Curriculum System of Agricultural Water Conservancy Engineering Major Based on Application-Oriented Talent Training

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Abstract. To satisfy the country's demand for rural grassroots application-oriented talents, we analyzed the requirements of application-oriented talents of agricultural water conservancy engineering in terms of knowledge, ability, and quality by referring to the experience of curriculum system reform of agricultural water conservancy engineering in China, clarified the ideas of curriculum reform for application-oriented talent training from five aspects, namely, basic courses, major basic courses, major compulsory courses, major elective courses, and practical courses, and studied the strategy of the curriculum system reform. After practice, good reform achievements were obtained. The curriculum system is appropriate for the training of application-oriented talents in agricultural water conservancy engineering who emphasize on practice and abilities, which can also be applied in related majors.

Keywords: agricultural water conservancy engineering · application-oriented · curriculum system

1 Introduction

The modern education of agricultural water resources engineering in China originated in the 1930s. The scope of agricultural water resources was defined by Mr. Li Yizhi, a famous water conservancy scientist (Lecture Notes on Agricultural Water Resources) and Mr. Sha Yuqing (Agricultural Water Resources) as the fundamental principles and practices of agricultural water resources, including irrigation, drainage, alkali washing, reclamation, and related contents like ditching, land preparation, and embank ment required for field protection, river management, etc. The former engineering and agricultural fields of agricultural water resources were combined into agricultural water conservancy engineering, which was classed as agricultural engineering when the Ministry of Education revised the Major Catalogue in 1998 [1].

The curriculum in agricultural water conservation engineering primarily develops individuals to work in rural water conservancy [2]. The agricultural water conservancy engineering degree is offered by 35 regular undergraduate colleges and universities and

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1 independent college. 36 colleges and universities are represented by 14 agriculture-focused colleges and universities, 5 comprehensive universities with agricultural major (two of which were formerly agricultural universities that were expanded into comprehensive universities), 4 comprehensive universities without agricultural major (two of which were water conservancy-focused universities that were expanded into comprehensive universities), and 13 engineering- or science-focused colleges and universities. Among the agricultural water conservancy majors in these colleges and universities, there are 11 national first-class major points and 15 of them have passed the China Engineering Education Accreditation.

Many agricultural water conservation engineering students trained in China's universities lack practical engineering experience. After graduation, the gap between theoretical learning and practical work makes it difficult for them to enter the workforce quickly and requires a lengthy adjustment period. The current curriculum for the agricultural water conservancy engineering major must be reformed to strengthen students' engineering ability training, realize the talents cultivated by the school, and work "seamlessly" [3], which is the direction of application-oriented talent training, to meet the growing demand for talents in rural water conservancy work. The talent training reform in agricultural water conservation engineering is moving in this direction.

2 Basic Requirements for Application-Oriented Talent Training of Agricultural Water Conservancy Engineering

2.1 Knowledge

The courses for training application-oriented talents in agricultural water conservation engineering include math, natural science, computer and information technology, engineering fundamentals, major fundamentals, major courses, ideological and political courses, foreign languages, and general studies. These can guarantee that the trained talents have rich basic science and professional knowledge, as well as a certain level of humanistic literacy. Only the condition of a "solid foundation" must be met by the knowledge level of application-oriented talents, while a "deep foundation" is not required [4, 5]. However, such talents need to obtain a certain breadth of knowledge. In terms of mathematics, engineering fundamentals, major fundamentals, etc., the types and numbers of class hours of courses should be relatively sufficient to ensure that graduates' career development and meet the need to enter graduate schools for further education. In addition, graduates of this major should be proficient in applying their knowledge to related fields such as water conservancy and hydropower engineering, hydrology and water resources engineering, as well as other professional expertise to meet the demands of rural water conservancy work [6].

2.2 Ability

The application-oriented talents of agricultural water conservancy engineering are required to systematically master the basic theory, professional knowledge, and basic skills of agricultural engineering and water conservancy engineering disciplines, basic

training in engineering engineer practice ability [7], good abilities of individual and group work, communication, and coordination, the ability to undertake difficult engineering projects independently, and the ability to solve complex technical problems. Such talents not only are competent in agricultural water conservancy engineering survey and planning, improvement of flooded low-yielding land, small hydropower design and construction, township/town water supply and drainage, design and construction of irrigation and drainage pumping stations, rural water environment and water ecological protection, but also can engage in project management, groundwater development and utilization and be fully competent in rural grassroots water conservancy work. In addition, such talents should have some innovative expansion ability and adapt to the complicated and changeable environment of rural water conservancy work.

