



# Application of Virtual Simulation Technology in University Laboratory Safety Education

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**Abstract.** The traditional laboratory safety education curriculum construction is not perfect, carry out a single form, boring content, professional pertinence is not strong, do not pay attention to practice, evaluation difficulties and other problems, so it can not arouse students' interest in learning, can not play a good safety education effect. The application of virtual simulation technology in laboratory safety education can improve the educational effect. The practice shows that the laboratory safety education based on VR panorama is a targeted, easy to use, low cost and effective way of education. It can promote students' awareness of experimental safety and learning interest, make up for the lack of practice in laboratory safety education, and improve the quality of laboratory safety education. It can be used as an effective and innovative way to carry out laboratory safety education and play an important role in auxiliary teaching.

**Keywords:** virtual simulation · laboratory · safety education

## 1 Introduction

Virtual simulation technology is a kind of educational means which develops rapidly in recent years. It uses computer technology to simulate the experiment process, so that students can carry out the experiment operation in a safe environment, in order to achieve the experimental effect. In the laboratory education, virtual simulation technology has important significance, especially in the laboratory safety education, its role is more prominent [1, 2].

Laboratory as a high risk environment, there are various safety risks. In order to ensure students' personal safety and the normal operation of laboratory equipment, laboratory safety education is particularly important [3]. And the traditional laboratory safety education is mainly through the form of explanation and slogans, this way of effect is limited, it is difficult to really let students understand the importance of laboratory safety knowledge.

Virtual simulation technology can solve this problem well. It can simulate a lot of laboratory conditions in the simulation environment, and can simulate the occurrence of various safety accidents, so that students carry out practical operations, and feel the consequences of safety accidents, so that students better understand the importance of

laboratory safety knowledge [4–6]. At the same time, the virtual simulation technology can also let students in the simulation experiment for many times to further deepen their understanding of the experimental content and experimental safety knowledge and mastery.

In addition, virtual simulation technology can also avoid various risks and hidden dangers in the experimental operation, but also can save the cost of experimental equipment and materials, improve the efficiency of the experiment. At the same time, in the virtual simulation experiment, students do not need to personally operate in the laboratory, but also can learn the theoretical knowledge of the experiment, so as to better understand the experimental process, and lay a solid foundation for the subsequent experimental operation [7].

## **2 Problems Existing in Laboratory Safety Education in Traditional Universities**

Laboratory safety education is very important to ensure the safety and health of laboratory personnel, but in reality, we find that there are some problems in laboratory safety education, these problems will not only affect the safety of laboratory personnel, but also have a serious impact on the scientific research work of the laboratory. This paper will focus on the laboratory safety education problems are analyzed and discussed, and put forward the corresponding solutions.

### **2.1 The Construction of Laboratory Safety Curriculum Is Not Perfect**

At present, laboratory safety education mainly focuses on classroom teaching. At present, most schools carry out student safety education, its curriculum arrangement is basically centralized teaching, teaching content is also macro learning some safety regulations and safety common sense, there is no long-term systematic course explanation, more did not form a complete curriculum plan, syllabus, etc. Some schools have set up relevant safety education courses and set up relevant course credits. But in practice, the number of courses is not enough, and most of them are in the form of elective courses, which can not arouse students' attention. Some colleges and universities engaged in laboratory safety education teachers professional is not strong, many colleges and universities safety education mostly by the department of student work counselors, security department personnel and other lecturers. In addition, college students laboratory safety education at the present stage is basically undifferentiated teaching. There is no targeted course teaching for the grade and major of students in class. Everyone uses the same teaching plan or courseware, resulting in the failure to carry out differentiated key safety education on the professional characteristics of each major.

### **2.2 Single Content of Education**

At present, the content of laboratory safety education is mainly focused on the explanation of safe operation skills, ignoring the publicity and popularization of laboratory safety management system. And the safety management system is the basis of ensuring

laboratory safety, laboratory personnel lack of understanding of it, easy to cause safety accidents. The existing laboratory safety education is mainly carried out in the form of classroom, in a single form, it is difficult to attract students' attention. And the laboratory safety education needs more vivid, visual way to carry out publicity. The existing laboratory safety education is often a one-time publicity, the lack of long-term follow-up and management, easy to ignore the key and difficult points in the laboratory safety work.

### **3 Design of Laboratory Safety Education Based on 3D Virtual Simulation**

#### **3.1 Design Principles**

Emphasize pertinence, reflect information. The design of laboratory safety education should be closely related to the status quo of the central laboratory, and the content of relevant safety education should be designed pertinently; It should conform to the characteristics of students' cognitive psychology, and make boring knowledge and skills interesting; It should be timeliness and practicability, and safety education information can be updated at any time.

