ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202510_8(10).0008

Enhancing Quality through Intelligence: Practical Exploration of Virtual Simulation Experimental Teaching

Jing Zhao[1, 3, *], Jian Li[2, 3] and Bo Yang[1, 3]

[1]School of Emergency Technology and Management, North China Institute of Science and Technology, Sanhe 065201, China

[2]School of Safety Engineering, North China Institute of Science and Technology, Sanhe 065201, China

[3]Multi-scene Water Chain Accident Wisdom Emergency Technology Innovation Center of Hebei, Sanhe 065201, China

[*] Corresponding author

Abstract

To integrate both theory and practice into the teaching system, virtual simulation experimental teaching is adopted in the learning process of the course *Introduction to Emergency Management* to enable students to develop practical operation capabilities while learning theoretical knowledge. This paper proposes three core components for the virtual simulation experimental teaching of *Introduction to Emergency Management*: analysis of teaching content, design of the virtual simulation experimental teaching platform, and evaluation of the virtual simulation experimental teaching platform.

Keywords

Simulation Experimental Teaching, Teaching Content Design, Teaching Platform, Evaluation.

1. Introduction

With the continuous development virtual technology, the application value of virtual simulation in the field of education has gradually become prominent. By using virtual simulation, it is possible to obtain an experience close to the real one while avoiding the limitations of cost, space and personal safety[1] The development in recent years has shown that the country is vigorously promoting the in-depth integration of high-tech industries and higher education, and is deeply carrying out the construction of demonstration national virtual simulation practice teaching platforms[2][3]. In the future, the teaching form of virtual simulation experiment teaching will surely be widely applied[4][5].

As one of the five types of "golden courses"[6], the "virtual simulation golden course"[7] has also attracted much attention from researchers. Virtual simulation experiments can provide students with simulated experimental situations for independently solving problems, and have gradually become an important means to promote students' learning and cultivate their abilities[8][9]. As an important carrier of students' learning ability, the virtual simulation experiment teaching platform integrates theory and practice into the teaching system. While learning theoretical knowledge, it can also cultivate students' practical operation ability synchronously. At the same time, it makes the abstract conceptual knowledge in books more concrete and vivid[10], thereby improving teaching effects, enriching students' horizons, and enhancing students' understanding ability, so as to achieve the following purposes: (1) Improve students' employment rate and enhance the competitiveness of schools; (2) Broaden students' thinking modes and improve their innovation ability; (3) Break through the closed teaching

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202510_8(10).0008

mode and realize a high degree of resource sharing; (4) Enhance students' creative ability and avoid safety accidents; (5) Strengthen the ability of knowledge reserve and realize the organic integration of theory and practice[11][12].

2. Technical Means of Virtual Simulation Experiment Teaching - *An Introduction to Emergency Management*

An Introduction to Emergency Management, as a compulsory general education course in our university, the purpose of constructing its virtual simulation experiment teaching platform is to enable students to use virtual simulation to get rid of real emergency events (before, during, when and after the incident), understand the whole life cycle of emergency management (preparation, response, recovery and disaster reduction), carry out emergency plan drills (inspection drills, demonstration drills, research-based drills), and at the same time assist in emergency decision-making and emergency capability assessment (emergency facilities, emergency materials, etc.).

In the learning process of *An Introduction to Emergency Management*, the use of virtual simulation experiment teaching has the following advantages: 1) The explanation and drill are more vivid. The virtual simulation experiment platform can enable students to perceive emergency events immersively and freely carry out virtual operations for emergency handling. 2) The pictures have a strong sense of reality, allowing students to observe the details of emergency scenarios, which is convenient for them to understand the whole life cycle of emergency management. The 3D virtual experiment platform with good interaction effect can enable students to perceive scenarios more truly, carry out some emergency rescue operations and get feedback. While completing learning tasks, they can obtain a more interesting and pleasant interactive experience and system use experience.

