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Exploration and Practice of the Engineering Training Teaching Reform in Agricultural Colleges under the Background of Engineering Education Certification

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Abstract: Engineering training teaching plays an important role in engineering education certification. Based on the demand of engineering education certification for agricultural colleges, the paper proposes reform methods focusing on the problems such as the plain teaching content, the simple teaching methodology, the deficiency of teaching staff construction, and insufficient education for innovation ability training of students. The educational goals of engineering training course have been achieved through the construction and improvement of teaching system, quality assurance system, innovation ability training system for students. Students' comprehensive quality and innovation ability has been significantly developed and improved.

1. Introduction

Engineering training is a compulsory practical course for students in engineering major in universities. It is also the basis for students to learn subsequent professional courses [1-2]. Through training and practice, students cannot only master the basic knowledge of machining and cultivate the practical operation ability, the course also plays a vital role in the cultivation of engineering consciousness, innovation consciousness, craftsman spirit, and teamwork ability of students [3-5]. In recent years, the implementation of the national "Double Thousand Plan" has made the construction of first-class majors and first-class courses become a hot topic in the teaching reform of universities [6]. To achieve the construction standards of first-class majors, it is necessary to pass the engineering education professional certification. Therefore, the engineering education professional certification has also become the top priority in the professional construction [7].

Engineering training teaching content in agricultural universities is an important index and certification content in engineering professional certification standards [8-9]. Engineering training center, as an important base for practical teaching in universities, is also the main hardware support platform for engineering education certification, which indicates the importance and unique status of engineering training in cultivation of student ability [10]. In recent years, in view of the urgent requirements of professional certification and education quality improvement, agricultural universities have constantly sorted out and reflected on some problems existing in engineering training and teaching, and carried out reform and continuous strengthening construction in the

course teaching system, quality assurance system, and innovation ability training system.

2. Problems in Engineering Training and Teaching

2.1. Teaching Hours Cannot Meet the Requirements of the Course Content

Besides the general compulsory courses such as ideological and political theory, college foreign language, college computer foundation, physical education, situation and policy, there are also three basic courses including mathematics, physics and chemistry, and specialized courses (including basic courses and compulsory courses), which occupy the majority of class hours. Engineering training course is a compulsory course for practice. For a long time, the duration of mechanical major is 4 weeks, and the duration of near-mechanical major is 2 weeks. Engineering training courses have many types of work. The practical operation of traditional jobs is the foundation. Hence the content cannot be easily abandoned. Along with the development of new processing methods and advanced processing technology, the content of practice teaching should be constantly increased, which causes that the teaching hours cannot meet the demand of the increasing course content.

2.2. The Depth of Teaching Content Cannot Meet the Industry Requirements

Limited by the hardware conditions and teaching hours of engineering practical teaching equipment in agricultural universities, there are more traditional engineering training content (such as common turning, common milling, welding processing, etc.) than advanced manufacturing technology content (such as numerical control processing, laser processing, additive manufacturing, etc.). Since advanced processing equipment is not enough for students, students can only understand the general working flow of advanced processing equipment, but have fewer opportunities to practice programming and processing operation by themselves, which cannot meet the requirements of application-oriented technical personnel training in the machinery industry.

2.3. The Teaching Methods are Relatively Old

The teaching methods of engineering training mostly adopt the traditional teacher-apprentice method, while the modern teaching methods are rarely applied to the teaching. The practice mode of "teacher-explainer-demonstration-student-practical operation" is adopted [11]. Under this teaching method, students do not have the opportunity to explore, resulting in weak learning interest.

2.4. Lack of Practice and Innovation Ability Training

In most of the training projects for each type of work, the teacher assigns the topic and demonstrates the operation, and the students passively accept the project without taking the initiative to think about the knowledge they have learned, and just follow the steps to imitate it [12]. Students' independent learning and innovative thinking are restricted, it is difficult to stimulate students' imagination and creativity. The cultivation of innovative ability is insufficient.

2.5. The Teaching Staff Structure is not stabilized

The construction and management of engineering training teachers has always been a marginal problem in the personnel reform of agricultural universities. Most universities have not formulated a special talent introduction and promotion system for practicing teachers. The title series of

instructors in each university are also different, including teacher series, experimental technology series, engineering technology series and engineering staff series, etc. They are theory course teacher, experimental course teacher, engineer, technician, etc. [13]. Usually, the traditional technicians are older, and their advanced processing technology is less and their professional level is not high. On the other hand, due to the poor teaching environment of practice, loud noise, dust, semi-manual labor, low pay, therefore, highly educated personnel are difficult to recruit. Undergraduate or junior college personnel do not meet the educational requirements of the provincial and university employment system. Hence it is difficult to recruit talents, resulting in the lack of teaching staff construction of teachers, seriously affecting the improvement of teaching quality.

