Innovative Exploration and Practice of Testing Technology Course under Digital and Intelligent Empowerment

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Abstract. This paper explores how to promote the teaching reform of the Testing Technology course through digital and intelligent technologies, focusing on three dimensions: intelligent support for the entire teaching process, the construction of a virtual-physical integrated teaching resource system, and intelligent assessment and evaluation methods for the entire learning process. It systematically elaborates on the application paths and implementation methods of digital-intelligent technologies in teaching. Through a series of teaching reforms and innovations, a new paradigm for digital-intelligent empowered teaching is proposed, providing theoretical and practical references for cultivating testing technology talents that meet the demands of the new era.

Keywords: Digital and Intelligent Empowerment; Testing Technology; Intelligentization; Virtual-Physical Integration; Assessment and Evaluation

1 Introduction

Against the backdrop of the rapid development of digital and intelligent technologies, the field of education is undergoing profound changes. Through online learning platforms, teachers can push diverse preview resources to students, including micro-videos, e-textbooks, online quizzes, etc. These resources not only stimulate students' learning interest but also help them initially grasp the core content of the course[1]. Teachers can use functions like real-time polling and data analysis on smart teaching platforms to understand students' comprehension of specific knowledge points and decide whether further explanation or expansion of related content is needed[2], thereby achieving the goal of individualized instruction[3] and providing a scientific basis for teaching decisions[4-5]. Students can participate in the teaching process through technologies like virtual simulation from a first-person perspective, gaining an immersive learning experience[6-11]. Under digital and intelligent empowerment, the quality of both teaching and learning has been greatly optimized, making it a key development direction for the present and future.

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The Testing Technology course, as a core professional background course for the Weapon Systems and Engineering major, is primarily driven by the testing technology requirements of large-scale complex weapon systems and focuses on the forefront of testing technology represented by intelligentization. Traditional teaching modes face issues such as abstract theories, limited practical resources, and single assessment methods. Based on the teaching practice exploration of the Testing Technology course, this paper discusses how digital-intelligent technologies can drive innovation and enhance teaching quality in the course from three aspects: the entire process covering pre-class, in-class, and post-class phases; the integration of virtual and physical teaching resources; and intelligent assessment and evaluation. This aims to provide strong support for cultivating new-era military talents with strong innovative capabilities and the ability to solve complex equipment testing problems.

2 Intelligent Support for the Entire Teaching Process

2.1 Pre-class Phase

The teaching design and implementation in the pre-class phase have gradually shifted from traditional one-way information delivery to data-driven precise preview guidance. Before class, MOOC resources are pushed via the Rain Classroom platform, allowing real-time acquisition of students' completion status of preview tasks and their learning behavior data, such as learning duration, interaction frequency, and focus on specific knowledge points. AI intelligent tools are used for diagnostic tests of preview effectiveness, analyzing student preview outcomes in a data-driven manner, identifying individual learning preferences and weaknesses, generating student profiles, and accordingly producing customized learning suggestions. For example, for students with strong theoretical understanding, the system can recommend more challenging extension reading materials; for students weaker in practical operation, virtual simulation experiments can guide them to familiarize themselves with relevant operational procedures in advance. The course has established a closed-loop system of "data collection — intelligent guidance — dynamic optimization" based on the smart teaching platform, which not only optimizes the distribution mechanism of preview resources but also achieves scientific and precise teaching decisions through data analysis, providing strong support for the overall quality improvement of course teaching.

2.2 In-class Phase

In-class teaching primarily addresses common, key, and difficult problems. The introduction of intelligent tools and immersive technologies significantly enhances teacher-student interaction and student engagement. Utilizing the data analysis functions of the smart teaching platform, teachers can grasp students' learning feedback in real-time, combine it with bullet-screen interactions to generate word clouds, promptly identify and resolve problems encountered by students during learning, and dynamically adjust the teaching pace and focus to better address key and difficult points in the teaching design. Simultaneously, these tools can record students' classroom performance data, providing important references for subsequent process evaluation. The application of digital-intelligent technologies in the in-class phase not only enriches teaching methods but also, through the combination of immersive technologies and innovative teaching models, significantly enhances students' learning interest and classroom participation, laying a solid foundation for high-quality teaching.