2.3 Quality

Professional, ideological, and humanistic quality should be the main characteristics of individuals applying their talents in agricultural water conservation engineering. Professional quality is the ability to apply professional knowledge as a professional technician to address issues that arise in project management, design, and construction, as well as to successfully carry out professional job activities. Ideological quality is achieved through professional ideological and political education and courses for cultivating their enthusiasm. This helps eliminate the fear to the front-line water conservation work in rural areas and helps the talents realize that it is also promising to service "agriculture, rural areas and farmers" and be rooted at the grass-roots level. Humanistic quality means that application-oriented talents have certain humanistic knowledge, understand humanistic thoughts, master humanistic methods, follow a humanistic spirit, work more humanely, and have the idea of advancing from engineering water conservancy to ecological water conservancy and landscape water conservancy. Water is the lifeblood of agricultural development, and the quality of talents is vital to the healthy development of rural water conservancy. In the process of training application-oriented talents, it is required to emphasize the overall development and comprehensive quality of talents.

3 Reform Ideas of Curriculum System of Agricultural Water Conservancy Engineering Based on Application-Oriented Talent Training

The authors discovered that the total number of credits needed to graduate from each degree ranged from 160 to 197, with 117 to 147 credits of professional education (including mathematics, natural science and computer courses), according to the talent training programs of 27 colleges and universities across China that were implemented between 2018–2020. The present curricula of each school are mostly centered on Civil Engineering and Water Conservancy courses, with a small number of agriculture-related courses such as soil and farming, irrigation and drainage engineering, and water-saving irrigation theory and technology. Although the curriculum systems of these schools are different, in terms of curriculum setting, many schools follow the traditional curriculum

system to set up major courses. Especially, the major courses of engineering or agricultural colleges and universities in northern or southern China are almost the same, which not only does not reflect the major characteristics but also does not reflect the regional schooling characteristics. The authors believe that, for course setting, agricultural water conservancy engineering courses should be considered comprehensively according to the schooling positioning and the schooling characteristics. In addition, the curriculum system reform of the agricultural water conservancy engineering should start from the following five aspects:

3.1 Setting of Basic Courses

The basic courses of agricultural water conservancy engineering as an engineering major must be set according to the standards of similar engineering majors, including Advanced Mathematics, College English, College Chemistry, College Physics, Computer Language, Political Theory, Sports, etc. If there are sufficient credits, a course on "College Chinese" can be set to further improve students' language expression and enhance their ability to write reports and papers.

3.2 Setting of Major Basic Courses

Major basic courses of agricultural water conservancy engineering major: (a) Mechanics courses: "Theoretical Mechanics" "Mechanics of Materials" "Soil Mechanics" "Structural Mechanics", and "Hydraulics" are generally set, which are similar to that of civil engineering, or Engineering Mechanics instead of "Theoretical Mechanics", "Mechanics of Materials" and "Structural Mechanics"; (b) Engineering drawing courses, such as "Engineering Drawing and CAD" course; (c) Engineering surveying courses, such as "Water Conservancy Engineering Surveying"; (d) Engineering geology courses, such as "Engineering Geology and Hydrogeology"; (e) Engineering hydrology courses, such as "Engineering Hydrology and Hydraulic Calculation"; (f) Engineering economy courses, such as "Water Conservancy Engineering Economy", "Water Conservancy Engineering Budget", etc.; (g) Agricultural soil and crop courses, such as "Soil and Crop Science", "Crop Habitat Science"; (h) Other basic engineering courses, such as "Construction Materials", "Reinforced Concrete Structure", "Electrical Engineering And Electrical Equipment". The application-oriented course setting of agricultural water conservancy engineering major can appropriately reduce the number of class hours of mechanics courses, and appropriately increase that of engineering drawing courses and engineering surveying courses.

3.3 Setting of Major Mandatory Courses

Major mandatory courses of agricultural water conservancy engineering major: (a) Courses on planning, design, and construction of small and medium-sized hydraulic structures, such as "Hydraulic Structures", "Canal System Structures", "Water Conservancy Engineering Construction"; (b) Courses of planning, design, and management of farmland water conservancy, such as "Irrigation and Drainage Engineering", "Farmland Hydrology", "Agricultural Hydrology", and "Pumps and Pumping Stations".; (c)

Courses of agricultural water resources management, such as "Water Resources Planning and Management" and "Water Resources Planning and Utilization". Among them, the courses of planning, design, and management of farmland water conservancy are the focus. To strengthen the teaching content of engineering management, the courses should be combined with the actual projects.

