Research on the "Integration of Virtual-reality" Practical Teaching Mode Based on Higher-order Ability Cultivation

Fei Song[a], Wei Pan[b]*, Jia Chen[c], Bangjun Lv[d]

Collage of Power Engineering, Naval University of Engineering, Wuhan, China

[a]17607193270@126.com,[b]panwei19860418@126.com,
[c]jiachen815@gmail.com,[d]71199512@qq.com

Abstract. To solve the problem of insufficient cultivation of higher-order ability in traditional practical teaching, the specific connotations of higher-order ability and low-order ability are defined and the internal logical relationships between the two are clarified. Then the advantages and disadvantages of virtual and real experiments in practical teaching are compared and analyzed, and the necessity and basic principles of carrying out integration of virtual-reality practical teaching are discussed. Under the guidance of the above research conclusions, a "integration of virtual-reality" practical teaching mode with the goal of higher-order ability training is constructed. The specific construction principles and suggestions are provided for the setting of teaching objectives, the adjustment of teaching content, the reform of teaching methods, as well as the adjustment of the evaluation system. The research results have certain guidance and reference significance for the implementation of virtual and real combined practical teaching.

Keywords: higher-order ability; integration of virtual-reality; practical teaching

1 Introduction

In Traditional practical teaching, safety problems, equipment sets, class hours restrictions, and reduction of students' burdens are often used as excuses. When carrying out practical teaching, teachers always take the lead to operate demonstrations, let students watch, instill knowledge in whole classes, directly provide students with ready-made conclusions or answers, or require students to complete operations mechanically according to established processes, which dampens students' enthusiasm for active learning and exploration and research to a certain extent, thereby resulting in practical activity teaching staying at the level of low-level ability, low-order learning and low-order thinking, so it can neither effectively promote the development of students' higher-order thinking ability nor effectively shape students' core qualities for social development. To solve the problems existing in the above practical teaching, it is

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imperative to carry out integration of virtual-reality practical teaching with the goal of higher-order ability cultivation.

2 Relationship Between Higher-Order Ability and Low-Order Ability

2.1 Definition of Higher-Order Ability and Low-Order Ability

Ability can be divided into higher-order and low-order abilities. Low-order ability refers to the psychological characteristics of using low-order thinking to complete memory tasks and solve well-structured problems, while higher-order ability refers to the psychological characteristics of solving ill-structured problems or complex tasks with higher-order thinking as the core. Higher-order ability includes higher-order thinking ability, higher-order social-emotional ability and higher-order motor skills, among which higher-order thinking ability is the core of higher-order ability. Currently, there are two main methods to define higher-order thinking ability[1, 2]. The first is to define higher-order thinking ability as the cognitive thinking ability at the high level in Bloom's cognitive goal classification. Bloom's Taxonomy of Educational Objectives divides cognitive objectives into six levels from low to high: memory, understanding, application, analysis, evaluation and creation[3, 4]. The first three levels are generally classified as low-order cognitive goals, while the last three levels are generally classified as higher-order cognitive goals. The second type of definition method is to define higher-order cognitive thinking ability as the ability of problem-solving, decision-making, critical thinking and creative thinking according to the characteristics of higher-order thinking ability. Although the starting points and advantages of the two types of definition methods are different, the core intersection of the defined higher-order thinking ability is consistent, and analysis, evaluation and creation are the core foundations of problem-solving, decision-making, critical thinking and creative thinking ability.

2.2 Relationship Between Higher-Order Ability and Low-Order Ability

There is a vicious circle between low-order learning, low-order knowledge and low-order ability, low-order thinking, which seriously hinders learners' development. Low-order ability, low-order thinking and low-order knowledge can easily be replaced by the increasingly rapidly developed intelligent information technology, while higher-order ability, higher-order thinking and higher-order knowledge are the essence of learners' development because they not only fully embody the spirit of human subjectivity but also are the key to the realization of distributed cognitive learning and development of human beings and the harmonious coexistence with artificial products. Therefore, the development of higher-order ability with higher-order thinking as the core is the focus of promoting learners' development. However, it should be emphasized that the cultivation of higher-order ability is based on low-order ability, and the development of ability also follows the process from low-order to higher-order.

