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Exploration of Experimental Teaching Reform of Computer Major under the Guidance of Discipline Competition

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Abstract

Computer experimental teaching has become an important factor influencing the cultivation of high-quality innovative talents. In order to transform the current backward experimental teaching concept, narrow objectives, lack of recognition of the importance of experimental teaching, change the unreasonable planning of laboratory construction and use, resulting in resource waste, reform the problem of lack of innovation in experimental teaching content and methods, improve the experimental teaching system and level, and transform the backward experimental teacher team construction and overall scientific research and teaching ability, this paper links the objectives of subject contests and experimental teaching objectives, and through the leading role of subject contests, innovates from the aspects of improving the importance of computer experimental teaching in subject contests, utilizing laboratory resources, transforming competition achievements into experimental courses, and reforming the experimental teacher team. Through mutual promotion, it drives the reform of computer professional experimental teaching, improves the level of subject contests and experimental teaching, and achieves the goal of cultivating high-quality innovative talents.

Keywords

Discipline competition, computer major, experimental teaching, teaching reform.

1. Introduction

With the help of 5G network, the computer industry has achieved unprecedented development. In 2016, the cloud computing industry made rapid progress, while from 2019 to 2021, computer system integration maintained a steady growth trend. In 2023, artificial intelligence development has been thriving, and remarkable progress has been made in fields such as computer medicine and intelligent automobile. The rapid development of the computer industry has also led to a pressing need for high-quality innovative talents. As the main source of innovative talent training, universities bear an important responsibility, and experimental teaching plays an important role in innovative talent training. As pointed out by Professor Yang Zhenning, a Nobel Laureate in Physics, 95% of science is experiment and observation[1]. Therefore, universities should change their educational philosophy, change the phenomenon of experimental teaching relying on theoretical teaching, change its subordinate status, and form a teaching model that emphasizes equal importance between experimental teaching and theoretical teaching.

To keep up with the rapid development of the computer industry, we have introduced subject contests that can closely follow the current trends and hotspots of the discipline as a powerful helper for experimental teaching at this stage. This article takes subject contests as a guide, deeply integrates experimental teaching and subject contests, promotes the development of

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experimental teaching, and cultivates high-quality innovative talents that meet the requirements of the new era.

2. Current Status of Experimental Teaching in Colleges and Universities

2.1. Laggard Experimental Teaching Concepts and Narrow Objectives, Lack of Recognition of the Importance of Experimental Teaching

Affected by traditional concepts, most universities in China believe that experimental teaching is only a supplement to theoretical teaching and an auxiliary teaching method. They do not recognize the importance of experimental teaching for the cultivation of innovative talents [2]. The objectives of experimental teaching are simply to verify theoretical knowledge and serve theoretical teaching, and their status in teaching is also far apart. Due to the lagging experimental teaching concept, teaching content is old and lacks challenge, and students complete experiments step by step. Over time, students lose interest in experimental teaching. As a result, it has formed a situation where Chinese college graduates have poor hands-on ability and lack of innovative thinking [3].

2.2. The Unreasonable Planning of Laboratory Construction Leads to Resource Wastage

Laboratories, as the primary places for cultivating students' practical abilities and innovative thinking, require comprehensive and coordinated planning before construction. It is essential to have phased development plans and long-term goals to ensure the orderly progress of experimental teaching. University laboratories can be divided into two main categories: basic laboratories and specialized laboratories [4]. Basic laboratories, with a higher quantity and lower configuration, are usually managed by the university's academic affairs office or laboratory management department. They handle almost all public basic and specialized laboratory courses, and each laboratory's schedule is almost fully occupied, resulting in a high utilization rate. On the other hand, specialized laboratories, typically managed by individual colleges, have fewer rooms but more equipment, making their management and maintenance more complex. Due to various management and maintenance reasons, these laboratories are rarely open to the public, leading to the underutilization and wastage of equipment and resources.

Currently, the funding for university laboratory construction comes from various sources, but the primary source is government financial allocation. After the funds are allocated to the university, it is up to the university to distribute them to different colleges. Each college decides the type of laboratory to be constructed and the types and quantities of equipment to be purchased. This construction approach often results in redundant basic infrastructure and a "small but comprehensive" situation. For example, if the Computer Science department offers a big data course and purchases a big data training platform, the Statistics department may also offer a similar course and buy the same big data training platform. Unreasonable planning leads to multiple colleges redundantly purchasing similar instruments, equipment, and software platforms, preventing the proper allocation of limited laboratory construction resources.