3.4 Setting of Major Elective Courses

To broaden students' knowledge, major elective courses may be set for the agricultural water conservancy engineering major according to the school's characteristics and the needs of the local industry: (a) Water conservation irrigation courses, such as "Water Conservation Irrigation Theory and Technology" and "New Water Conservation Irrigation Technology"; (b) Courses in orchard and pasture agriculture water conservation, such as "Fruit Tree Irrigation" and "Pasture Irrigation Engineering"; (c) Courses in facility agriculture, such as "Facility Agriculture Engineering". (d) Courses in township/town water supply and drainage, such as "Township/Town Water Supply Engineering"; (e) Courses in intelligent water resources, such as "Artificial Intelligence and Intelligent Irrigation Area"; (f) Courses in improvement of saline and flooded low-yielding land, such as "Saline Land Improvement Technology"; (g) Groundwater development and utilization courses, such as "Groundwater Utilization"; (h) Other new theories, technologies, and materials courses, such as remote sensing technology and Internet of Things technology courses.

3.5 Setting of Practical Courses

The number of practical courses should be increased for the agricultural water conservancy engineering major to ensure that students get sufficient training in practical skills. Setting of practical courses: (a) Practice courses, such as "Awareness Practice", "Surveying Internship", "Engineering Geology Practice", "Job Practice", "Production Practice", and "Graduation Practice; (b) Experimental courses, such as: "College Physics Experiment", "Analytical Chemistry Experiment", "Construction Material Experiment", "Geotechnical Experiment", "Hydraulics Experiment" "Experiments on Reinforced Concrete Structures", "Irrigation and Drainage Engineering Experiments" [8]; (c) Design courses, such as "Hydraulic Reinforced Concrete Course Design" "Hydraulic Structure Course Design", "Irrigation and Drainage Engineering Course Design", "Pumps and Pumping Stations Course Design" [9]; (d) " Graduation design".

4 Reform Strategy of Curriculum System of Agricultural Water Conservancy Engineering Major Based on Application-Oriented Talent Training

4.1 Increase the Proportion of Practical Courses

Today's regular undergraduate curricula adhere to the notion of a "solid foundation and wide scope" [10], and basic and major basic courses are of large proportions, which is beneficial for undergraduate students' long-term growth and further academic pursuits.

In recent years, however, there has been a serious increase in the introduction of science courses in engineering majors [11], with some schools even offering courses according to teachers to ensure their workload. As a result, more and more basic courses and major basic courses are offered, while practical courses become fewer and fewer, and by the third college year, students are still not engaged in practical courses, and this has a significant impact on the quality of talent development. The application-oriented talents of agricultural water conservancy engineering should orient to the front lines of rural water conservancy work, so training courses should be designed with "emphasis on practice and abilities". It may be appropriate to reduce the proportion of basic courses and major basic courses and increase the proportion of practical courses. For example, 28.5 credits, 16.8% of total class hours, were given in the practical courses of the former agricultural water conservancy engineering major training program at Nanchang Institute of Technology. The revised practical course credits for the application-oriented talent training program are 53.5 credits, 31.5% of total class hours. The number of practical courses has increased by 25 credits, and the proportion of the total class hours has increased significantly by 14.7%. The time of the practical course of "Production Practice" was originally 2 weeks, and after it is adjusted to the "Job Internship", the practice time is largely increased to 23 weeks. In addition, 0.5 weeks are increased for "Engineering Surveying Practice" and "Engineering Geology Practice" and the numbers of class hours are also increased for "Hydraulic Reinforced Concrete Course Design" "Hydraulic Structure Course Design", "Irrigation and Drainage Engineering Course Design", "Pumps and Pumping Stations Course Design.

4.2 Set Major Elective Courses According to Schooling Characteristics

Major selective courses of about 10 credits are generally arranged for the agricultural water conservancy engineering major. The elective courses of application-oriented talent training should reflect major characteristics, keep pace with the times and follow the development direction of rural water conservancy work.

There are 36 colleges and universities with the agricultural water conservancy engineering major in different regions of China. The contents of rural water conservancy work in different regions are different. For example, southern China is rich in water resources, so flood drainage is an important part of rural water conservancy work; water resources are scarce in northwestern China, so water-efficient irrigation is more important in such work. The elective courses for application-oriented talent training in different regions should be set differently, corresponding to the local rural water conservancy work, to better serve the local economic development. For example, the fruit tree irrigation course may be set for the agricultural water conservancy engineering major in regions with developed forest and fruit industries in southern China, the groundwater utilization course may be set for such major in regions with irrigation of groundwater resources in northern China, the saline-alkali soil improvement technology course can be set for this major in the saline-alkali regions in northwestern China, and the grassland irrigation engineering course can be set for such major in grassland regions in pastoral areas.