Teaching can not blindly emphasize the cultivation of higher-order ability, but ignore the necessary low-order ability and knowledge mastery and reserve, otherwise, the cultivation of higher-order ability will be impossible.

3 Relationship Between Virtual Experiment and Real Experiment

3.1 The Respective Advantages of Virtual and Real Experiments

In the traditional experimental course teaching, students only have abstract theoretical knowledge in their minds before entering a physical laboratory, and they lack perceptual knowledge, thus resulting in a disconnection between theory and practice. After entering the laboratory, they feel unable to start, and they have unskilled operation and low efficiency, and it is difficult to guarantee the quality of experiments and the safety of instruments and equipment. Virtual experiments establish a bridge between theoretical and physical experiments, which plays a transitional role. Students overcome the psychological pressure of worrying about damaging equipment and instruments and will not damage instruments and equipment or cause safety accidents because of misoperation[5, 6]. Therefore, they can practice and attempt boldly in virtual experiments and provide convenient conditions for repeated practice, thus laying a foundation for physical experiments, accumulating certain practical experience and operational skills, and better solving the above problems.

Experimental teaching not only helps students understand and verify some known laws of human beings but also cultivates students’ practical ability and let them accumulate experimental operation experience and master experimental research methods so that they can explore and discover unknown laws of human beings[7, 8]. Virtual experiments are only known laws obtained by physical experiments through computer simulation, so it can be said that there are no virtual experiments if there are no real experiments, and humans’ understanding will stagnate without physical experiments, which is the essential difference between virtual experiments and physical experiments. Secondly, there may be some abnormal phenomena and faults in the physical experiment, which can not be reflected in the virtual experiment. Therefore, virtual experiments can not replace physical experiments, just as the computer can not completely replace humans, so the physical experiment is the most important link in the integration of virtual-reality experimental teaching.

3.2 Relationship Between Experimental Skills in Virtual and Real Teaching Modes

Experimental skills in virtual experimental training can be reflected in physical experiments to promote the development of skills in physical experiments, and the skills in virtual experimental examinations, in turn, reflect the mastery of skills in physical experiments[9, 10]. We think that the skills that students master by doing virtual experiments aren’t the physical experiment skills themselves, and it is meaningful only when the knowledge accumulated in the virtual experiment training can realize the positive transfer to the physical experiment. Whether the positive transfer relationship can be established between the virtual and the real is the key to the success of the "integration of virtual-reality" experimental teaching mode. Cognitive psychology provides a basis for us. Cognitive psychology divides knowledge into two categories: declarative knowledge and procedural knowledge. Procedural knowledge includes cognitive skills and motor skills. Experimental skills (whether virtual or practical), which are procedural knowledge, are closely related to the field of cognition and motor skills. In the virtual experimental environment, students can establish an intuitive impression in their minds by observing the solid model, know about the function of the equipment through operation, and deeply understand the experimental principles and rules through thinking. These preliminary cognitive skills and certain operational skills developed in "doing" must have a positive transfer effect in the physical experiment, thus promoting the completion of the physical experiment and the mastery of practical skills.

4 Integration of Virtual-Reality Practical Teaching Mode with the Goal of Higher-Order Ability Training

It is argued that the teaching reform developing students' higher-order abilities first changes the teaching objectives and takes the development of learners' higher-order abilities as the teaching objectives; secondly, it is necessary to change the way of learning, make the learning style innovate, independent, personalized, and technology-based; Thirdly, it is necessary to change the learning environment and integrate learning into a learning environment that promotes the development of learners' higher-order abilities, such as a learning environment that integrates skills, theories and knowledge. Based on the above guiding principles, the overall block diagram of the "integration of virtual-reality" practical teaching mode with the goal of high-level ability training constructed is shown in Fig. 1.