2.3 Post-class Phase

As an important component of the teaching closed loop, the post-class phase achieves comprehensive intelligentization in homework assignment, grading, and feedback with the support of digital-intelligent technologies. AI agents are applied to analyze the learning effectiveness of each student, generate targeted remedial plans, and provide precise personalized learning guidance. For instance, for students weak in a particular knowledge point, the system can recommend relevant review materials or extension exercises; for students with overall excellent performance, more challenging tasks can be provided to further stimulate their learning potential [14]. This personalized learning support not only helps meet the differentiated needs of students but also enhances their autonomous learning ability to a certain extent. Furthermore, digital-intelligent technologies provide teachers with comprehensive tools for teaching effectiveness reflection. Through statistical analysis of homework data, teachers can clearly understand students' mastery of knowledge and potential issues in the teaching process. For example, a high error rate on a specific knowledge point may indicate that the teaching design for that part needs further optimization. In summary, the application of digital-intelligent technologies in the post-class phase, through automated grading, personalized suggestions, and teaching effectiveness reflection, provides strong support for the continuous improvement of teaching quality.

3 Building a Virtual-Physical Integrated Teaching Resource System

In the experimental teaching environment, while the original experimental equipment ensured the completion of experimental projects, the preset parameter space and integrated equipment could hardly support students in conducting innovative explorations based on their individual competency progression. To address these issues, the course team relied on smart classrooms and virtual simulation technology to create a collaborative teaching space of "Smart Classroom — Physical Experiment — Virtual Simulation," as shown in Figure 1.

In the smart classroom scenario, dynamic visual presentation of teaching process data is achieved through the deployment of multi-screen interaction systems. In the laboratory, a comprehensive experimental system covering the entire chain of "equipment data layer - sensor layer - testing layer - data analysis layer" was established.

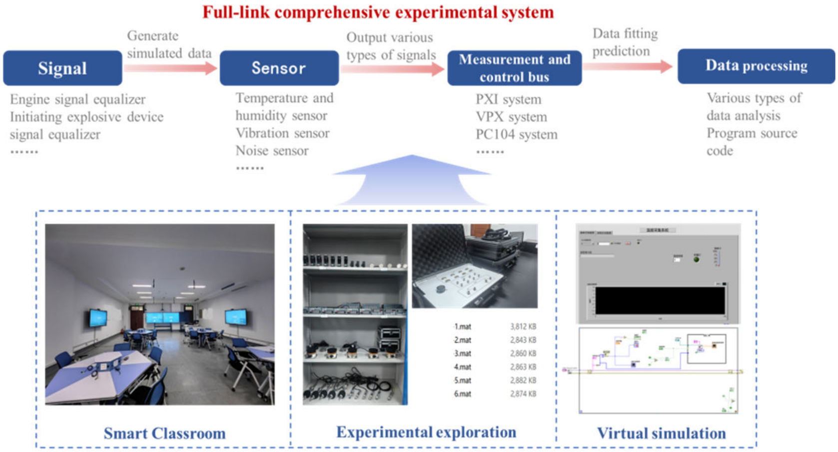

Fig. 1. "Smart-Physical-Virtual" Collaborative Experimental Platform

To meet the demand for students' autonomous exploratory experiments, a graded virtual simulation experiment platform was developed based on LabVIEW and LabWindows/CVI platforms, encompassing a three-tier architecture of Basic Layer, Advanced Layer, and Innovation Layer, as shown in Figure 2.

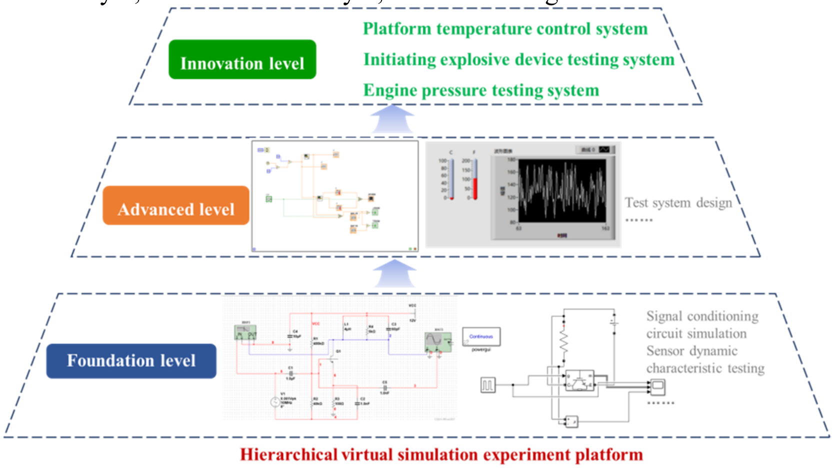

Fig. 2. Virtual Simulation Platform

The Basic Layer provides various standardized experimental modules; the Advanced Layer focuses on equipment-level testing system prototype development; the Innovation Layer, through open interfaces, allows students to write custom algorithms and verify their performance, providing a platform for cultivating scientific research and innovation capabilities. The multi-dimensional, multi-faceted teaching resource system and AI technology empowerment provide strong and precise support for students to carry out various progressive innovative explorations based on individual abilities.