In addition, China's rural water conservancy work is also developing rapidly, the contents of which are constantly changing. The development direction of such work should

be followed in the curriculum of application-oriented talents in agricultural water conservancy engineering. In recent years, the main contents of China's rural water conservancy work include small reservoir reinforcement projects, small river management projects, small farmland water conservancy projects, high-standard farmland water conservancy projects, land consolidation projects, drinking water safety projects for rural residents, and rural water environmental management projects. At present, intelligent irrigation areas and digital twin irrigation areas are on the rise. These contents require different major elective courses, such as Township/Town Water Supply Engineering, Land Planning and Utilization, Artificial Intelligence and Intelligent Irrigation Areas.

4.3 Focus on Combining Curriculum and Production Practices

The training of application-oriented talents in agricultural water conservancy engineering focuses on the practical ability of students to better serve the frontline grassroots work. The curriculum should be closely combined with production practices to train talents practically, mainly through the following measures: in terms of major courses (such as "Irrigation and Drainage Engineering", "Water Conservancy Engineering Construction", "Pumps and Pumping Station", "Water Resources Engineering Surveying", etc.), it is required to strengthen the contacts with local management organizations, design institutes, construction organizations, and scientific research institutions, establish off-campus practice bases, engage off-campus tutors, let students to "go out" and teachers to "come in" to ensure students receive practical engineering training. In terms of curriculum arrangement, after the end of major courses (such as "Irrigation and Drainage Engineering", "Hydraulic Structures", "Water Conservancy Engineering Construction", and "Pump and Pumping Station"), part of time should be preserved for job practice, so that students can go to the production line, combine the knowledge with the actual production, enhance knowledge and ability in practice. In the topic selection of graduation design and graduation thesis, it is required to pay attention to the cooperation with organizations in agriculture, water conservancy, and other related industries, and select the topics together with the off-campus tutors. In addition, while cultivating students' ability to solve practical problems, we should also cultivate their innovation ability consciously.

4.4 Adopt Diversified Approaches

In the reform of curriculum System of agricultural water conservancy engineering major based on application-oriented talent training, the following three approaches can be applied to really develop the application skills. The first is to a three-stage study mode: since major knowledge is often abstract, it is more difficult for students to study, so in the teaching arrangement, after students learn the major courses, students can apply their major knowledge through job practice and then return to school to study other major courses and course design. This three-stage study mode of "theory study - job practice - theory study" can effectively improve the application ability of students. The second is to implement the tutor system: Major teachers are selected as tutors. After the freshmen enter the college/university, tutor teams should be establish through the two-way selection of teachers and students, with no more than six students guided by one tutor. The tutor system runs through the entire process of student training. It is stipulated

that students must regularly report their studies to tutors, who should guide, help and motivate them to solve professional problems they encounter. During the summer and winter vacations, tutors are encouraged to arrange for students to participate in scientific research training, attend academic conferences, and broaden their horizons through field research. The third is to establish a student innovation system: It is requested to encourage students to participate in scientific research training or engineering practice while studying in school, and the major should provide a corresponding platform for experimental practice, and major tutors should guide students so as to arouse students' innovation consciousness and improve their ability to apply their professional knowledge in the process.

5 Conclusion

The application-oriented talents of agricultural water conservancy major work at the front line of rural water conservancy work and there are different requirements in knowledge, ability, quality, and others from the general talents, who emphasize on practice and abilities. In the curriculum system of application-oriented talent training, the proportion of practical courses should be increased, major and regional characteristics should be highlighted, and the curriculum system should be combined with rural work practice. It is required to reform the curriculum system in terms of the setting of basic courses, major basic courses, major compulsory courses, major elective courses, and practical courses, and establish a three-stage study system, a major tutor system, and a student innovation practice system to practice the curriculum system. The teaching method of alternative study and practice is implemented in the three-stage study system, which deepens students' understanding of major knowledge and improves their ability to combine theory with practice. The tutor system realizes the whole process guidance of tutors to students' professional issues and effectively improves their mastery of professional knowledge. The student innovation practice system systematizes students' innovation practice activities and can improve students' overall quality, practice ability, innovation ability, and hands-on ability. The results of practice show that great achievements have been made in the curriculum system reform, and the reform program can be popularized and applied in the similar majors in China.

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