

Experimental Course Construction at Local Application-Oriented Universities: Reality and Development Strategies

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Abstract: This article examines the existing problems in experimental course construction at local application-oriented universities, considering aspects of teaching staff construction, experimental course content construction, experimental equipment configuration, and experimental teaching management. Combined with the construction process of the mechanical experiment courses at Suzhou University, which is local to us, we put forward the countermeasures for the construction of experimental courses: strengthening the recruitment of experimental teachers to build a “dual-talented” teaching staff, founding top-quality experimental courses combined with the “local and application-oriented” school management orientation, raising funds from various channels to increase the investment in laboratory construction, and improving the evaluation mechanisms for experimental courses.

1. Introduction

With the transformation and upgrading of China's economic development, the contradiction between the supply of applied talent and social demand is constantly changing. Under the guidance of the CPC Central Committee and the State Council, some colleges and universities are transforming into application-oriented universities^[1-3]. To adapt to the new normal of economic development, Suzhou University was transformed and approved as the construction unit of Anhui Provincial Local Application-oriented High-level University in 2015. With the transformation of colleges and universities, the orientation and personnel training objectives of application-oriented universities are also changing.

The curriculum is the basis of talent training and teaching in colleges and universities, and its influence on teaching quality is highly valued^[4]. Talent cultivation in application-oriented universities is different from that in traditional academic universities. It pays more attention to professional skill and practical ability training, so carrying out curriculum reform and construction is imperative^[5-7]. As an indispensable part of the college curriculum, the experimental course is the key to cultivating students' practical abilities. To a certain extent, the construction of an experimental course determines the quality of talent training in application-oriented universities^[8-11]. However, Suzhou University, like other newly built universities of this type, faces some practical problems, such as relatively backward teaching infrastructure, weak improvement of the teaching staff's quality due to geographical restrictions, and imperfect management systems.

The mechanical design, manufacturing, and automation major at Suzhou University began to recruit students in 2011. Creating a unique school management strategy and cultivating high-quality

applied talent is crucial for intensifying competitiveness and sustainable development. Based on the problems that exist in cultivating the ability of the experimental course of the mechanical specialty at Suzhou University, this paper explains the strategies that local application-oriented universities should adopt when cultivating application-oriented talent.

2. The Deficiency of Experimental Course Construction

2.1. The Construction of Teaching Staff

In 2018, the Ministry of Education formulated and issued the National Standard for Mechanical Teaching Quality which requires that the ratio of students to teachers be at or below 24:1 in order to make sure that the number and structure of full-time mechanical teachers meet teaching needs^[12]. However, the number and structure of full-time teachers in many local colleges and universities do not meet the National Standard's requirements. There is a specific lack of high-level academic leaders, "dual-talented" teachers, and high-level full-time experimental teachers. At present, many experimental courses in colleges and universities are taught by teachers who also teach theoretical courses. These courses have the advantage of effectively combining theoretical and experimental courses and strengthening students' understanding of theoretical knowledge. However, this kind of teaching model often leads teachers to focus on the theory portion of the course and ignore the important position of experimental teaching for cultivating students' practical ability. When teaching these experimental courses, teachers do not consider how the experimental course supports the students' graduation requirements, which leads to a failure to fully realize the course's teaching objectives. Many teachers enter their teaching posts directly after their own college or university graduation, and their practical engineering abilities are relatively weak. Due to the restrictions of treatment and promotion of professional titles, there are few full-time experimental teachers in colleges and universities. There are only two full-time experimental teachers in mechanical specialties at our university, and there are no senior experimental teachers. The cultivation of practical mechanical abilities at universities like ours cannot be done without the guidance of high-level experimental teachers. In recent years, our school has continuously strengthened the introduction of talent with high-level mechanical engineering practice skills. However, because the school is in a fourth-tier city, local high-level talent is scarce and it is difficult to introduce outside talent due to limited salaries, which leads to a shortage of the teachers required to construct experimental courses, creating an unreasonable structure.