When designing virtual simulation experiments, progressive tasks from basic operations to advanced applications can be set up, helping students improve their innovation skills while gradually mastering abilities [12]. Relying on the virtual-physical integrated experiment platform can effectively expand the teaching space and time dimensions, while also enhancing students' learning autonomy and interactivity[13].

For example, in the testing technology course, various experimental equipment such as sensors and buses are modularly transformed and integrated, making it more convenient and efficient for students to call the experimental equipment. On this basis, students use software such as LabVIEW to design and develop testing systems, and debug the software and hardware so that useful information can be extracted from the signals collected by the hardware in the software system. Furthermore, students add intelligent programs to the virtual instrument software to carry out intelligent transformation of the testing system, so as to cultivate their awareness and ability of innovation.

To ensure the timeliness and advancement of teaching content, the dynamic updating and optimization of digital-intelligent teaching resources are particularly important. In the context of rapidly developing technologies, theoretical and practical knowledge in the field of testing technology is constantly updated. Therefore, teaching resources must keep pace with industry development trends, promptly incorporating new technologies, standards, and cases. The course team deeply collaborates with relevant industrial departments, introducing military-grade bus testing systems and actual equipment measurement data to build practical teaching resources. In terms of MOOC resource construction, a two-level resource matrix of "National-level Excellent Courses — Military-level Excellent Courses" has been established, achieving effective aggregation of discrete teaching resources and dynamic updating of cutting-edge content. This is not only an important manifestation of course innovation under digital-intelligent empowerment but also a key guarantee for achieving high-quality teaching [15].

4 Intelligent Assessment and Evaluation Methods for the Entire Learning Process

4.1 Dynamic Monitoring of the Learning Process

In the teaching environment empowered by digital-intelligent technologies, process assessment becomes an important component of student learning evaluation. Through online learning platforms, teachers can comprehensively record students' learning behavior data during pre-class, in-class, and post-class phases, including multi-dimensional information such as learning duration, interaction frequency, and homework completion quality. This data not only reflects students' learning attitudes and participation but also provides teachers with a scientific basis for teaching decisions [4].

For example, in the teaching process, the "Qinglu Intelligent Teaching System" is used in the "Testing Technology" course to dynamically monitor students' theoretical learning, practical operations, and classroom participation. The "Seminar Camera" is used to monitor students' classroom behaviors (such as the rate of students looking up, classroom participation, group discussion participation, enthusiasm for answering questions, etc.). And intelligent scoring is carried out for each link of the learning process according to the "Qinglu Classroom Management Software", providing basic data support for the quantitative evaluation of the learning process.

The content of the dynamic monitoring of the entire learning process is shown in Figure 3.

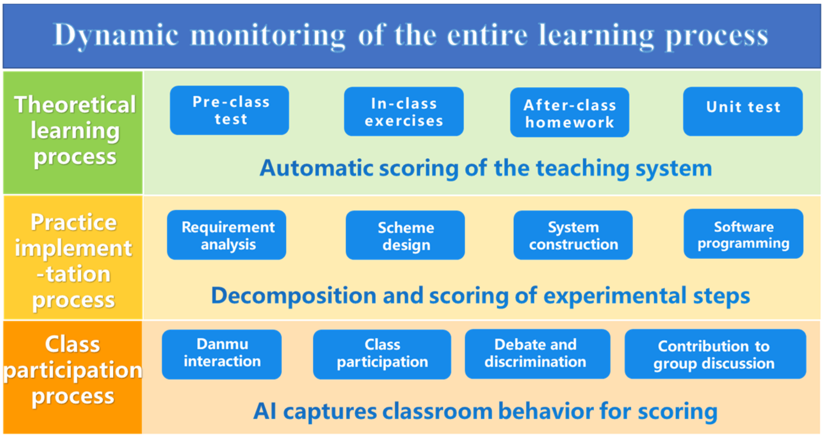

Fig. 3. Dynamic Monitoring of the Entire Learning Process

Dynamically tracking students' learning trajectories emphasizes continuous attention to students' usual performance, avoiding the limitation of "one exam determines all" in traditional assessment models. This data-driven assessment method not only improves the accuracy of evaluation but also provides students with more opportunities to demonstrate their abilities.

4.2 Quantitative Evaluation of Competencies and Qualities

Constructing a multi-subject evaluation system is one of the important manifestations of digital-intelligent technology empowering teaching evaluation. In this system, teacher evaluation, student self-assessment, and peer assessment together constitute the main body of evaluation, achieving diversification of evaluation perspectives and comprehensiveness of evaluation results. To evaluate learning outcomes more scientifically, comprehensively, and specifically, the Testing Technology course designs various process assessment projects such as mind maps, thematic reports, and system design. It adopts a "self-assessment + peer assessment + teacher assessment" model to conduct comprehensive quantitative evaluation of each student's competencies and qualities, forming a three-dimensional evaluation system of "Knowledge - Ability - Literacy," as shown in Figure 4.

