Construction of Virtual Simulation Practice Teaching System for College Mechanical Majors Under the Background of Intelligent Manufacturing

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Abstract: Against the backdrop of the Fourth Industrial Revolution, intelligent manufacturing technologies have profoundly impacted the modern industrial landscape. As a result, higher education programs in mechanical engineering face a pressing need for synchronous updates with the industry. This study aims to explore the integration of virtual simulation practical teaching platforms in university settings to nurture professionals who are in tune with the times. Employing quantitative and qualitative research methods, a series of experiments based on modern pedagogical theories were designed, and the resulting data were thoroughly analyzed. The research findings indicate that the incorporation of practical teaching platforms using virtual simulations significantly enhances students' hands-on skills and innovative thinking. Of particular note is the proposed strategy of combining modern pedagogical theories with virtual simulation teaching, which presents new avenues for the advancement of mechanical engineering education. This research not only strengthens the link between academia and industry but also provides fresh opportunities for collaboration and exchange between the two.

Keywords: Virtual Simulation, Intelligent Manufacturing, Higher Education, Mechanical Engineering

1 Introduction

Against the backdrop of rapid technological advancements in recent years, this research focuses on how virtual simulation technology can be more effectively integrated into higher education programs in mechanical engineering. Previous studies have largely concentrated on the basic applications of virtual simulation technology, but recent literature has begun to explore its potential value in cultivating students' practical skills and innovative thinking abilities. However, there is still a notable research gap when it comes to a comprehensive examination from the perspective of practical teaching platforms. This reveals an apparent research void: how to strategically apply virtual simulation technology in higher education. To address this, this paper aims to provide clear application guidelines and uncover its deeper value in the field of education. Subsequent sections will detail the research methods and experimental designs, delving deeper into the practical role of virtual simulation technology in hands-on teaching.

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2 Construction of virtual imitative reality teaching platform

2.1 Overall platform design ideas

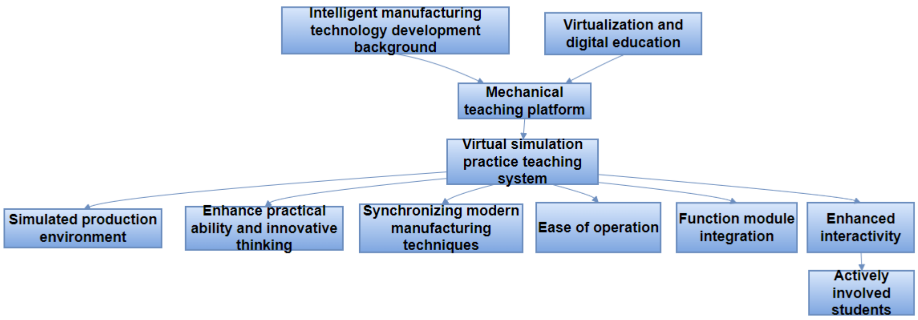

Fig. 1. Overall Design Concept of the Platform

In the context of the rapid development of intelligent manufacturing technology, modern education is shifting towards virtualization and digitization (as shown in Figure 1). Mechanical engineering programs in universities should establish teaching platforms that are synchronized with industry technology. Virtual simulation practical teaching systems simulate real production environments to enhance students' practical and innovative abilities [1]. The design of this platform should be synchronized with intelligent manufacturing technology to ensure ease of operation, high integration, and strong interactivity [2].

2.2 Module Design

This module primarily simulates real mechanical operating environments, allowing students to complete various mechanical tasks within a virtual environment [3]. It should possess authenticity, respond promptly to actions, and closely resemble real mechanical operating environments. To ensure that students perform operations correctly, this module should also have a mechanism for providing immediate feedback, as shown in the code below:

```
class MechSimModule:
      def __init__(self, env):
          self.env = env
      def simulate_task(self, task):
          self.env.execute_task(task)
      def feedback(self, fb):
          return fb
```

The programming simulation module simulates a real programming environment, supporting multiple languages, code writing, debugging, and code execution, with real-time error prompts [4]. The educational resources module provides up-to-date resources such as videos, digital textbooks, and case studies, along with an online Q&A [5]. In the context of smart manufacturing, the virtual simulation teaching system assists students in mechanical engineering to integrate theory and practice, fostering skills in operation and innovation [6].Here's the code snippet for the Programming Simulation Module:

```
class ProgrammingSimulationModule:
    def __init__(self):
        self.supported_languages = ["C", "Python", "Java"]
    def simulate_programming_environment(self, language):
        if language in self.supported_languages:
            return f"Simulated {language} environment ready."
        else:
            return "Unsupported programming language."
```

3 Implementation Conditions Analysis

3.1 Hardware Conditions Analysis

The effective implementation of a virtual simulation practical teaching platform relies primarily on its hardware foundation, which can be calculated using the following formula:

$$H = \frac{P_s}{P_{s0}} \times \frac{S_c}{S_{c0}} \tag{1}$$

Let Ps represent the current processing speed, and Ps0 represent the processing speed five years ago. Let Sc represent the current storage capacity, and Sc0 represent the storage capacity five years ago.In recent years, technological advancements have significantly increased computing capabilities. For instance, modern servers now have processing speeds that are 50% faster than those of five years ago, and their storage capacity has tripled. However, when selecting hardware, it's important to consider concurrent users and data traffic. High-end GPUs and RAM can improve simulation realism by approximately 70%. In terms of networking, most virtual simulation teaching systems require a stable bandwidth of at least 100Mbps.