2.3. Experimental teaching content and methods lack innovation

In some universities, laboratory instructors have not upgraded experimental teaching materials for many years, leading to a lack of innovation in the content and methods of experimental teaching. While teachers may find it convenient to stick to the familiar, classic experiments in outdated materials, there is a gradual emergence of issues such as a lack of innovative and comprehensive experiments, with a prevalence of confirmatory experiments. This has even led to a phenomenon where experimental teaching lags behind theoretical teaching, creating a "hanging upside-down" scenario [5]. Over the years, each session of the

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laboratory course involves repeating the previous year's chalkboard notes, with teachers systematically explaining experimental theory, methods, steps, and content. Students, in an effort to secure high grades, replicate the experiment results within the provided procedure, producing a satisfactory experiment report. Unfortunately, this process lacks critical thinking, innovation, and, in extreme cases, students resort to copying experiment reports left behind by senior students [6]. Such a lack of active learning and critical thinking during the experimental process goes against the original intent of modern education and fails to cultivate students with an innovative spirit.

2.4. Experimental Teaching Content and Methods Lack Innovation

To this day, many experimental courses are still attached to theoretical courses, with experimental teaching being just one form of instruction. The structure of experimental course systems is often designed to "validate newly taught theoretical knowledge" and consequently mirrors the structure of theoretical course systems, lacking an independent framework [7]. Since experimental course systems are closely linked to theoretical ones, the integration of theory and practice is limited, and individual experiments are often isolated entities. Each experimental course consists of several independent experiments without forming an organic course. Therefore, the division of labor and connection between different experimental courses are challenging to establish, resembling a scattered collection without clear objectives.

The main purpose of offering experimental courses is to enhance students' observational, practical, expressive, thinking, and innovative abilities [8]. Currently, most students know how to perform experiments, but only a small percentage actively reflects on why they are doing it and how they can improve. This indicates that there is still room for improvement in the level of experimental teaching, and it has not reached the methodological heights necessary to guide students in independent problem-solving.

2.5. The Construction of the Experimental Teaching Staff lags behind, with an Overall Low Level of Scientific Research and Teaching Capabilities

In most contemporary universities, positions for technical personnel are generally classified as teaching support roles, remaining subordinate [9]. Teacher training plans developed by schools are typically aimed at full-time teachers, and colleges have not thoroughly considered training programs, title evaluations, and team building for the experimental teaching staff. Due to the lack of attention to experimental teachers, their self-esteem is compromised, affecting their enthusiasm for work and leading to instability in the workforce.

Due to historical reasons in the development of universities, many experimental teachers have lower academic qualifications and lower professional titles. As universities rapidly expand, the workload for both research and experimental teaching increases. These teachers find it challenging to adapt to the fast-paced work rhythm, often only coping with routine experimental teaching [10]. Simultaneously, these teachers face retirement, resulting in a gap in the experimental teaching staff that urgently requires replenishment. However, due to the lack of emphasis on experimental positions and the unfavorable career prospects, many high-performing teachers with strong research capabilities are unwilling to take on experimental teaching positions. This further contributes to the problem of a new generation of experimental teachers with overall low scientific research capabilities and teaching proficiency.

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3. Goals and Connections between Computer Experimental Teaching and Discipline Competitions

3.1. Objectives of computer experimental teaching

The objective of computer experimental teaching is to enable students to deeply study and master the content through practical experiments. This aims to train students' practical skills, enhance their hands-on abilities, and ultimately improve their problem-solving and innovation capabilities [11]. Following educational principles, higher education can classify experiments into confirmatory experiments, comprehensive design experiments, and innovative research experiments based on the experiment's object [12]. The first two types are usually completed by lower-grade students, involving the use and debugging of common experimental equipment, verification of basic theorems and principles, application of comprehensive knowledge, and implementation of experiments designed by students themselves. Innovative research experiments are typically undertaken by higher-grade and graduate students. Organized in research teams under the guidance of experimental teachers, these experiments involve valuable and innovative research, honing students' independent research capabilities and instilling scientific research methods.

3.2. Objectives of discipline competitions

Discipline competitions are integral to higher education reform, emphasizing practical education. They not only serve as a crucial platform for promoting students' practical and innovative capabilities but also function as a significant means to evaluate the quality of talent cultivation in higher education [13]. These competitions, organized by event organizers, set competition directions and topics. Participants complete the competition within a specified time frame, with evaluations conducted by expert panels or through public selection. The goal is to apply knowledge learned in experimental and open experimental learning to solve real-world problems, enhancing students' abilities to analyze and solve problems [14-15].