2.2. The Content Construction of Experimental Courses

The overall curriculum system framework of mechanical design and automation specialty in our university is divided into three levels: general ability training, professional ability training, and development ability training. It is composed of seven modules: the general course, basic subject course, professional course, centralized experiment, professional development course, innovation and entrepreneurship development course, and social responsibility education course, as shown in Figure 1.

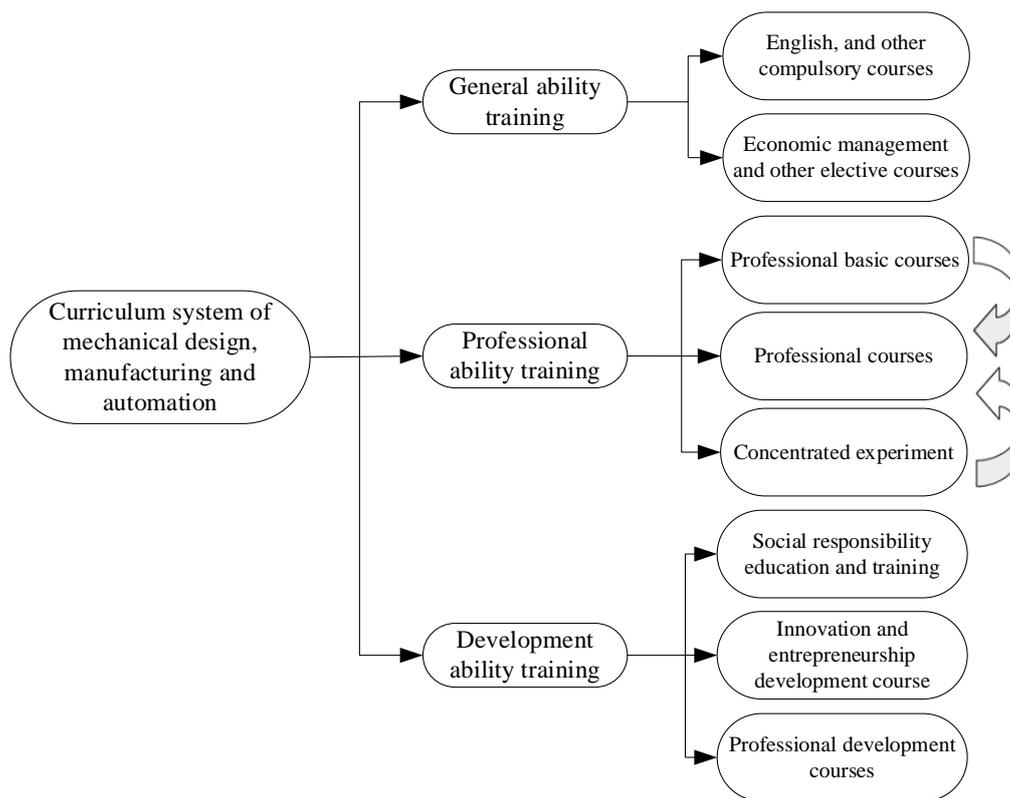


Figure 1 Basic framework of curriculum system of mechanical specialty.

Although the proportion of practical links (including the experimental course) credits in the total credits meets the basic requirements of the Anhui mechanical and instrument undergraduate professional evaluation, it fails to highlight the orientation of local application-oriented universities and lacks its own characteristics. When creating the training plan, we only pay attention to the construction of the curriculum system; we neglect the construction of the specific curriculum content, which leads to the repetition of different experimental curriculum contents.

Due to restrictions within the city where the university is located, there are many traditional low-end processing enterprises. When first-year students who have majored in mechanics go to the businesses for professional cognitive practice, they are not willing to deeply understand the steps in the production line processing because the production environment is poor, they feel confused about the future of their major, and the experience may fail to achieve the purpose of stimulating their interest in learning through cognitive practice. Some teachers invite enterprise experts to complete the experimental teaching, but the teaching of enterprise experts often turns into enterprise propaganda and training, which cannot guarantee the quality of their teaching. Teachers also fail to promptly update their teaching content to reflect the development of industry technology in experimental teaching. There are many traditional demonstrations and confirmatory experiments that fail to stimulate students' interest in learning. Students' desire for hands-on operation is not strong, and some students remain bystanders during the experiments. The training goal of cultivating students' engineering practice ability through experimental courses has not been realized.

