

Application and Practice of the “Theory-Virtual-Reality” Integrated Teaching Model in the Course Computer-Aided Manufacturing

Pan Yang

Chongqing Industry & Trade Polytechnic, Chongqing, China

Abstract: Taking the course Computer-Aided Manufacturing for the mechanical design and manufacturing specialty in higher vocational colleges as an example, this paper conducts a study on the application and practice of "Theory-Virtual-Reality" integrated teaching in this course. Firstly, the core concepts and characteristics of "Theory-Virtual-Reality" integrated teaching are elaborated from a theoretical perspective, and its important value in vocational education is analyzed. Secondly, an in-depth analysis is made of the existing problems in the current teaching of the course Computer-Aided Manufacturing. Finally, combined with specific teaching cases, this paper discusses how to organically integrate theoretical teaching, virtual simulation, and practical operation to construct a student-centered and task-oriented teaching system, thereby providing a certain reference for carrying out "Theory-Virtual-Reality" integrated teaching for mechanical majors in higher vocational colleges.

Keywords: Theory-Virtual-Reality; Integrated Teaching Model; Computer-Aided Manufacturing; Higher Vocational Colleges; Mechanical Majors; Teaching Practice

1. Introduction

With the rapid development of information technology, vocational education is facing an unprecedented transformation and challenge. In particular, for mechanical majors in higher vocational colleges, the traditional teaching method can no longer meet the requirements of the modern manufacturing industry for highly skilled talents [1]. In recent years, the "Theory-Virtual-Reality" integrated teaching model has gradually become an important direction for vocational education reform. In this model, the combination of theoretical knowledge, virtual simulation, and practical operation can

improve students' learning outcomes and practical ability. This teaching method can not only solve the problems of incomplete teaching facilities and high operational risk in traditional teaching, but also greatly improve teaching effectiveness and education quality [2]. Especially for the course Computer-Aided Manufacturing, the "Theory-Virtual-Reality" integrated teaching method has important practical value.

At present, the course Computer-Aided Manufacturing in higher vocational colleges suffers from problems such as the disconnection between theory and practice, insufficient teaching resources, and low student enthusiasm [3]. As a result, students lack sufficient operational ability and the ability to solve practical problems to meet enterprises' demand for highly technical talents. Therefore, it is very necessary to find a more scientific and efficient teaching method. The "Theory-Virtual-Reality" integrated teaching model is proposed in response to the above situation. On this basis, a virtual simulation platform is established and combined with real equipment operation to achieve the integration of theoretical knowledge and practical ability, thereby improving students' professional quality and employability.

From the perspective of educational reform, the "Theory-Virtual-Reality" integrated teaching model is not only an innovation in teaching methods, but also an important manifestation of the modernization of vocational education. Being student-centered and emphasizing interactivity and experience in the learning process is the characteristic of this model, which conforms to the development trend of modern vocational education. It also provides teachers with more flexible teaching methods, making what is learned in the classroom closer to actual working conditions, thereby improving students' post-adaptability. Therefore, the significance of exploring and experimenting with the "Theory-Virtual-Reality" integrated teaching

method in the course Computer-Aided Manufacturing lies in promoting the improvement of teaching methods and pointing out the direction for higher vocational colleges to improve students' technical quality.

The purpose of this study is to explore the application and practice path of the "Theory-Virtual-Reality" integrated teaching method in the course Computer-Aided Manufacturing for mechanical majors in higher vocational colleges, so as to solve the long-standing problems of the disconnection between theory and practice, the shortage of practical training resources, and students' weak hands-on ability. At present, with the development of intelligent and digital manufacturing, higher requirements are placed on technical and skilled talents, while the traditional teaching model cannot meet this demand [4]. Therefore, it is necessary to combine theoretical teaching, virtual simulation, and physical operation to form a teaching system that better meets actual needs, so as to improve students' comprehensive quality and vocational ability. Through an in-depth analysis of the theoretical basis and implementation methods of the "Theory-Virtual-Reality" integrated teaching model, the reform of the course Computer-Aided Manufacturing will be provided with a scientific basis and a certain reference value.