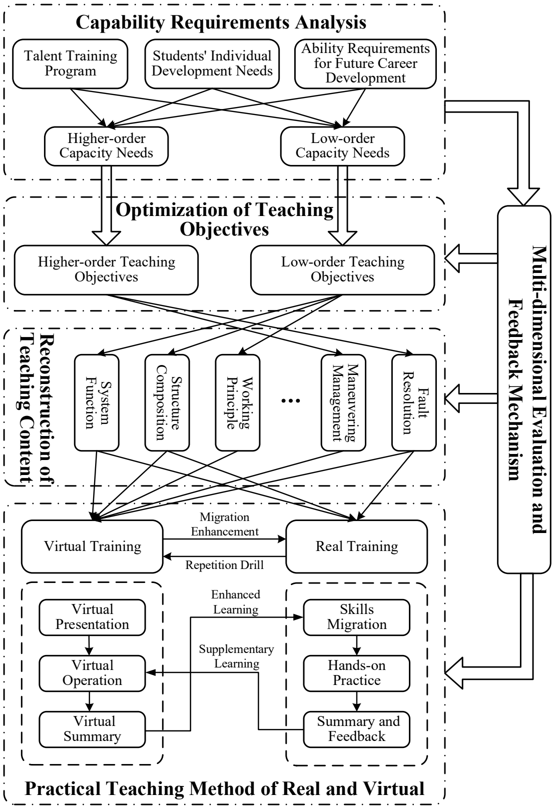

Fig. 1. Block diagram of the "integration of virtual-reality" practical teaching mode based on higher-order ability training

4.1 Optimization of Practical Teaching Objectives Focusing on Higher-Order Ability Training

According to the major talent training program, the ability needs of future career development and students' personality development, the higher-order and low-order ability needs of talent training are comprehensively and systematically sorted out, and the curriculum teaching objectives are formulated according to the needs of benchmarking ability. According to Bloom's cognitive goal classification, the higher-order and low-order teaching objectives are distinguished. The higher-order teaching objectives focus on the cultivation and setting of higher-order abilities such as analysis, synthesis, evaluation and innovative application, while the low-order teaching objectives concentrate on the cultivation and setting of low-order abilities such as understanding and application. The setting of low-order teaching objectives should serve the realization of higher-order teaching objectives.

4.2 Goal-Oriented Teaching Content Reconstruction

Focusing on the achievement of teaching objectives, the practical teaching content is reconstructed and optimized, and the higher-order knowledge content that can achieve the higher-order teaching objectives is added, such as comprehensive application, scenario assignment, troubleshooting and other practical teaching content. With the higher-order teaching objectives as the traction, the learning of low-order teaching content is integrated into the learning process of higher-order teaching content, thus following the constructivist learning theory and achieving the organic connection and integration of low-order and higher-order teaching content from low to high and step by step.

4.3 Integration of Virtual-Reality Practical Teaching Method

In practical teaching, a realistic learning environment is designed by using virtual reality technology so that learners can actively acquire knowledge and skills through interactive activities with the virtual learning environment. In this way, learners can perceive those abstract concepts that cannot be perceived in real life through the virtual learning environment. Meanwhile, the scope of learners' perception can be expanded, and repeated exploration and learning can be carried out to strengthen knowledge, ability and skills. Then through real training, the efficiency and level of real training can be improved through knowledge transfer. The knowledge and skills obtained by virtual training can be more easily used to carry out higher-order practical tasks, such as troubleshooting and comprehensive manipulation. In the specific teaching process, learners can carry out collaborative practice in virtual and real learning environments in the form of group division of labor and task-driven. Therefore, learners can not only achieve specific learning objectives and learning content but also cultivate and exercise their higher-order emotional abilities such as solidarity and cooperation, communication and coordination, organization and command. The specific fit between the virtual and real experiments is shown in Fig. 1.

