable part of college students' professional knowledge acquisitions and skill trainings. With the help of virtual simulation technology, the experimental teaching center makes use of digital, multimedia and networking software and hardware technology and the virtual experimental platform for metal cutting tools. Under the virtual experiment platform, students can complete the cognitive and practical process that is difficult to realize in the real environment, so as to improve students' in-depth understanding and comprehensive application of knowledge.

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Reference

[1] Zhu Qiankun, Li Chao, Cui Xiaoxi, Teaching model based on virtual lab system, Research and exploration in laboratory, 27 (2008) 84-86.

[2] Zhang Li, Huang Gang, Chen Xingang, Construction of Virtual Experiment Teaching Platform for the Principle of Microcomputer, Experimental science and technology, 11(2013)19-21.
[3] Wen Fuan, Research and application of virtual experimental teaching system, The Chinese Journal of ICT in Education, 21(2008)37-39.

[4] Peng Xiaojian, Exploration on construction of virtual simulation experimental teaching center in new normal situation for higher education, Experimental technology and management, 33(2016)237-240.

[5] Lu Shoulin, Taking the opportunity of constructing the virtual laboratory to implement the experimental teaching reform, Experimental technology and management, 26(2009)157-159.