As for the specific problems to be addressed in this research, this paper will discuss the design and application of the "Theory-Virtual-Reality" integrated teaching method. Based on existing research results, the basic ideas and important components of this teaching model are summarized, and taking the course Computer-Aided Manufacturing as an example, the specific teaching reform scheme for mechanical majors in higher vocational colleges is elaborated [5]. Corresponding countermeasures are proposed for the problems frequently encountered in teaching, such as the configuration of teaching equipment, the development of teaching resources, and the improvement of teachers' competence, and actual teaching cases are used to verify their feasibility and effectiveness. It will also analyze the influence of this teaching model on students' learning interest, skill mastery, and employment competitiveness, further improve the teaching evaluation system, and ensure the measurability and sustainability of teaching quality [6].

It is hoped that this research can bring new ideas

and methods to the curriculum reform of mechanical majors in higher vocational colleges, promote the popularization and application of the "Theory-Virtual-Reality" integrated teaching model, and at the same time provide certain reference value and significance for teaching practice and academic research in related fields, thereby promoting the high-quality development of vocational education. In the future, with the advancement of technology and the continuous updating of educational concepts, the "Theory-Virtual-Reality" integrated teaching method will be widely applied in more specialties and become an important way to cultivate high-quality technical workers.

2. Theoretical Basis and Practical Connotation of "Theory-Virtual-Reality" Integrated Teaching

The "Theory-Virtual-Reality" integrated teaching is a comprehensive teaching method that combines theoretical teaching, virtual simulation, and practical operation, with the aim of improving students' practical ability and comprehensive quality through a variety of teaching means. This model breaks the traditional situation in which theory and practice are separated, and carries out learning in real or simulated real situations, enabling students to master knowledge and skills in the process of "learning by doing and doing while learning" [7]. Such a teaching method not only attaches importance to students' understanding of theoretical knowledge, but also to their application ability in actual environments, reflecting the ability-oriented characteristic of vocational education. In addition, the "Theory-Virtual-Reality" integrated teaching concept also advocates the deep integration of information technology and teaching content, using virtual simulation technology to solve the problem of the shortage of practical training resources, thereby improving teaching efficiency and quality [8].

The characteristics of "Theory-Virtual-Reality" integrated teaching are mainly reflected in three aspects: the integrity of teaching content, the authenticity of the teaching environment, and the interactivity of the teaching process. Teaching content is no longer limited to a single theoretical lecture or pure practical operation, but combines the two to form a complete knowledge system. The teaching environment emphasizes the combination of authenticity and

simulation, namely the presence of both real equipment and scenes and virtual simulation platforms, thus bringing students a learning experience closer to reality [9]. The teaching process attaches importance to interaction and communication between teachers and students, and advocates students' active participation and active thinking, thereby improving students' autonomous learning ability and problem-solving ability. Because of these characteristics, it can effectively stimulate students' learning enthusiasm and improve their learning outcomes, while conforming to the needs of contemporary vocational education for high-quality technical and skilled talents.

In terms of actual practice, the "Theory-Virtual-Reality" integrated teaching method has been used and verified in many fields of vocational education. For example, in numerical-control practical training courses, this model introduces virtual simulation software so that students can conduct virtual exercises before operation, which can reduce practical training costs, improve operational safety, and enhance students' hands-on ability. In the new energy vehicle specialty, the mixed and progressive "Theory-Virtual-Reality" integrated teaching model adopts a staged and layered teaching design, continuously improving students' theoretical level and practical ability, and achieves good teaching results. These practical cases show that the "Theory-Virtual-Reality" integrated teaching method not only has strong operability, but can also effectively improve teaching quality, providing a new idea and method for vocational education reform.

The application value of the "Theory-Virtual-Reality" integrated teaching method in vocational education is increasing. It mainly relies on the organic integration of theory, virtual simulation and practical operation to improve students learning outcomes and professional skills. This model can well solve the problem of the disconnection between theory and practice in traditional teaching, and can cultivate students hands-on ability and engineering awareness. In the teaching of the welding technology specialty in secondary vocational schools, the "Theory-Virtual-Reality" integrated teaching method is adopted to learn welding processes by using virtual simulation experimental equipment, and combined with actual operation training, so that students can better master relevant operating skills and

improve their comprehensive ability. In this way, teaching quality is improved and a strong guarantee is provided for the cultivation of high-quality technical and skilled talents.