2.3. Experimental Equipment Configuration

The predecessor of the Secondary College of Mechanical Specialty in our university is the Department of Physics, which is an older program than the mechanical major. With the development of the university, the number of subjects and students is increasing. However, due to the lack of

updates to the supporting experimental equipment, much of the equipment is relatively old and cannot meet the teaching needs. The discipline development and curriculum construction of the mechanical specialty are closely related to the national economic development and industrial technology, and the proposal of “new engineering” education reform is in line with the new situation of China's strategic development, the new situation of international competition, and the new requirements of establishing morality and cultivating talent^[13]. The limited sources of funds and the lack of investment in the construction of “new engineering,” compared with the same kind of colleges in economically developed areas, hinders the development and construction of the mechanical discipline.

2.4. Experimental Teaching Management

A good experimental teaching management mechanism guarantees the orderly and effective development of experimental teaching. Experimental teaching management includes daily laboratory management, process management, and quality assessment. Compared with the strict management system of theoretical courses, such as the supervision of lectures, the inspection of teaching materials, and the inspection of final examination materials, the experimental teaching management system is relatively loose. In the daily examination, we only pay attention to the safety and hygiene of the laboratory, and in the final examination, we only pay attention to whether the experimental assessment materials are completed or not; the process and effects of the experimental teaching are barely assessed, if they are assessed at all. The experimental instructor alone evaluates the experimental results at the end of the semester, so the main body of assessment is limited. Moreover, most of the experimental instructors' final evaluations of the experimental results are based on the experimental report results. There is only one type of evaluation method and form, which is insufficient to actively mobilize students who only focus on the completion of the experimental report in the experimental process. The experimental performance evaluation is one-sided and distorted, which leads to a decrease in students' enthusiasm for practice and the exploration of experiments and encourages a lax learning atmosphere.

3. Countermeasures For the Construction and Development of Experimental Courses

3.1. Strengthen the Recruitment of Experimental Teachers and Build a “Dual-talented” Teaching Team

The cultivation of application-oriented talent requires high-quality application-oriented teachers. To build a “dual-talented” teaching team with high comprehensive quality, the university gradually improved its talent introduction mechanism and teacher training plan. In 2019, the implementation measures for talent introduction at Suzhou University were revised to give preferential treatment to the introduced engineering application talent and applicants with doctorates according to different positions. In the past three years, we have introduced nine teachers with doctorates, three with master's degrees, and three with master's degrees plus more than three years of experience in enterprises, one of whom was a full-time experimental teacher. With their participation, the experience of working with enterprises and the enterprises' ability requirements for talent are integrated into the experimental teaching, which promotes the reform of the experiment course content and teaching methods, and is conducive to the cultivation and development of students' practical abilities.

At present, there are many young teachers of mechanical specialties in our university, accounting for 81.3% of the teachers under 35 years old. According to the characteristics of cultivating applied talent in our school and the principle of combining full-time with part-time, in the past five years the

university has arranged for one teacher with a mechanical specialty to study abroad, four to study for postdoctoral degrees in China, four to work part-time in enterprises, and four to take short-term studies. Among them, Dr. Liu Conghu took a part-time job at the Anhui Axle Company Ltd, guiding students to participate in enterprise-related scientific research projects, using enterprise problems as students' graduation design and innovation projects, and cultivating students' engineering practice ability and independent innovation ability.