3. Engineering Training Teaching Reform Based on Professional Certification

In order to meet the standards of professional certification, our university has carried on the reform and practice of engineering training teaching in the aspects of curriculum teaching system, quality assurance system, student innovation ability cultivation system, etc.

3.1. Construction of Agricultural Engineering Characteristic Engineering Training and Teaching System

3.1.1. Improve Outcome-Oriented Curriculum Objectives

Professional certification emphasizes "outcome-oriented". In traditional professional training programs, the training objectives are general and rough, and there is no detailed explanation on how to achieve the objectives. The training objectives (learning outcomes) under professional certification have specific terms, and the achievement of the training objectives is supported by more than ten specific graduation requirements. Each graduation requirement is met by several courses. Therefore, engineering training courses should formulate their own teaching objectives according to the training objectives of the major and the graduation requirements supported by this course. It can neither exaggerate the role of this course nor escape the responsibility of the training objectives. The following is the teaching objectives of engineering training course for Mechanical Design and Manufacture major:

Course objective 1: To understand the general process and technological knowledge of mechanical and electrical product manufacturing; Familiar with common machining methods, and types of main equipment used in machining. Be able to use the knowledge of structure design and processing process analysis of common mechanical parts, and reflect innovative thinking in the design.

Course objective 2: To Master the structure principle and operation skills of traditional processing equipment and advanced processing equipment, to establish the concept of modern manufacturing engineering, and to form the consciousness of production safety. Be able to use a variety of processing technology to design and manufacture mechanical and electrical products.

Course objective 3: To cultivate the consciousness of environmental protection, resource saving and green manufacturing in the mechanical manufacturing practice, and initially establish the consciousness of modern engineering such as market and information, quality and benefit, safety and environmental protection, and sustainable development.

Course objective 4: To cultivate labor concept and professional spirit. Abide by mechanical engineering professional ethics and industry norms, cultivate rigorous work attitude and work style of combining theory with practice. Integrate ideological and political elements into the curriculum, strengthen the education of family feelings and craftsman spirit, and initially establish professional

ethics, professional spirit, and professional quality.

Course objective 5: To Cultivate the spirit of innovation and teamwork. Driven by the project, we establish an innovation team with reasonable division of labor, coordination and cooperation among the team members to complete the structural design, process analysis, processing and manufacturing, assembly and debugging, cost analysis, summary and report of innovative products, so as to improve the organizational management and interpersonal skills.

3.1.2. Construction of Agricultural Engineering Characteristic Curriculum System

With the rapid development of society, enterprises and public institutions have been increasing their requirements on the training of talents in universities. The single teaching content of traditional engineering training cannot fully meet the needs of innovative applied talents. Therefore, an engineering training curriculum system with agricultural engineering characteristics is constructed (as shown in Figure 1), including four stages: basic engineering cognition, basic skills training, comprehensive ability training, and innovation ability training.