In the field of mechanical majors, the application of "Theory-Virtual-Reality" integrated teaching also has important significance. Taking the course Fundamentals of Mechanical Engineering Control as an example [10], the content of this course is abstract and requires interdisciplinary knowledge to understand, and the traditional teaching method cannot satisfy students' needs for actual engineering projects. By teaching with a combination of virtual simulation and practical operation, students can first conduct system modeling and simulation analysis in a virtual environment, and on this basis carry out actual operation to verify theoretical knowledge, achieving the organic combination of theory and practice. In this way, students' comprehensive qualities can be exercised and their practical abilities can be cultivated, fully conforming to the training requirements of application-oriented talents.

The promotion of the "Theory-Virtual-Reality" integrated teaching model in vocational education is conducive to promoting the rational allocation of teaching resources and the modern development of teaching methods. With the development and progress of information technology, virtual simulation technology has gradually been widely applied in the field of education and has also played a positive role in vocational education, enabling vocational education to adopt more teaching means to improve teaching quality. In the course Smart Home Installation and Maintenance, a virtual simulation platform is used to build and debug smart home systems, and then real equipment is used for operation training, so that students can learn complex operation processes in a safe and controllable environment. This teaching method can improve teaching quality without increasing training costs, and has positive significance for improving the schooling level of colleges, thus having strong practical promotion value.

3. Analysis of the Current Teaching Status and Problems of the Course Computer-Aided Manufacturing

At present, the course Computer-Aided Manufacturing in higher vocational colleges mainly adopts traditional classroom teaching as the dominant approach, supplemented by some

experimental operation parts. However, this teaching model has many problems in actual application and cannot meet the training needs of the modern manufacturing industry for highly skilled talents, because this course covers knowledge such as complex 3D modeling, machining path planning, and numerical-control programming. The traditional teaching method mostly follows the pattern of teacher lecturing followed by students' after-class practice, which lacks intuitiveness and practicality. Due to the limited experimental equipment resources, students have few opportunities to operate by themselves in the teaching process, resulting in a disconnection between theory and practice, which affects learning outcomes and the development of vocational ability. In addition, the updating speed of teaching content is relatively slow and cannot keep up with the technological development of the industry in a timely manner, causing a gap between the knowledge students learn and the actual needs of enterprises.

Most teachers' teaching methods are still one-way, unidirectional lecturing-based teaching models without interactivity and innovation, which will make students develop a weariness of learning and low learning enthusiasm, and fail to form the ability of active exploration and problem solving. Since the course content is relatively abstract, students have great difficulty in understanding complex concepts, and the traditional teaching method cannot effectively solve this problem. For example, when carrying out CAM software operation training, due to the lack of real-scene experience, students often cannot master actual operating skills well, thus affecting learning outcomes. On the other hand, the teaching evaluation system is also relatively unitary, mainly relying on examination scores to measure students' learning, ignoring the cultivation of students' practical ability and innovative spirit, which is not conducive to a comprehensive evaluation of students' overall ability.

With regard to the above problems, the current teaching model has obvious defects in teaching resources, teaching methods, and evaluation systems. The allocation of teaching resources is uneven, especially in practical training equipment and virtual simulation platforms, where many higher vocational colleges have insufficient investment, affecting students' experience and the development of practical

ability. The teaching methods are unitary, and information-based means are not well utilized to enhance intuitiveness and interactivity, resulting in low learning interest among students. The teaching evaluation methods are relatively unitary and cannot well reflect students' knowledge and application ability. Therefore, it is urgent to change the existing educational methods and find a teaching method more suitable for students' actual situation, so as to improve teaching quality and the effect of talent cultivation.

In the current teaching of the course Computer-Aided Manufacturing, there are obvious deficiencies in students' learning outcomes and ability cultivation. On the one hand, students do not master theoretical knowledge solidly enough and lack the ability to effectively combine abstract programming logic with actual machining operations. Therefore, when encountering complex part-machining tasks, they are prone to comprehension deviations or operational errors. On the other hand, in practice, students' hands-on ability and problem-solving ability need to be improved. Some students are not proficient in software operation and lack systematic training, making it difficult to independently complete the whole process from design to machining in actual projects. This shows that the current teaching method has defects in the combination of theory and practice and cannot effectively stimulate students' enthusiasm for active learning and their innovation ability.