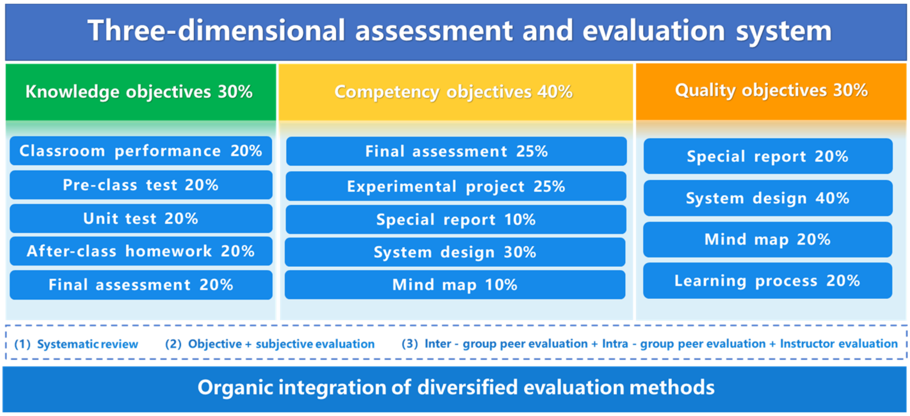

Fig. 4. Three-Dimensional Objective Evaluation System

By integrating multiple evaluation results, students can receive more comprehensive and multi-faceted learning feedback, thereby better guiding their subsequent learning [6][13]. Furthermore, the entire learning process of students is evaluated more comprehensively and scientifically.

5 Reform Effectiveness

Under the student-development-centered philosophy, the digital-intelligent empowered teaching model is developing rapidly. Based

5.1 The Comprehensive Quality of Students has been Significantly Improved

After analyzing the test papers, it is found that while the proportion of subjective questions that examine students' abilities has increased significantly to 80%, the score rate has increased by 20.5%, which fully indicates that the students' abilities to analyze and solve problems have been significantly enhanced.

In the past three years, students have published four relevant academic papers. Among the 78 students in recent sessions, a total of 40 person - times have participated in and won awards in various competitions related to the courses at or above the provincial - ministerial level, accounting for 51.3% of the total number of students.

These achievements strongly prove the positive role of the curriculum reform in cultivating students' abilities.

5.2 The Level of the Teaching Staff has been Significantly Improved

In the past five years, the teaching team has won 2 first prizes and 1 second prize in the school - level teaching achievement awards, 2 first prizes in the school - level excellent educational research, 1 second prize in the provincial teaching competition, and 3 second prizes in the school - level teaching competition. They have carried out 6 educational studies and published more than 10 teaching - related papers.These achievements prove that the innovative teaching reform has significantly improved the teaching capacity.

6 Summary

Under the student-development-centered philosophy, the digital-intelligent empowered teaching model is developing rapidly. Based on the teaching practice of the Testing Technology course, this paper explores digital-intelligent empowerment in three aspects: the entire teaching process, resource system construction, and assessment evaluation. Through teaching practice, it has been found that in the pre-class, in-class, and post-class teaching phases, the application of smart teaching platforms enables precise and personalized learning guidance, greatly improving learning efficiency and achieving individualized instruction, making teaching more precise and scientific. By creating a multi-dimensional and multi-faceted "Virtual-Physical-Intelligent" resource system, personalized exploration based on individual student abilities can be satisfied, significantly enhancing learning initiative. Relying on the data recording and entire learning process monitoring of the smart teaching platform, combined with the established quantitative model for competencies and qualities, quantitative evaluation of abstract abilities and qualities can be achieved, thereby evaluating student learning outcomes more scientifically and effectively.

Adopting these advanced technologies also poses some challenges. Firstly, it requires teachers to be proficient in operating the intelligent teaching system before teaching and to prepare a large amount of basic teaching work. Secondly, in the actual teaching operation process of the resource system combining virtual and real elements, a more detailed implementation plan design is needed; otherwise, it is difficult to guarantee the teaching effect. Finally, the intelligent evaluation model of teaching effect needs to be continuously revised according to the actual teaching situation to ensure the scientificity and correctness of the model.

The teaching reform practice of the Testing Technology course based on digitalization and intelligentization provides a practical paradigm for related courses and offers theoretical and practical references for cultivating testing technology talents that meet the demands of the new era.

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