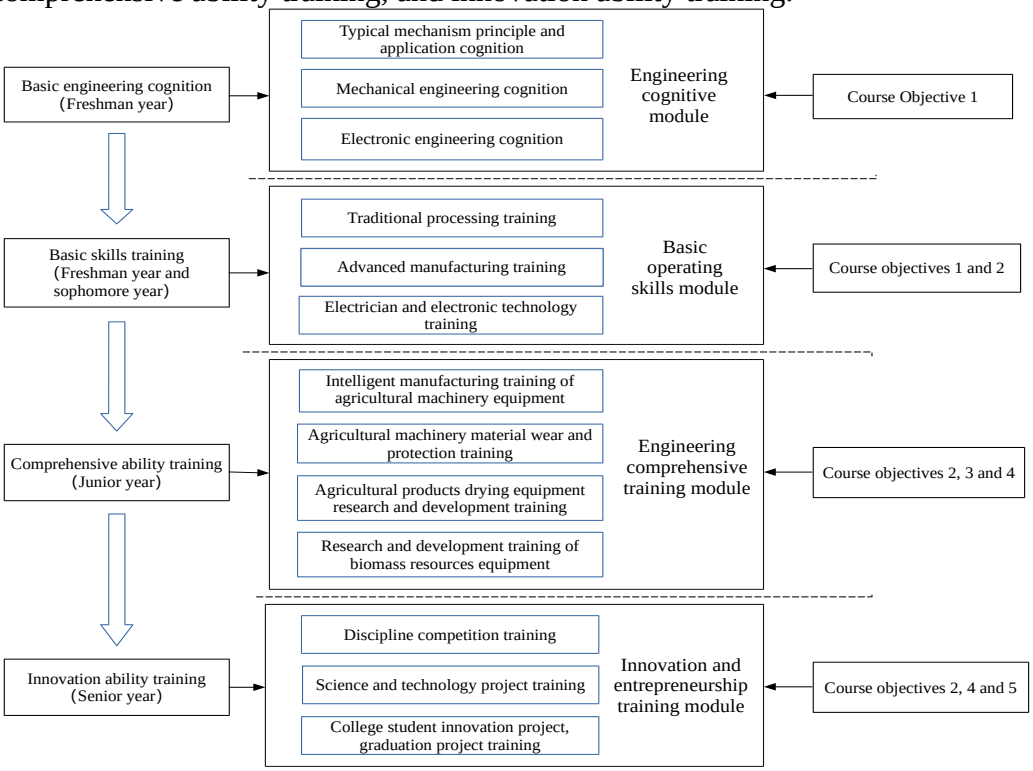

Figure 1: Engineering training curriculum system

Students receive training at different levels in different grades. Traditional processing training (including turning, milling, planning, grinding, fitter, casting, forging, welding, etc.) and electrical and electronic technology training are retained in the basic skills training. In addition to numerical control machining training, advanced manufacturing training increases laser machining, electric discharge machining, additive manufacturing, reverse engineering and other new technology and technology training content have been added to keep up the development. Personnel training has been introduced to meet the needs of social development. In the comprehensive ability training stage, combined with the characteristics of agricultural colleges and universities, the training content of modern agricultural equipment design and manufacturing is carried out. The intelligent manufacturing training platform of agricultural machinery equipment, the wear and protection training platform of agricultural machinery materials, the research and development training

platform of agricultural drying equipment, and the research and development training platform of biomass resource equipment are set up. The comprehensive training content is in line with the professional training. During the practical training of innovation ability, students of different majors form innovation groups are in the innovation association. Discipline competition project training, teachers' scientific research project training, college students' innovation and entrepreneurship training, graduation project training, graduation project training have guided teachers to carry out regular lectures and training on innovation theory, and cultivated students' team spirit and innovation and entrepreneurship ability.

3.1.3. Establish Teacher-Guided and Student-Led Teaching Model

The traditional engineering training adopts the teaching mode of "master leads apprentice", in which the parts processed in practice are decided by the teachers. The students' thinking is constrained, and it cannot arouse their interest in learning. After the reform, the curriculum is divided into four parts: "engineering cognition module", "basic operation skills module", "engineering comprehensive training module", and "innovation and entrepreneurship training module".

"Basic Operation Skills module" adopts the method of "teachers' guidance and students' theoretical explanation + teacher demonstration operation + students' practical operation", which combines theory with practice. The goal is for students to master the principle of processing technology and proficiently use processing equipment, laying a foundation for subsequent comprehensive practical training. For theoretical knowledge learning and demonstration operation, the model of "flipped classroom" can be adopted, with teachers guiding and students leading the learning. The form is not limited in classroom. Multimedia teaching means can be added, and technologies such as Internet and VR virtual reality can be adopted to simulate modern factory production scenes.

"Engineering comprehensive training module" and "innovation and entrepreneurship training module" adopt project-driven model. According to the training objectives of the course, project library was established and project products were stored, such as electromechanical sowing drive seed arrangement device, laser repair of agricultural machinery transmission shaft, grain moisture detection system, automatic blackboard cleaning system, automatic face cutting machine, and automatic lifting platform of projector, etc. Project products should have certain practical functions to enhance students' interest. The student group should first analyze the function of the product and determine the implementation plan of the function. Then, carry on the product drawing design, analyze the manufacturing principle of each component of the product, the processing method, the process cost analysis. The parts are processed and manufactured, and finally assembled into products. The whole project implementation process is student-centered, and the instructor gives corresponding guidance. Students carry out independent learning, inquiring learning and cooperative learning. This can stimulate their learning enthusiasm and innovation and cultivate their ability to solve complex engineering problems by using the knowledge they have learned and adopt appropriate skills and technologies when facing complex engineering problems.