Emphasis on experience, reflect high efficiency. The design of virtual scene should emphasize situational and immersive experience. Three-dimensional simulation technology is used to model laboratory environment, equipment, materials, etc., and can be combined with handle, helmet, VR glasses and other human-machine interaction technology means to achieve immersive operation and learning experience in virtual scene. So that students can quickly and effectively acquire laboratory safety-related knowledge and skills.

Emphasize low cost and reflect economy. In recent years, some colleges and universities have tried to use virtual simulation technology to develop experimental safety education games and develop interactive virtual simulation teaching projects of experimental safety education scenarios, etc., all of which have achieved good results. However, all of them are chemical related laboratories, and all of them are newly developed software or systems, which require a large amount of investment and have little reference significance for non-high-risk laboratories. Therefore, it is necessary to consider the economy of carrying out laboratory safety education in the form of VR panorama and carry out low-cost design.

##### **3.1.1 Material Preparation**

The experimental teaching center is fully investigated, and the safety knowledge involved in the laboratory is comprehensively sorted out, such as: safety thought education, safety rules and regulations education, safety general knowledge education, large instruments and equipment safe operation skills education, emergency treatment ability education and other aspects. The content that can be designed and transformed by VR panorama technology is identified, and the relevant laboratory safety education materials are reclassified and made, so as to prepare for the later production of VR panorama program.

### **3.1.2 Model Production**

Use CAD, Sketchup and other software to make the 3D model of the central laboratory, restore the real scene, layout, equipment, materials and so on of the central laboratory, and preliminarily render it.

### **3.1.3 VR Panorama Program Production**

With the models and materials prepared in the early stage, the VR panorama program will be made using the relevant software and platforms such as Mars, Venus and 720 Cloud, etc. The specific steps include: The Mars software is used to further optimize and supplement the environment, materials and scenery of the model, carry out secondary rendering, and output multiple and multi-angle panoramic pictures; Using Venus or 720 Cloud software or platform, design and arrange the output panorama according to narrative techniques, add interactive buttons, including forward and backward interaction with the instruments in the scene and bulletin board, such as: click a large instrument, operation video or corresponding instrument introduction, safe use precautions will pop up; Click forward and back can be immersed in the space level to enter the next scene or return to the previous scene.

### **3.1.4 Sampling Experiment Design**

Based on the newly added laboratory safety entrance examination in 2023, the comparative experiment of testing the effect of virtual simulation education program was developed, and the question bank of the laboratory safety examination system was supplemented according to the safety education content involved in the central laboratory obtained from the research, so that the examination content could be targeted. 3 groups of 2020 freshmen were selected as experimental samples to carry out different forms of laboratory safety education. After the completion of safety education, they entered the laboratory safety examination platform for testing, and then analyzed the test results to evaluate the effect of safety education.

## **3.2 Design Results**

### **3.2.1 Cognitive Learning Part**

Cognitive learning includes: rules and regulations, safety signs, fire facilities, protective facilities, emergency rescue goods, etc., the laboratory often encountered safety signs, emergency rescue goods, protective facilities, fire facilities to sort out, and put forward cognitive requirements, to ensure that students understand the safety signs, understand how to use common fire facilities, in the event of danger When the first time can correctly use emergency rescue goods, protective facilities, etc., for self-rescue or rescue others.

### **3.2.2 Scenario Learning Part**

Scene learning includes: safe operation of experimental sites and large experimental instruments and equipment, emergency injury treatment and safe escape, etc. Students are required to master this part of the content.

## **4 Construct Virtual Simulation Chemical Laboratory Safety Education System**

### **4.1 Virtual Simulation Technology Is Used to Increase the Depth of Chemical Experiment Safety Training Content**

The traditional laboratory safety training mode basically uses the “big integration” teaching program, and lacks the targeted course design according to college students’ grade, major, gender and psychology. In view of these deficiencies, colleges and universities can combine various general courses and professional courses the relevant knowledge points, through virtual simulation technology to achieve laboratory safety training. In view of typical and prone accident safety scenarios, build a case database, use virtual reality technology in the virtual environment for risk identification and risk experience, learn safety protection measures and safety standards in the virtual environment, and learn the disposal methods of emergency safety accidents. In addition, in the course design, through the virtual simulation technology of the classic experiment experiment design, operation, principle, data analysis, and experiment expansion to display, promote enable students to study independently, self-exploration, develop rigorous, realistic, accurate scientific attitude.

