

# The innovative construction of modern experimental teaching system and the exploration of practical path

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**Abstract:** This paper systematically expounds the theoretical system and practical path of modern experimental teaching, and focuses on the innovative application of complex system simulation and data analysis technology in experimental teaching. Through the construction of a new trinity of experimental teaching mode of "technology, ideology and politics-scientific research", the transformation from traditional skill training to comprehensive innovation ability training is realized. This paper discusses the specific practice in the construction of professional knowledge system, teaching method innovation, scientific research transformation and application, and shows the unique value of experimental teaching in cultivating students' innovative thinking and practical ability. It provides a new paradigm for the professional development of experimental teaching team, and provides theoretical reference and practical guidance for the reform of higher education experimental teaching in the new era.

**Key words:** experimental teaching; Complex system simulation; Data analysis; Teaching reform

## 1. The theoretical system of experimental technology based on complex system simulation and data analysis is constructed

The fundamental breakthrough of modern experimental teaching lies in the establishment of the theoretical foundation with complex system modeling and data analysis as the core. The construction of this theoretical system has made the experimental teaching leap from the traditional verification operation to the research methodology of exploring complex practical problems. Under the background of rapid development of digital economy, the theoretical basis of experimental teaching is undergoing profound changes. The traditional experimental teaching theory is mainly based on the positivist methodology, emphasizing the verification and repetition of known theories. The modern experimental teaching theory is more integrated with the ideas of constructivism, complex system theory and socio-technical system theory, and emphasizes the active construction of knowledge and exploration of unknown fields in real or simulation environment.

In terms of the in-depth expansion of professional knowledge system, experimental teaching staff need to break through the traditional discipline boundaries and establish an interdisciplinary knowledge network. Based on economics and management, it deeply integrates the research methods of system dynamics, energy system engineering, social psychology and other disciplines to form a unique experimental methodology system. The interdisciplinary knowledge structure, make the experiment teaching can cope with "carbon neutral", "hydrogen economy", "garbage power generation" macro thesis experiment requirements, such as the abstract strategic issues into modeling, simulation, test subjects. In power system simulation experiments, for example, not only need to consider the technical parameters and economic indicators, also need to include social acceptance and environmental impact of multi-dimensional evaluation factors, which requires the experiment teaching staff with interdisciplinary knowledge integration capability.

In terms of discipline frontier tracking, experimental teaching must maintain a keen perception of the development of emerging technologies. According to the latest research in 2024, the rapid development of energy system simulation modeling, sociotechnical system acceptance and other fields provides new technical tools and methodological support for experimental teaching. In particular, the mature application of digital twin technology makes it possible to build an experimental environment in the virtual space that completely corresponds to the physical world. By continuously paying attention to the international frontier research progress, experimental teaching staff can transform the latest scientific research achievements into teaching resources and build a forward-looking experimental

teaching system. For example, the multi-modal data acquisition and analysis technology is introduced into the experimental process evaluation, which realizes the transformation from empirical judgment to data-driven. This transformation not only improves the accuracy of experimental evaluation, but also provides data support for personalized experimental teaching.

The theoretical innovation of experimental teaching is also reflected in the breakthrough of methodology. Traditional experimental teaching is often limited to the cultivation of a single skill, while modern experimental teaching emphasizes the training of systematic thinking. Through the construction of digital twin system and theoretical model, students can simulate the operation law of complex system in virtual environment, and cultivate the ability to solve practical problems. This kind of teaching method not only improved the students' professional skills, more important is to develop the system thinking and innovation consciousness. Intelligent manufacturing experiment teaching as an example, the students can through digital twin system, in the virtual environment design, simulation and optimization of the whole production system, the full range of training can help students form the systematic thinking and innovation ability<sup>[1-4]</sup>.

## **2. Promote the "technology-ideological and political-scientific research" trinity teaching reform practice**

The innovation and development of modern experimental teaching is reflected in the deep integration of technical means, ideological and political education and scientific research transformation. This integration not only improved the experimental teaching effect, more to redefine the value of the experimental teaching. According to the spirit of "Research Work on Carrying out Experimental Teaching and Teaching Laboratory Construction of the Department of Higher Education of the Ministry of Education", experimental teaching should become an important carrier to cultivate students' innovative spirit and practical ability, which requires us to carry out systematic innovation in teaching concept, content and method.

In terms of teaching content and method innovation, experimental teaching needs to break through the limitations of traditional mode. Taking the course "Comprehensive Practical Training of Business Plan" as an example, by building a virtual entrepreneurship platform integrating market analysis, financial prediction and risk assessment, the course has realized the transformation from "paper talk" to immersive experience. This innovation not only improve the students' interest in learning, more important is to cultivate the decision-making ability in real environment. The application of virtual simulation technology, so that students in a safe environment to experience the whole process of entrepreneurship, through trial and error learning to master professional knowledge. The practical data of 2024 show that the students who adopted virtual simulation experiment teaching improved 35% in the ability to solve complex problems compared with the traditional teaching group, which fully proves the effectiveness of modern experimental teaching methods.

Course education of organic is the important dimensions of the experimental teaching reform. Through carefully designed experimental cases, students are guided to think about deep-seated problems such as social responsibility and business ethics. For example, when analyzing agricultural entrepreneurship projects, national policies such as the "rural revitalization strategy" are naturally integrated into the experimental content, so that students can establish correct values while mastering professional skills. This "salt dissolved in water" type of ideological and political education realizes the organic unity of knowledge transmission and value guidance. According to a survey in 2024, 87% of students believe that through the ideological and political elements of the curriculum in experimental teaching, they have enhanced their understanding of professional ethics and social responsibility, which indicates that experimental teaching has unique advantages in value guidance.