3.2. Establish a Teaching Quality Assurance System

3.2.1. Establish Teaching Quality Monitoring and Management System

Teaching quality monitoring and management system is an important guarantee for the realization of teaching objectives in both quality and quantity. The school attaches great importance to the monitoring and management of the quality of practical teaching. The Engineering, Science

and Education Reference Committee has formulated teaching quality monitoring systems such as the Duties of Trainee Teachers, the Inspection System of Practical Teaching, the System of Teaching Supervision Listening to Lectures, and the System of Peer Evaluation of Teaching, and the System of Student Evaluation of Teaching, etc. It has established a three-level teaching quality inspection system of school, college and department, and employed three-level supervision. At the beginning, middle and end of each semester, the teaching Quality Evaluation Center organizes experts from university and department level to conduct teaching inspection. During the whole semester, the college organizes the college supervisors to carry out regular teaching inspection and monitoring. Supervisors of all departments in the engineering Training Center carry out on-site practice teaching inspection from time to time. The center organizes teaching competition, teaching observation and experience exchange activities for internal teachers every semester to promote mature teaching experience. At the end of the semester, the school organizes teachers of "Metalworking Practice", "Fundamentals of Mechanical Manufacturing Technology", "Engineering Materials and Molding Technology" and other courses to conduct peer evaluation and teaching. At the end of the course, students will also evaluate the teaching of the instructor. The teaching effect inspected, monitored and evaluated by all levels and departments shall be timely fed back to the teaching quality evaluation team of the college and the center. After comprehensive discussion, the evaluation team will give rectification suggestions and feedback to the teachers themselves, who will continuously improve the specific contents and methods of teaching. Teachers with excellent teaching effect will be given priority in promotion, evaluation, and salary distribution, so that trainee teachers will pay attention to teaching reform and teaching innovation, improving teaching ability, finding out the gap, and forming a good competitive atmosphere.

3.2.2. Continuous Investment in Improving Teaching Environment and Equipment

Practical teaching is different from theoretical teaching. Good practice environment, complete kinds and sufficient amount of teaching equipment are the basis to ensure the quality of engineering training teaching. Since the 13th Five-Year Plan, especially since entering the construction cycle of professional certification and a new round of teaching level evaluation, the university has intensified efforts to build teaching hardware of engineering training center. In 2019, the university took advantage of the "Central and Western Universities Construction Project" to build a new basic experimental building, in which the practical teaching base of the engineering training center covers an area of 3,000 square meters. The practice teaching environment has been significantly improved. In 2020 and 2021, the university purchased advanced processing equipment such as vertical machining center, CNC lathe, CNC wire cutting machine, high-precision laser metal cutting machine, three-coordinate measuring machine, 3D printer, and other advanced processing equipment with the funds of "Special Project of Central Financial Support for the Development of Local Universities" and "Special Bond Project for Education". The teaching platform of "advanced laser technology and digital application" has been introduced to expand and enrich practical training projects, broadening students' knowledge horizons and creating good teaching environment.

3.2.3. Continue to Strengthen the Construction of Teaching Staff

Teachers are the leading force of practice teaching and the power source of promoting teaching reform and improving teaching quality. Since the 13th Five-Year Plan, the university has taken the construction of practical teachers as an important part of the construction of teacher talent, adopting the policy of "introduction, cultivation, training, employment" to build a team of modern engineering and technology practical teachers with The Times.

As regard to the large shortage of practical teachers, the personnel section strictly controls the

entrance, recruits practical teachers with master's degree, and sets up practical operation assessment in the recruitment link. For teaching staff with low academic qualifications, the center encourages teachers to obtain master's or doctor's degree to improve their professional theoretical level and professional ability. In the past five years, all the staff got master degree or above. New teachers have to take one year of intensive skills training and pass the examination before they start to teach. The skills intensive training is mainly divided into two stages. In the first stage, new teachers are selected to receive short-term training in factories and enterprises for three months. The center has established a stable talent training relationship with Shenyang Machine Tool Co., LTD. and Demeiyinghua System Technology Co., LTD. In the second stage, experienced teachers from the center will be hired as mentors, and long-term guidance and training will be conducted in a one-to-one manner. For craftsman instructors with rich teaching experience and outstanding skill level who have reached retirement age, the policy of "one person, one discussion" is adopted to properly recruit and rehire them to promote their ability as soon as possible through their role in spreading, helping and leading. Through the above measures, the center has established a team of teachers with high theoretical level and strong professional ability. The practical teaching level has been significantly improved.