In the teaching process, there are also problems of low student participation and lack of learning motivation. Because the course content is relatively abstract and some teaching resources do not make good use of virtual simulation technology to assist teaching, students will feel a fear of difficulty when learning, thus affecting the overall learning effect. At the same time, teachers pay more attention to the transmission of knowledge in teaching and ignore the cultivation of students' comprehensive abilities, such as teamwork ability, engineering thinking ability and innovation awareness. Such a teaching model will weaken students' adaptability to real work, and they will encounter great occupational transition pressure in companies. Therefore, how to use the "Theory-Virtual-Reality" integrated teaching reform to improve students' autonomy and hands-on ability has become an important issue

in current education reform.

Research on the above problems has shown that the traditional teaching method has certain limitations in promoting students' ability development. For example, in numerical-control lathe practical training courses, students often cannot well apply theoretical knowledge to actual operation, so the learning effect is poor. A similar situation also appears in the course Computer-Aided Manufacturing. In the process of using complex CAM software, students lack sufficient practical opportunities and cannot establish systematic engineering thinking and operational ability. Therefore, it is necessary to introduce the "Theory-Virtual-Reality" integrated teaching method, using a combination of virtual simulation, physical operation, and theoretical lecture to increase students' curiosity and hands-on operational ability, and to achieve the purpose of optimizing teaching effects and improving teaching quality.

4. Practical Exploration of "Theory-Virtual-Reality" Integrated Teaching in the Course Computer-Aided Manufacturing

In the course Computer-Aided Manufacturing, theoretical knowledge and virtual simulation appear together, and the integrated teaching design is intended to combine these two parts to form a student-oriented and ability-led teaching model. According to Huang Zhiyuan's research, the "Theory-Virtual-Reality" integrated teaching model advocates using internet technology to share resources and communicate interactively, thereby improving students' autonomous learning ability and actual operation skills. Therefore, in this course, the teaching design first needs to determine the course objectives, and then proceed around aspects such as CAD/CAM software operation skills, understanding of machining processes, and mastery of production processes. In addition, virtual simulation platforms (such as SolidWorks and Mastercam, etc.) are used, so that students can carry out part modeling, path planning, and machining simulation in a virtual environment, thereby reducing experimental costs and improving teaching efficiency. It is also necessary to set up appropriate practical training projects so that students can carry out practical operations on real mechanical equipment and achieve the purpose of "learning while doing and applying what is learned."

In terms of implementation path, "Theory-Virtual-Reality" integrated teaching should rely on information-based teaching platforms to integrate online and offline resources and form a variety of teaching methods. Wan Jiao believes that the application of virtual reality technology can well solve the problems of insufficient equipment and high operational risk in traditional teaching, creating a more intuitive and safe learning environment for students. Therefore, in the course Computer-Aided Manufacturing, teachers can use virtual simulation systems for demonstration and guide students to explore and learn cooperatively by themselves. At the same time, project-based teaching is adopted to bring real enterprise cases into the classroom, so that students can improve their comprehensive ability in the process of completing specific tasks. It is also necessary to establish a scientific evaluation system, using a combination of process evaluation and summative evaluation to comprehensively examine students academic achievements and the development of the skills they have learned, ensuring the measurability and sustainability of teaching outcomes.

In order to ensure the effect of "Theory-Virtual-Reality" integrated teaching, while building the faculty team, it is necessary to improve teachers' theoretical level and technical level. On the one hand, teachers should have a solid disciplinary background and high information-based teaching ability, and be able to skillfully use various teaching tools. On the other hand, schools should increase investment to improve virtual simulation equipment and practical training conditions, providing necessary material support for teaching reform. At the same time, school-enterprise cooperation should be strengthened, and industry experts should be invited to participate in course design, so that teaching content is more in line with actual production needs and the pertinence and practicality of talent cultivation are improved. After adopting the above methods, the "Theory-Virtual-Reality" integrated teaching method in the course Computer-Aided Manufacturing will be better applied, thereby providing stronger support for the talent cultivation of mechanical majors in higher vocational colleges.

After the "Theory-Virtual-Reality" integrated teaching model is introduced into the course Computer-Aided Manufacturing, the

effectiveness of this model in improving students' practical ability and understanding of theory is verified on the basis of analyzing actual teaching cases. Taking the mechanical specialty of a certain higher vocational college as an example, the curriculum includes three parts: theoretical lecture, virtual simulation, and practical operation, enabling students to learn the operation process of CAM software and the design methods of machining processes in a real working environment. Through teaching feedback data, it can be found that after implementing the practice-oriented teaching method, students are more willing to actively participate in learning in class, and their homework completion and project practice performance are much better than before.