4.4 Multidimensional Evaluation Feedback Mechanism

To test the achievement degree and teaching effect of teaching objectives, a multi-dimensional assessment and evaluation scheme covering after-class, higher-order and low-order, process and finality is designed to comprehensively evaluate students' ability generation. In-class and after-class assessment and focuses on the cultivation of students' learning enthusiasm and autonomous learning habits through the assessment and evaluation of catechism learning and homework completion. The higher-order and low-order examination and evaluation focus on the achievement of higher-order and low-order teaching objectives and the generation of students' abilities through case studies, seminar presentations and customized assignments. Process and finality assessment focuses on the daily development of students and the follow-up evaluation of the whole process through accompanying quizzes and a final exam. According to the results and data of multi-dimensional assessment and evaluation, the closed-loop feedback control mechanism of teaching quality is introduced to regularly summarize the teaching quality and teaching effectiveness, modify and improve the teaching design and virtual and real teaching conditions in a targeted way, complement the shortcomings of students' knowledge and ability, and constantly the teaching quality to ensure the achievement of teaching objectives and the realization of the whole-process education. Specific relationships are detailed in Fig. 1.

5 Conclusion

This paper clarifies the specific connotation and logical relationship between higher-order and low-order ability, and emphasizes that the cultivation of higher-order abilities is based on low-order abilities. Secondly, the advantages and disadvantages of virtual and real experiments are analyzed. It is pointed out that the two are complementary to each other, and it is necessary to carry out the integration of virtual-reality practical teaching. Thirdly, according to the above principles, a integration of virtual-reality practical teaching mode based on the cultivation of higher-order ability is constructed, and specific guidance is provided for the setting of teaching objectives, teaching methods, content adjustment and the establishment of the evaluation system. The research results have certain guidance and reference significance for the cultivation of higher-order ability and integration of virtual-reality practical teaching.

References

1. Arievitch M I. (2020) The vision of Developmental Teaching and Learning and Bloom's Taxonomy of educational objectives. Learning, Culture and Social Interaction, 25, 100274. https://doi.org/10.1016/j.lcsi.2019.01.007.
2. Jia Z, Balinas M J. (2024) Teaching Strategies in Psychiatric Nursing Based on Bloom's Taxonomy of Educational Objectives. Cureus, 16(4): e57759-e57763. https://doi.org/10.7759/cureus.57759.
3. Woojung C, Seonghoon K. (2020) Analysis of Achievement Standards of 2015 Revised High School Mathematics Curriculum Based on Bloom's Revised Taxonomy of Educational Objectives. Korean Association For Learner-Centered Curriculum And Instruction, 20(1): 381-402. https://doi.org/10.22251/jlcci.2020.20.1.381.
4. Rathod S, Halapeti B. (2022) Improving Students' Higher-order Thinking Ability by Exploring KWHL Diagram. Journal of Educational Research and Policies, 4(9):112-115. https://doi.org/10.53469/JERP.2022.04(09).19.
5. H A, Syamsuddin, Febryanti, et al. (2021) Development of student worksheets assisted by GeoGebra application in improving higher-order thinking ability in mathematics learning. Journal of Physics: Conference Series, 1882(1):334-337. https://doi.org/10.1088/1742-6596/1882/1/012048.
6. Megawati, Hartatiana, K A W. (2020) Analysis of student's thinking ability to solve higher-order thinking skills (HOTS) math problems. Journal of Physics: Conference Series, 1480(1): 012050-012053. https://doi.org/10.1088/1742-6596/1480/1/012050.
7. Norbert P, Piotr F. (2022) Applicability of Augmented and Virtual Reality for Education in Robotics. Journal of Automation, Mobile Robotics and Intelligent Systems, 16(3): 65-74. https://doi.org/10.14313/JAMRIS/3-2022/25.

8. Gang S, Xinglong W. (2021) Application of Computer Virtual Reality Technology in Practical Teaching of Construction Engineering Survey. Journal of Physics: Conference Series, 1915(3): 234-237. https://doi.org/10.1088/1742-6596/1915/3/032072.
9. Man F, Fan Y, Rongqi Y. (2021) Application of Virtual Reality Technology (VR) in Practice Teaching of Sports Rehabilitation Major. Journal of Physics: Conference Series, 1852(4): 109-113. https://doi.org/10.1088/1742-6596/1852/4/042007.
10. Davide C, Federico L D, Alberto C, et al. (2022) Immersive virtual reality and passive haptic interfaces to improve procedural learning in a formal training course for first responders. Virtual Reality, 27(2): 985-1012. https://doi.org/10.1007/S10055-022-00704-9.