2.1. Virtual Simulation Experiment Teaching Content Design

The development of virtual simulation experimental teaching content constitutes the core of platform construction. The content construction should include the following three parts: 1) The basic knowledge introduction part focusing on conveying basic knowledge; 2) The interactive application knowledge part focusing on situational practical learning content; 3) The divergent creative design practice focusing on practical application. The virtual simulation experiment teaching content of the course *An Introduction to Emergency Management* includes:

1. The virtual simulation experiment teaching content covers a variety of experimental contents, mainly including the whole-process multi-dimensional display of emergency events such as natural disasters, accident disasters, public health events, and social security events; the interactive experience of the whole life cycle of emergency management where students can operate for human-computer interaction; the whole-process emergency plan drills such as command and control, warning and public security; and the management and evaluation of emergency decision-making schemes.

2. Closely combined with the demand for emergency application-oriented talents in emergency rescue in the Beijing-Tianjin-Hebei region, the virtual simulation experiment teaching platform should include the virtual simulation combined experiment for emergency skills training, and support later update and expansion.

2.2. Virtual Simulation Experimental Teaching Platform

Integrating the 5E teaching model and the I-MMLOE model, students enter a virtual scenario where they receive instructional guidance through the development of storylines. Developers can directly transform textual knowledge into application scenarios. Through an intuitive form of knowledge presentation, students are encouraged to engage in deeper exploratory learning and explore ways to apply knowledge. Subsequently, by means of error correction and

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202510_8(10).0008

explanation, students' interest in learning is stimulated, enabling them to independently practice and apply knowledge.

The core objectives of the system are as follows:

1. Transform textual knowledge (such as meteorological principles, mechanical laws, engineering processes, etc.) into operable and perceivable virtual application scenarios.

2. Drive the learning process with storylines to replace the traditional "cramming" teaching method and stimulate students' enthusiasm for active exploration.

3. Through the closed loop of "practice - error correction - explanation - re-practice", enable students to explore the practical application methods of knowledge in independent operations and achieve in-depth transformation from "cognition" to "application".

4. Break the constraints of time and space, allowing students to complete high-risk and high-cost practical training in a safe and low-cost virtual environment.

The model design steps include:

1. Disassemble the model structure according to teaching knowledge points (for example, split the "emergency management life cycle" into sub-components such as preparation, response, recovery, and mitigation, with each component associated with corresponding state parameters and explanations);

2. Retain key teaching details, simplify non-core decorative elements, and balance model accuracy and operational performance;

3. Preset interactive interfaces to facilitate the implementation of interactive logics such as rescue, response, and organizational coordination in Unity3D.

2.3. Evaluation of Virtual Simulation Experimental Teaching Platform

To meet the teaching requirements of "scenario authenticity, operational practicality, and decision comprehensiveness" in the course *Introduction to Emergency Management*, this scheme is based on the existing comprehensive evaluation system. By systematically re-designing the four core dimensions of education, teaching, technology, and art, a comprehensive evaluation system for the virtual simulation platform adapted to the characteristics of the course is constructed. Relying on the PDCA cycle, a dynamic improvement mechanism is established to realize the closed-loop optimization of experimental teaching evaluation and project management.

In view of the teaching characteristics of the course *Introduction to Emergency Management* , the evaluation indicators, weight allocation, and assessment methods of the four dimensions are designed in a targeted manner. This ensures that the evaluation not only covers the core goals of "teaching and learning" but also takes into account the adaptability of "technology implementation" and "scenario experience".

I. Educational Dimension: Centered on Competence Cultivation

With the core goal of "cultivating students' abilities in emergency decision-making, resource allocation, and risk assessment", hierarchical evaluation indicators are designed to emphasize the assessment orientation of "knowledge application" and "practical operation ability".

II. Teaching Dimension: Adapted to Virtual Teaching Processes

Centering on the closed loop of "teaching goals - teaching content - teaching interaction - teaching effects", evaluation indicators suitable for virtual simulation teaching scenarios are designed, highlighting "process-oriented evaluation" and "personalized feedback".