3.2. Combining with the Orientation of “Local and Application Oriented” School Running, Creating Excellent Experimental Courses

As an important agricultural production and mineral development base in the north of Anhui province, Suzhou has many agricultural and mining machinery production and R&D enterprises that have a great demand for mechanical graduates. Thus, there are certain inherent advantages to the construction and development of mechanical specialties in Suzhou. The school is, therefore, oriented toward specialty construction to cultivate applied engineering and technical talent to build local economic development. Based on the platform of school-enterprise cooperation, the college has gradually established a professional construction committee composed of enterprise experts, technical experts, and professional teachers. According to the survey results of the enterprises' talent ability needs, the university has built experimental courses with students' practical and innovation abilities as the core. The relationship between the enterprises' requirements for the students' quality and practical ability and the different experimental courses' training objectives is established to realize a high degree of fit between the cultivation of students' ability in colleges and universities and the enterprises' demand for talent.

In the experimental courses, the traditional teaching model where teachers are responsible for both theory and the corresponding experimental content is changed. Different experimental teaching centers are established by professional experimental courses that may share some or all of the same content, and where the experimental center is responsible for the construction planning and teaching arrangement of the experimental course content. For example, teachers from different majors set up the PLC experimental teaching center together; mechanical teachers set up the mechanical innovation design teaching center and 3D printing innovation laboratory. The 3D printing innovation laboratory is composed of six teachers, three with doctorates and three with master's degrees. The group's teachers changed the traditional rigid teaching model of a mechanical CAD/CAM course, which focuses on theoretical explanations, and introduced 3D printing technology. Two comprehensive, innovative experiments with 3D printing technology were set up to cultivate students' ability to analyze and solve problems. Through comprehensive innovative experimental project training, several students' work was approved by the Provincial College Students' Innovation and Entrepreneurship Training Project. These students applied for national patents, which stimulated their ability to innovate^[14]. At the same time, the teachers of the research group constantly transformed their personal scientific research projects into experimental teaching projects and innovation competition projects for students. In 2019, the team won one first prize and one second prize in the finals of the National Three-Dimensional Digital Innovation Design Competition. It realized the mutual transformation, mutual promotion, and common development of experimental teaching, innovation competition, and scientific research projects, as shown in Figure 2, and students' practical ability and professionalism have improved.

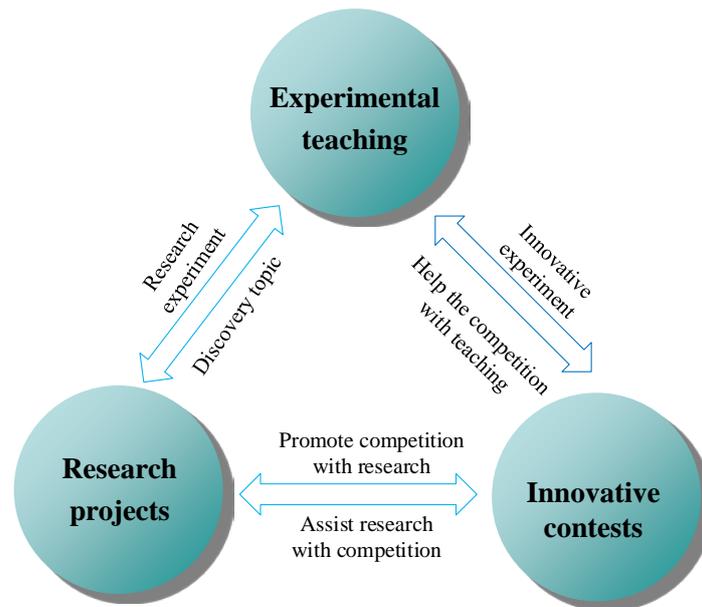


Figure 2 The relationship between experimental teaching, innovation competition, and scientific research.