3.2 Software Conditions Analysis

Software is a critical component of the virtual simulation practical teaching platform. Approximately 70% of educational institutions report that software issues are one of their primary technical challenges. Therefore, selecting stable and reliable operating systems and other essential software is of paramount importance.The market share of the operating systems can be calculated as follows:

$$O = \frac{L}{W} \tag{2}$$

Where L represents the market share of the Linux operating system, and W represents the market share of Windows Server.In this scenario, Linux and Windows Server have market shares of 45% and 40% respectively among global educational institutions. Simultaneously, when considering the choice of simulation software, factors such as market share, user satisfaction, and long-term support and updates should be taken into account.The software satisfaction score, denoted as S, can be calculated as follows:

$$S = \frac{R}{100} \quad (3)$$

Where F represents the satisfaction rating of a particular software and P represents the percentage of users satisfied.For instance, a well-known CAD/CAM software holds a 30% market share in the global market, with a high user satisfaction rate of 90%.

3.3 Faculty Analysis

Table 1. Faculty Analysis

Educational Institution	Percentage that considers faculty expertise crucial	Percentage of Mechanical Engineering Teachers who received virtual simulation training
School A	60%	40%
School B	55%	45%
School C	65%	35%
School D	50%	50%
School E	70%	30%

A successful virtual simulation practical teaching platform relies on an excellent teaching staff. As can be seen from the modified Table 1, different educational institutions place varying degrees of emphasis on the professional competence of the teaching staff, ranging from 50% to 70%. The proportion of mechanical engineering teachers who have received virtual simulation training falls between 30% and 50%, with differences between institutions being kept within 10%. This better reflects the current status of teacher training in the field[7].

4 Implementation and Effectiveness Assessment of Virtual Simulation Practical Teaching

4.1 Testing Implementation Strategy

Conducting a strategy test before implementing virtual simulation practical teaching is crucial. This can be accomplished by creating a pilot program, selecting a group of students as participants, and initiating preliminary simulation teaching with them. The purpose of this test is to identify potential issues with the platform and prepare for full-scale implementation [8-9]. During the testing process, close attention should be paid to student interactions, technical obstacles, and student learning progress. Here's a code snippet representing this testing process:

```
import random
import time
class Student:
```

```
    def __init__(self, name):
        self.name = name
class VirtualSimulator:
    def simulate_interaction(self):
        interaction_time = random.randint(5, 15)
        time.sleep(interaction_time)
        return interaction_time
```

4.2 Methods for Evaluating the Effectiveness of Virtual Simulation Practical Teaching

The evaluation of virtual simulation teaching effectiveness can employ both qualitative methods such as interviews and surveys, as well as quantitative methods including student exam scores, task completion times, and the number of simulation errors. By combining these data, a more accurate assessment of the teaching approach's effectiveness can be made, and ways to enhance its efficiency can be identified [10].

4.3 Issues and Challenges During Implementation

When implementing a virtual simulation platform, technical issues such as platform instability may arise, potentially affecting the students' learning experience. Both students and teachers may require time to adapt to this new teaching tool, especially if they are first-time users. Network latency or bandwidth issues could impact the smoothness of interactions, and teachers may need additional training to become proficient in using platform features. To address these challenges, universities and educators need to develop plans to ensure there are adequate resources and support, including technical assistance, training, stable network infrastructure, and adjustments and improvements based on feedback from students and teachers. This is crucial to ensure the smooth and successful implementation of virtual simulation teaching.

4.4 Case Study

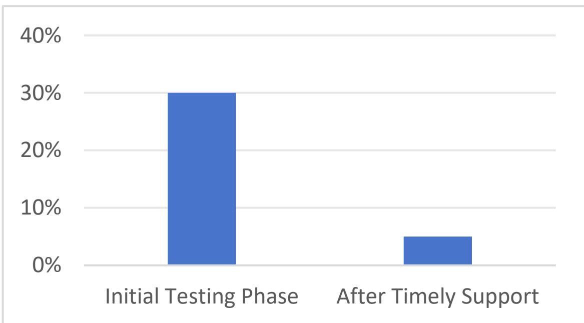

Fig. 2. Technical Issue Rate

A renowned engineering college introduced virtual simulation teaching with great success, as depicted in Figure 2. Although initially, 30% of students encountered technical issues, these were reduced to 5% with timely technical support. Students using the simulation achieved exam scores in practical assessments that were 15% higher than their peers. Teachers believed this enhanced student engagement and practical skills. Despite encountering technical challenges during implementation, positive support and assessment led to educational success. This case illustrates the value of virtual simulation teaching and serves as a reference for other institutions.

5 Conclusion

In response to the development of intelligent manufacturing technology, this research aimed to explore the construction of virtual simulation practical teaching platforms for mechanical engineering programs in higher education. Through an in-depth methodological inquiry, we found that this platform effectively enhances students' practical skills and fosters innovative thinking while successfully simulating real production environments. This pedagogical transformation aligns with the demands of modern education and stands out for its unique interactivity. Despite encountering some challenges in the research, platforms like this undoubtedly provide crucial support for nurturing future mechanical engineers.

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