3.3. Connections between the two

While the objectives of computer experimental teaching and discipline competitions differ, sharing three commonalities makes it possible to integrate them effectively. Both aim to cultivate the ability to apply learned knowledge to solve practical problems, possess distinct professional characteristics, and target specific types of professions. By recognizing these three shared elements, computer experimental teaching and discipline competitions can be seamlessly combined. A diagram illustrating their relationship is shown in Figure 1.

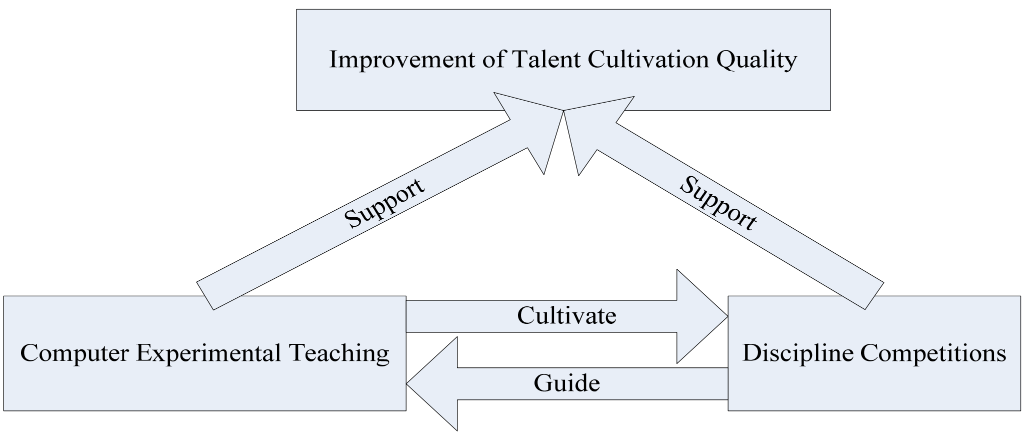

Figure 1. Relationship Chart between Computer Experimental Teaching and Subject Competition

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Effective computer experimental teaching can establish a solid foundation for discipline competitions, producing outstanding students with strong hands-on and practical abilities. Discipline competitions, in turn, can provide feedback on the quality of computer experimental teaching, guiding reforms in this area. By integrating computer experimental teaching with discipline competitions, the overall quality of talent cultivation can be improved. Separating them might result in mechanical confirmatory experimental teaching, making it challenging to inspire students to engage in innovative research experiments, with discipline competitions becoming mere last-minute efforts without sustainable sources of innovation.

4. Reforming Experimental Teaching Guided by Discipline Competitions

4.1. Recognizing the Importance of Computer Experimental Teaching in Discipline Competitions

As discipline competitions gain increasing attention in higher education, the levels and quantity of awards have become vital indicators of talent cultivation quality. Guiding students to participate in discipline competitions and winning awards has become an important criterion for the promotion of university teachers. Students, through participation and success in discipline competitions, improve their practical and innovative abilities, gaining advantages for future employment and further education. In this context, excelling in discipline competitions has become a win-win situation for universities, teachers, and students. To bridge the gap between computer experimental teaching and discipline competitions, it is essential to elevate awareness among teachers and students regarding the importance of computer experimental teaching. By doing so, practical teachers can be motivated to improve their teaching methods, increase the proportion of comprehensive design experiments, and enhance their enthusiasm. Simultaneously, this awareness can draw attention from academic leaders, leading to increased investment in computer laboratories, upgrading both hardware and software. This not only provides support for discipline competitions but also forms the basis for offering comprehensive design experiments in laboratories. Under the guidance of discipline competitions, a significant effort is made to emphasize the importance of laboratory investment by the school, elevate the overall teaching level of teachers, and create a new situation where students change their attitudes toward learning experimental courses.

4.2. Optimizing the Utilization of Laboratory Resources

Computer science is the systematic study of the theoretical foundations of information and computation, including their practical applications in computer systems. Computer professional laboratories serve as practical bases for the implementation and application of this knowledge. To genuinely cultivate innovative talents and meet the needs of discipline competitions, a planned and goal-oriented opening of laboratory resources is essential. By utilizing open laboratories, the needs for further student and teacher learning can be met, addressing the current inadequacy of competition venues. Open laboratory access can be categorized into three modes to meet different needs: basic laboratories open to all students, professional laboratories open to students in specific majors, and unused laboratories open to competition participants. The third mode includes small meeting rooms and laboratories open 24 hours, facilitating communication among students and teachers. This approach addresses the phenomenon of limited learning time for traditional experimental teaching, teacher pacing pressures, and uncompleted student experiments. Students completing comprehensive innovative experiments lay a solid foundation for subsequent competition projects. Guidance teachers also have ample time and space to guide students on how to collect literature, write project proposals, and prepare defense materials. The school's Experimental Training Center, equipped with 18 laboratories and 3 meeting rooms, valued at over 20 million yuan, has fully implemented the opening of professional laboratories during non-teaching hours. To support

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discipline competitions, the center has established a competition innovation laboratory, providing stable support for teams participating in competitions such as the "Internet+" innovation and entrepreneurship team, "Challenge Cup" competition team, "Blue Bridge Cup" competition team, "China College Student Computer Design Competition" team, and "National College Student Intelligent Car Competition" team. Relevant equipment and meeting rooms are available for reservation by guidance teachers, ensuring efficient use of laboratory resources.