### **4.2 Application of Virtual Simulation Technology in Laboratory Emergency Drill**

Fire drill is an important part of chemical laboratory safety education. Due to the limitations of time and space, resources and so on, fire drill in reality is often a mere formality, unable to achieve effective and extensive effect of fire drill. Safety drills for chemical laboratories in colleges and universities include gas poisoning treatment, high temperature scald treatment, acid and alkali burn treatment, hazardous chemical waste treatment and other items. Traditional safety drills are more restricted, but virtual simulation platform is used to carry out virtual drills with freedom of time and space, without affecting the normal work and life order, and can be constructed flexibly Laboratory site, in the premise of not affecting the normal teaching or work to carry out targeted exercises. And in the whole exercise process, the system can give feedback according to the experimenter’s virtual operation, and can analyze the whole process, scientific and objective records rehearsed the process. Virtual simulation fire drill can carry out accurate simulation of fire origin, development, smoke and high temperature distribution, fire extinguishing methods, and avoid potential hazards to students such as trampling and drill consumables in the actual drill. Emergency escape through virtual simulation teaching activities such as drill and cardiopulmonary resuscitation can help students master the basic skills of emergency escape and first aid, which reflects the significance of laboratory safety education.

### **4.3 Application of Virtual Simulation Technology in Chemical Laboratory Access Assessment**

The traditional chemical laboratory access assessment involves a small area, the experimental operation is not easy to carry out, the application of virtual simulation technology

in the chemical laboratory access assessment, greatly increase the scientific rigor and operability of the assessment, but also to ensure the safety of the operating personnel complete. The application of virtual simulation technology in chemical laboratory access assessment and the establishment of assessment platform can enrich the content of laboratory access assessment. In the establishment of the virtual simulation laboratory access platform, the comprehensive judgment of laboratory safety risks, laboratory standard operating norms, laboratory equipment safety, personal safety, waste safety disposal, fire and first aid and other knowledge should be included in the assessment content, score statistics should be carried out according to the determined scoring weight, and the passing line should be set up. The system will automatically issue the electronic training certificate to the students who reach the pass line and above. For the students who fail the examination, the system should push the learning content of the training projects with fewer scores, and take part in the laboratory access assessment again after reaching the given learning time. The establishment of laboratory access platform involving virtual simulation technology has more benefits, which can not only improve the safety values of students and experiment operators, but also promote the construction of campus safety culture.

## 5 Conclusion

The advantages of VR safety education over traditional education include the following:

1. **Openness.** Virtual simulation exercises based on VR technology have broken through the time and space restrictions of traditional safety education exercises. For example, electric power safety operation, field exercise will consume a lot of time, people and money, but VR technology can simulate the working environment and difficult to copy the equipment, only need to prepare simple related equipment and software, you can receive real-time learning and training.
2. **Security.** The two objectives of authenticity and safety are often in conflict in some dangerous drills, such as working at altitude, dangerous goods operation. In order to ensure the safety of the exerciser, authenticity has to be sacrificed, and many scenes and effects can only be “imagined” in the mind of the exerciser. The biggest advantage of virtual simulation exercise lies in its safety. In the virtual environment, the exerciser can arbitrarily and repeatedly try, even extreme operations, to avoid causing actual harm.
3. **High efficiency.** Compared with traditional safety exercises, virtual simulation exercises have a high fidelity. The exerciser can fully reconstruct the drill scene from sight, sound and touch, and experience how to operate in real disasters. At the same time, safety knowledge is embedded in the virtual environment for real-time education, but also through the first perspective of shock experience accident consequences. Diversified training methods can make the exerciser have a strong sense, deeply understand the significance of safety education, and keep the safety consciousness in mind.

The application of virtual reality and augmented reality technology in the field of laboratory safety is still in the ascendant, but it is far from being popularized in the laboratory safety education of most universities and research institutions. Because of

the good effect and low cost of laboratory safety training using immersive virtual reality and augmented reality technology, it will be more and more widely used in the future. But it needs to be pointed out that the role of practical training should not be ignored in laboratory safety education, but the virtual world and the real world training should be combined to achieve excellence.

Potential complementary, in order to achieve the maximum effect of laboratory safety education.

**Acknowledgments.** The authors would like to thank the Changchun University of Chinese Medicine Higher Education Teaching Reform Research Project: “Research on the construction and Practice of laboratory safety culture in universities”.

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