3.3. Construction of Agricultural Engineering Characteristic Innovation Ability Training System

The goal of the construction of first-class major and first-class curriculum involves the cultivation of students' innovation ability. For engineering majors, engineering training course is an important support for the cultivation of innovation ability. Therefore, the Engineering Innovation Center is generally set up under the engineering training center for construction. The Engineering Training Center of our university sets up the Innovation Training Department, which includes several innovation clubs, and each club has several project innovation groups. After the completion of engineering training teaching subjects, students can participate in innovation groups and demonstrate their innovation ability by participating in project-driven discipline competitions. The Engineering Training Center is the innovative practice base, which is fully open to students, and the equipment and resources can be shared by the whole university. The innovation club is student-centered and led. From product design and functional demonstration to manufacturing, installation and debugging, all are completed by students. Teachers provide technical guidance and project guidance for innovative projects. Through years of construction, four agricultural engineering innovation teams have been incubated and formed, which are "intelligent agricultural machinery equipment design team", "agricultural machinery parts surface strengthening technical team", "intelligent grain drying equipment design team" and "engineering training comprehensive ability competition team".

"Intelligent Agricultural Machinery Equipment Design Team" and "Multi-grain Intelligent Drying Equipment Design Team" have participated in "National College Students Intelligent Agricultural Equipment Innovation Competition", "College Students Innovative Method Competition", "National three-dimensional Digital Innovation Design Competition" and other competitions since 2012. Through the competition, students are guided to master the engineering and technical knowledge of agricultural equipment design, mechanical 3D drawing, parts processing and assembly, etc., which exercises students' innovation and practice ability and lays a foundation for subsequent professional study. By extending and expanding the heat treatment technology of metal materials, the "Surface strengthening technical team of agricultural machinery parts" guides the students to learn and discuss laser cladding, plasma surfacing, laser quenching and other technologies of agricultural machinery parts. They not only learn the new process and new

technology, but also have a deeper understanding of the knowledge of agricultural machinery materials, which is in line with the needs of the profession and the industry. The team also achieved excellent results by participating in "Internet + College Students Innovation and Entrepreneurship Competition", "Challenge Cup College Students Entrepreneurship Plan Competition" and other competitions. The "Engineering Training Comprehensive Ability Competition Team" was established in 2013. It directly faces the university-level, provincial-level and national-level engineering training comprehensive ability competition. Through the competition projects, the students completed the training in various stages, such as problem analysis, scheme formulation, design calculation, product modeling and simulation, process analysis, parts manufacturing, product assembly, cost accounting and field competition. The knowledge units of reverse engineering, mechanical CAD, finite element analysis, engineering material selection, and mechanical processing technology have been comprehensively trained. The students' engineering comprehensive practical ability and innovation ability have been significantly improved.

4. Implementation Effect

(1) Students' comprehensive practical ability and innovation ability of engineering have been continuously improved.

Engineering professional certification emphasizes outcome-oriented. The most intuitive outcome of the outcome output is the award of various competitions. In the past three years, students majoring in machinery have won more than 150 awards in various competitions above provincial and ministerial level, including 29 national awards. We have completed more than 50 innovation and entrepreneurship training programs for university students at or above the provincial level, including 12 national projects. The comprehensive innovation ability of students has improved steadily.

(2) A number of distinctive comprehensive training platforms have been built to provide strong support for the practical teaching of engineering majors in agricultural university.

By constructing a curriculum system suitable for the training objectives of the major, the reform of teaching content and teaching mode is deepened, and training programs and creating a training platform with agricultural engineering characteristics is expanded. It lays a solid practical teaching foundation for the engineering certification, audit, and evaluation of agricultural mechanization and automation, mechanical design and manufacturing and automation, agricultural building environment and energy engineering, agricultural engineering and other majors. It also provides reference experience for the engineering training and teaching of agricultural university.

5. Conclusion

Engineering training is an important link to cultivate students' engineering comprehensive practical skills and innovation ability. Under the background of double first-class construction and engineering certification, engineering training has been assigned more responsibilities in the training objectives. Engineering training and teaching in agricultural universities are based on mechanical engineering subject. Through the comprehensive construction of curriculum teaching system, teaching quality assurance system, and innovation ability training system, a practical teaching and teaching system has been formed with mechanical design and manufacturing and automation major. Through various and multi-channel financing, the training base has been expanded, advanced processing equipment has been purchased, and comprehensive and innovative training projects have been added. The training course content is in line with the industry and the training needs of application-oriented innovative talents are met. Through the construction of innovative associations with industry characteristics, driven by discipline competitions, big

innovation projects and teachers' scientific research projects, students' innovation ability has been cultivated, and good social effects have been achieved.

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