The systematic promotion of experimental teaching reform needs to innovate the teaching organization model. The construction of virtual teaching and research section breaks the boundary between college and school, and promotes the sharing of teaching resources and the exchange of teaching methods. By regularly organizing cross-school teaching seminars and collective lesson preparation activities, experimental teaching staff can timely share advanced ideas and methods, and promote the common progress of the whole teaching team. This open teaching organization mode provides an institutional guarantee for the continuous innovation of experimental teaching. According to statistics, by 2024, more than 500 virtual teaching and research rooms have been built in China, which effectively promotes the sharing of experimental teaching resources and the improvement of teaching quality.

The evaluation system of experimental teaching also needs to be reformed accordingly. The traditional outcome evaluation is changing to process evaluation, and the accurate evaluation of students' learning process is realized through multimodal data collection and analysis. This data-driven evaluation method can not only objectively reflect students' learning effect, but also provide scientific basis for teaching improvement. The latest research in 2025 shows that the experimental teaching evaluation system based on learning analysis technology can capture the characteristics of students' learning behavior in real time and provide personalized teaching improvement suggestions for teachers, which marks that the experimental teaching evaluation has entered the era of intelligence<sup>[5]</sup>.

### **3. Innovate the experimental technology path of "building model laboratory and solving real problems"**

The core value of modern experimental teaching lies in its ability to solve practical problems. Through the construction of model laboratory, the macroscopic social, economic and energy problems are transformed into operational experimental processes, and the leap from theory to practice is realized. This innovation not only expands the application scope of experimental teaching, but more importantly, cultivates students' ability to solve complex practical problems.

The deep integration of experimental teaching and scientific research is the key to improve the quality of teaching. Transforming cutting-edge scientific research achievements into experimental teaching content not only enriches teaching resources, but also cultivates students' scientific research literacy. For example, the multimodal data analysis model is applied to the virtual entrepreneurship platform to achieve accurate assessment of students' decision-making process. This mechanism of scientific research feeding back teaching ensures the cutting-edge and scientific content of experimental teaching. According to the latest statistics, the proportion of students participating in scientific research projects has increased by 42% in the experimental courses using the teaching mode of scientific research feedback, which indicates that experimental teaching is playing an increasingly important role in cultivating students' scientific research ability.

Technology innovation of experimental teaching in the integrated application of interdisciplinary approach. Through the integration of data analysis, system simulation, social investigation and other methods, a comprehensive experimental research framework is constructed. This interdisciplinary research method enables students to understand complex problems from multiple dimensions and cultivate their systems thinking ability. For example, in the research of energy economic system, multiple factors such as technical feasibility, economic rationality and social acceptance are considered at the same time, which enables students to form a comprehensive problem perspective. The 2024 evaluation data showed that students who participated in the interdisciplinary experimental program scored 28% higher in systems thinking ability than those in the traditional experimental group, which proved the effectiveness of the interdisciplinary experimental teaching method.

The value of experimental teaching is also reflected in its contribution to social development. By applying experimental teaching methods to solve practical problems, experimental teaching staff can directly serve the needs of social development. For example, by building a regional energy system model, it can provide technical support for local governments to make decisions; Social acceptance survey is carried out to provide reference for the promotion of new technologies. This model, which combines experimental teaching with social service, expands the social function of experimental teaching<sup>[6]</sup>.

### **4. The value manifestation and development prospect of experimental teaching innovation**

The value of experimental teaching innovation is not only reflected in the improvement of teaching effect, but also in its role in promoting the reform of education system. Through systematic innovative practice, experimental teaching is redefining its position and role in higher education. According to the 2025 education development plan, experimental teaching will become the core link of innovative talent training, which requires us to further deepen the reform of experimental teaching and give full play to its unique value in talent training.

The professional development path of experimental teaching staff needs to be re-planned. Traditionally, experimental teaching staff are often positioned in the role of technical support, but the modern experimental teaching system requires them to become the leader of teaching innovation. This role transformation needs the corresponding system guarantee and professional development support.

Through the establishment of scientific evaluation system and career development channel, the innovation vitality of experimental teaching staff should be stimulated to promote the continuous improvement of experimental teaching quality. In 2024, according to a survey of the role of experiment teaching staff are from the traditional "experimental support personnel" to "teaching innovation leader", it reflects the advancement of the experimental teaching in higher education.

The docking of experimental teaching and industrial demand is the key direction of future development. By strengthening the cooperation with enterprises, the real production practice problems are introduced into the experimental teaching, so as to cultivate students' engineering practice ability. At the same time, through the co-construction of laboratories, co-development of courses and other forms, to promote the deep integration of industry, university and research, improve the practicality and foresight of experimental teaching. In 2025, according to the cooperation with the industry to carry out the project of experiment teaching, the students' employment competitive power increased by 35%, which fully proved that the fusion production and education in the importance of experimental teaching<sup>[7]</sup>.

The value of experimental teaching is ultimately reflected in its contribution to the cultivation of innovative talents. Through the experiment of system training, the students not only master the professional knowledge and skills, more important is to cultivate the innovative thinking and practical ability. The improvement of such comprehensive quality will enable students to have stronger competitiveness in their future career and better serve the national innovation-driven development strategy. Tracking survey in 2025, trained in modern experiment teaching of the students, in terms of innovative entrepreneurial performance is superior to the traditional teaching mode to cultivate students, it proves that the experimental teaching in the key role of cultivating creative personnel.

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