III. Technical Dimension: Guaranteed by Technical Stability

1. With the core of "technical stability, interactive fluency, and data security", and combined with the complexity of virtual scenarios in Introduction to Emergency Management (e.g., multi-scenario switching and multi-role collaboration).

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202510_8(10).0008

3. Conclusion

Closely combining the demand for emergency application-oriented talents in emergency rescue in the Beijing-Tianjin-Hebei region, the professional characteristics of Emergency Management University, and targeting the positioning of application-oriented undergraduate colleges and universities, this paper takes the course *Introduction to Emergency Management* as an example to propose a virtual simulation experimental teaching model. This model aims to construct a virtual simulation experimental teaching platform with three levels, which are as follows: the basic knowledge introduction level, which focuses on delivering basic knowledge; the interactive application knowledge level, which centers on situational practical learning content; the divergent creative design practice level, which prioritizes practical application.

Acknowledgements

The key research topic of the "14th Five-Year Plan" of the Higher Education Society of Hebei Province(GJXH2024-283; GJXHZ2024-27); Undergraduate Teaching Project of North China University of Science and Technology (HKJG202401), Smart Course Project (ZHKC202508), Textbook Project (JC202510); Innovation and Entrepreneurship Course Construction in Hebei Province (2025CXKC182); Research and Practice Project on Innovation and Entrepreneurship Education Reform in Higher Education Institutions in Hebei Province (2025CXCY244).

References

[1] Lin Mike Tz Yauw et al. A Study on the Effect of Virtual Reality 3D Exploratory Education on Students' Creativity and Leadership[J]. EURASIA Journal of Mathematics, Science and Technology Education,2017,13(7).3151-3161.

[2] Application of virtual reality technology in education[J]. Education, 2019, (09): 3.

[3] W.L. Li. Practice and exploration of simulation experiential learning situation design[C]//Wuhan University, Scientific Research Publishing. Proceedings of Conference on Creative Education (CCE2012). Nanhai Neusoft Institute of Information Technology, 2012: 78-80.

[4] P. Li, C.J. Mao, J. Xu. Developing National Virtual Simulation Experimental Teaching Centers to Improve the Informatization Level of Experimental Teaching in Universities[J]. Research and Exploration in Laboratory, 2013, 32(11): 5-8.

[5] W.G. Wang, J.H. Hu, H. Liu. Current Situation and Development of Virtual Simulation Experimental Teaching in Foreign Universities[J]. Research and Exploration in Laboratory, 2015, 34(05): 214-219.

[6] Y. Wu. Building "Golden Courses" in China[J]. China University Teaching, 2018, (12): 4-9.

[7] Q. Gao, Q. Lu. Practice of "Golden Course" Construction Based on Virtual Simulation Experimental Teaching — A Case Study of the "Mobile Communication Technology" Course in the Industrial College[J]. Industry and Information Technology Education, 2023, (01): 84-89.

[8] H.Q. Xiong. Virtual Simulation Experimental Teaching Promotes the Integrated Reform and Innovation of Theoretical Teaching and Experimental Teaching[J]. Experimental Technology and Management, 2020, 37(05): 1-4+16. DOI: 10.16791/j.cnki.sjg.2020.05.001.

[9] He, Z. K., & Huang, T. (2018). Exploration on the Construction of Virtual Simulation Experimental Teaching Projects[J]. Experimental Technology and Management, 35(02), 108-111+116.

[10] H.X. Zhao. Application of Knowledge Visualization in the Teaching of the "Principles of Communication" Course[J]. Success (Education), 2013, (24): 230.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202510_8(10).0008

[11] Du, Y. L., Huang, G., Wang, F., et al. (2015). Constructing a Virtual Simulation Experiment Platform and Exploring an Innovative Talent Cultivation Model[J]. Experimental Technology and Management, 32(12), 26-29.

[12] Liu, G. P., & Wang, X. (2020). Virtual Reality Reshaping Online Education: Learning Resources, Teaching Organization, and System Platforms[J]. China Educational Technology, (11), 87-96.