3.3. Opening Up Fundraising Channels and Increasing Investment in Laboratory Construction

As the foundation of the students' experimental courses and the teachers' scientific research, the construction of laboratory software and hardware is particularly important. Under the leadership of the masters of the college and the person in charge of the mechanical specialty, the mechanical specialty constantly expands channels to strengthen laboratory construction. First, the mechanical specialty leader led us to constantly improve our strength, and we actively declared discipline construction funds. The mechanical specialty of Suzhou University has been successively rated as the key construction specialty at the school level and the implementation specialty of the Provincial Excellent Talent Education Program. The mechanical specialty teaching team has won the honor of the “dual-talented” teaching team of Suzhou University. The 3D printing application innovation center has been approved as a school-level construction platform and has obtained financial support for professional construction. Second, was the introduction of enterprise funds by creating conditions that encouraged teachers to actively undertake enterprise research projects that provided a stable source of funds for professional construction. Finally, with the purpose of serving local enterprises and cultivating students' professional quality, was actively contacting local enterprises and establishing an outside campus student training center. In 2018, the mechanical professional teaching team and the Anhui Axle Company Ltd jointly applied for the approval of the Suzhou Mechanical Equipment Collaborative Innovation Engineering Technology Research Center. The center not only provides students with a professional off-campus practice base, but also lays a platform foundation for the transformation of teachers' scientific research achievements.

3.4. Improving the Examination and Evaluation Mechanism of Experimental Courses

Building a perfect assessment mechanism is a powerful guarantee of the quality of experimental teaching^[15,16]. First, the assessment subject should eliminate the traditional uniqueness of the experimental instructor and include the supervising teachers and students. Students should be included in the main body of the examination, and the students should think about the requirements of each experiment from the perspective of the experimental instructor. The students' initiative in the experimental process should be mobilized through self-evaluation and mutual evaluation of the

experimental group. At the same time, using the supervising teachers' rich teaching and assessment experience as a reference would make the experimental teaching process more effective, reasonable, and fair. Second, the experimental teaching examination forms should be diversified. Different experimental teaching methods have different training requirements and are assessed differently. For example, machine tool processing, fitter, and CNC processing experiments of mechanical specialties are mainly assessed by their on-site operation; the application of AutoCAD software uses online assessments, and students submit their daily learning results to the experimental teaching management system so as to guide teachers to assess students' learning outcomes promptly and so problems can be fed back to students. Finally, according to the different contents of the experiment, the requirements of the examination should be hierarchical. The mechanical specialty's experimental course is generally divided into verification experiments, design experiments, and comprehensive innovation experiments. The verification experiment should focus on the standardization of students' experimental operations and the accuracy of the experimental results. The design experiment requires students to design the experimental scheme according to the experimental problems and then carry out the experimental operation, data recording, result analysis, and the discussion and analysis of the experimental results. The comprehensive, innovative experiment requires the student group to complete the design report within the specified time according to the topic given by the teacher or the topic prepared by the students in combination with the course, and the assessment focuses on the students' innovation and the standardization of the design report. Table 1 shows the subjects, forms, and requirements of the different types of experiments.

Table 1 The subjects, forms, and requirements of different types of experiments.

Experiment type	Assessment subject	Assessment form	Assessment requirements
Operation and processing experiments	Teacher + student's self-evaluation	Field operation	Operation standardization + accuracy of experimental results
Simulation experiments	Teacher + student's self-evaluation	Online operation	Proficiency in simulation operation + simulation result
Validating experiments	Teacher + student's self-evaluation	Field operation	Operation standardization + accuracy of experimental results
Designing experiments	Teacher + student's mutual evaluation	Field operation + defense	Experimental scheme design + analysis of experimental results
Comprehensive innovative experiment	Teacher + student's mutual evaluation	PPT report+ defense	Innovation + standardization of design report

4. Conclusion

The curriculum is the heart of higher education, and the construction of experimental courses is the key to the transformation from ordinary undergraduate universities to application-oriented universities. This paper analyzes the practical problems existing in the construction process of experimental courses in local application-oriented universities from the aspects of teaching staff construction, content construction for experimental courses, experimental teaching management, and

experimental equipment configuration, and puts forward the corresponding development and construction countermeasures. Local application-oriented universities should focus on the orientation toward serving the local economic development, abandon the teaching concept of having primarily theoretical courses and experimental courses as an auxiliary offering, build their own characteristic experimental courses, and take “competency-based” as the teaching logic in order to match the applied talent and the needs of enterprises and realize the sustainable development of application-oriented universities.

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