4.3. Transforming Competition Achievements into Experimental Courses

Organizing and summarizing competition achievements to create relevant experimental courses is essential. Under the organization of college departments, competition teams can use their years of competition experience to extract and refine cutting-edge research and leading technology into innovative experimental projects. These projects can replace confirmatory experiments with comprehensive innovative experiments, update outdated experimental content with cutting-edge content, and replace old technology methods with advanced ones. The transformed experimental courses closely follow the forefront of the times, with a significant increase in the proportion of comprehensive design experiments and innovative research experiments in course content. For example, the guidance teacher Mr. Wu Ling, who won eight first prizes, ten second prizes, and four third prizes in the Big Data and Artificial Intelligence Application Competition in Anhui Province, and two first prizes, six second prizes, and one third prize in the Innovation Design Competition of College Students' Networks and Distributed Systems in Anhui Province. Through years of accumulation, practice, and optimization, the competition content has been embedded into the experimental courses of "Primary Big Data Technology and Applications," "Advanced Big Data Technology and Applications," and "Computer Networks and Wireless Communications."

Compiling competition cases into competition video shorts is another approach. Successful competition cases integrate multiple courses into a cohesive process, summarizing the forefront of research and advanced technological directions. Through short videos, guidance teachers can record and explain the information of competition cases. Students can continue their research on the basis of successful cases or gain inspiration from them. This method provides a solid foundation for future participation in discipline competitions. For instance, the guidance teacher team for the National College Student Intelligent Car Competition recorded short video courses for the "Basic Four-Wheel Group," "Omni-Directional Movement Group," "Double-Car Relay Group," "Energy-Saving Beacon Group," and "Battery Off-Road Group." These videos serve as a gradual inheritance of competition achievements, promoting the reform of experimental courses.

During the process of participating in discipline competitions, collaboration between teachers and students not only stimulates students' subjective initiative in learning but also sparks the thinking of guidance teachers. This collaboration enriches the knowledge structure, improves teaching concepts, updates teaching methods, and significantly enhances both teaching and research aspects. Over the five years of using discipline competitions to guide computer experimental teaching reforms, guidance teachers have led 23 teaching and research projects related to discipline competitions and experimental teaching, publishing 51 related research papers.

4.4. Building the Experimental Teaching Faculty

Establishing a high-level experimental teaching faculty plays a crucial role in experimental teaching, discipline competitions, teaching and research, and cultivating students' practical and innovative capabilities. To achieve this: Separate theoretical and experimental teaching, allowing experimental teachers to independently handle experimental courses. Consider both theoretical and experimental teaching as equally important components of education, forming an organic whole. Elevate the overall teaching level of experimental teachers to enhance the quality of experimental teaching. This can be achieved by fully involving experimental teachers in discipline competitions, where they can learn cutting-edge scientific and technological advances, innovative teaching methods, and solid theoretical foundations. Implement a comprehensive training system, conduct regular continuing education and qualification examinations, and strengthen the capabilities of experimental teachers in professional knowledge and skills. Stabilize the faculty of experimental teachers by incorporating the positions of frontline experimental teachers into the teacher quota. Significantly improve the treatment of experimental teachers, encouraging those with strong research capabilities, effective teaching, and frontline work in discipline competitions to join the ranks of experimental teachers. Recognize and publicize the contributions of experimental teachers to laboratory construction, discipline competitions, innovation and entrepreneurship, and teaching reforms through official networks and self-media.

5. Conclusion

This article analyzes the crucial role of computer experimental teaching in enhancing students' innovative capabilities, cultivating high-quality innovative talents, and the current state of computer experimental teaching. By associating the goals of discipline competitions with computer experimental teaching objectives, the successful experiences and rich achievements of discipline competitions are applied to computer experimental teaching. This promotes the reform of computer professional experimental teaching, improves the experimental course system, updates experimental teaching content, and enhances both discipline competition and experimental teaching levels. This mutual promotion aims to achieve the goal of cultivating high-quality innovative talents. Through practical verification, positive results have been achieved, providing active references for experimental teaching reforms in local colleges.

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