In the specific implementation process, teachers use the virtual simulation platform to provide students with a risk-free environment to practice machining path optimization and parameter setting, and then students enter the practical training workshop for physical processing, so that theoretical knowledge and practical skills can be well combined. This teaching method can not only improve students' hands-on ability, but also enhance their ability to solve practical problems. Through the comparison of two groups of students, it is found that after receiving the "Theory-Virtual-Reality" integrated teaching method, the number of students who passed the vocational qualification certification examination is much larger than that of students who did not adopt this teaching method, which shows that the "Theory-Virtual-Reality" integrated teaching method can improve students' overall vocational skill level.

From the perspective of teaching effectiveness, the "Theory-Virtual-Reality" integrated teaching method well solves the problem of the disconnection between theory and practice in traditional teaching, thereby improving students learning enthusiasm and initiative. By using multi-dimensional evaluation methods to measure the teaching effect, including students satisfaction survey of the course, students academic performance and enterprises internship situations, it is found that this model can effectively improve students engineering practical ability and post adaptability. In addition, in teaching, teachers have also begun to form a student-centered concept and continuously promote the innovation of teaching content and methods, bringing beneficial experience and

inspiration to the curriculum reform of mechanical majors in higher vocational colleges.

Acknowledgments

This work was supported by the Project of Education and Teaching Reform of Chongqing Industry & Trade Polytechnic (2025) under Grant No. JG20250227.

References

- [1] Qin Kaige, Lei Honghua, Gong Xiang. Research on the Innovation of "Theory-Virtual-Reality" Digital Integrated Teaching for Industrial Robot Majors in Higher Vocational Colleges — Taking the Course Industrial Robot Operation and Programming as an Example. *Paper Making Equipment & Materials*, 2023, 52(10): 245-247.
- [2] Wei Xinyu, Wei Shan. Teaching Design of Virtual Simulation Training Based on "Theory-Virtual-Reality" Integration in Secondary Vocational Schools — Taking the Course Hydraulic Control Technology as an Example. *Equipment Manufacturing Technology*, 2025, (01): 103-106.
- [3] Liu Changping. Research on the "Theory-Virtual-Reality" Integrated Teaching Reform of Accounting in Secondary Vocational Schools Based on "Internet+". *Fortune Times*, 2020, (05): 178.
- [4] Liang Gang, Lu Haichang. Research on the "Theory-Virtual-Reality" Integrated Teaching of the Course Electrical Control Technology. *Equipment Manufacturing Technology*, 2025, (03): 85-88.
- [5] Lv Shuang, Li Yue, Li Yipeng. Application of the "Theory-Virtual-Reality" Integrated Teaching Model in the Course Industrial Robot Operation and Programming in Secondary Vocational Schools. *Southern Agricultural Machinery*, 2024, 55(17): 182-185+198.
- [6] ZHANG H. Research on the application of Theory-Virtual-Real integrated teaching in the course Industrial Robot Operation and Programming for secondary vocational education. *Changchun Normal University*, 2024.
- [7] CHEN Z Y. Research on the application of Theory-Virtual-Real integrated teaching mode in CNC training courses. *Tianjin University of Technology and Education*,

2022. DOI: 10.27711/d.cnki.gtjgc.2022.000117.
- [8] YUAN C H, WANG W C. Application of virtual-real integrated teaching mode in basic nursing technology teaching under the intelligent background. *Journal of Nurses Training*, 2023, 38(15):1379-1382+1387. DOI 10.16821/j.cnki.hsjx.2023.15.008.
- [9] HUANG Z L. Practical research on the hybrid progressive “Theory-Virtual-Real integrated” teaching mode for new energy vehicle majors. *Automobile Maintenance and Repair*, 2024, (24):23-24. DOI: 10.16613/j.cnki.1006-6489.2024.24.002.
- [10] LYU J Y, YANG R Q, ZHENG M H. Application of the "Theory-Virtual-Real" integrated teaching mode in the course Fundamentals of Mechanical Engineering Control. *Equipment Manufacturing Technology*, 2022, (09):234-237.