Construction and Practice of the "Integration of General and Specialized Education" Curriculum System for Smart Agriculture under the Guidance of New Agricultural Science

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Abstract The construction of new agricultural science has put forward the core requirements of "interdisciplinary integration, service industry demand, and cultivation of composite talents" for the smart agriculture major. The "integration of general and specialized education" is the key path to solve the problems of "prominent disciplinary barriers, fragmented knowledge structure, and weak practical ability" in the traditional curriculum system. In this paper, the College of Smart Agriculture from Yulin Normal University is taken as the research object. Based on the characteristics of regional agricultural industry and the positioning of professional education, the prominent problems in the current professional curriculum system of smart agriculture are analyzed, the construction concept of "strong foundation in general education, precise core in professional education, and breaking through boundaries in integrated education" is proposed, and a "three dimensions and four layers" integrated curriculum system framework for general and specialized education is constructed. Moreover, practical exploration is conducted from the aspects of curriculum module design, teaching mode innovation, and guarantee mechanism construction. Practice has shown that this curriculum system effectively enhances students' interdisciplinary application abilities and industry adaptability, and provides a practical sample for the reform of smart agriculture courses in local universities under the background of new agricultural science.
Key words New agricultural science; Smart agriculture; Integration of general and specialized education; Curriculum system; Talent cultivation
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Since 2021, the Ministry of Education has continued to promote the construction of new agricultural science, and proposed the core goal of "taking moral education as the foundation, strengthening agriculture as the responsibility, and building a talent training system that adapts to agricultural modernization". As the core professional direction of new agricultural science, smart agriculture integrates modern information technologies such as the Internet of Things, big data, and artificial intelligence with traditional agricultural knowledge[1]. It is a key support for promoting the digital transformation of agriculture and assisting rural revitalization. At present, the demand for smart agricultural talents in the agricultural industry has shifted from "single technology" to "interdisciplinary composite", requiring students to have a solid agricultural foundation, master cutting-edge digital technologies, and possess comprehensive abilities to solve complex agricultural scenarios. This demand directly forces the reform of curriculum system for smart agriculture major in universities, breaks the traditional binary separation model of "general education + profession", and achieves deep integration of general education and professional education.

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1 Current situation and existing problems of curriculum system of smart agriculture major

1.1 Fragmented course structure In the traditional curriculum system, general education courses are mainly based on basic disciplines such as mathematics, English, and computer science, while professional courses are divided into two modules: agricultural fundamentals and information technology. The three lack content correlation and logical connection, forming a teaching pattern of "fighting on their own". For example, the data analysis methods learned by students in the course of "Advanced Mathematics" are difficult to apply to the professional course of "Agricultural Big Data"; the knowledge of crop growth patterns in the course of "Plant Physiology" is disconnected from the course of "Design of Smart Irrigation System".

1.2 Lagging knowledge update The iteration speed of smart agriculture technology is fast, and the application of technologies such as the Internet of Things and artificial intelligence in agriculture is constantly expanding. However, some professional courses still use traditional textbooks, and the coverage on emerging fields such as smart breeding, smart plant protection, and agricultural drone applications is insufficient.

1.3 Surface-level practical teaching Practical courses mainly focus on single course experiments and short-term field internships, lacking interdisciplinary and comprehensive practical projects. Although students can master individual technical operations, they often find it difficult to comprehensively apply general knowledge and professional skills when facing the entire process of "from field data collection to intelligent decision-making output", and there is a significant gap between practical ability and industry demand.

1.4 Insufficient regional adaptation The course content mostly draws on the general framework of comprehensive agricultural colleges, but lacks sufficient attention to the digital needs of Guangxi regional characteristic agriculture. There is a lack of localized content on agricultural facility design in the hilly and mountainous areas of southeastern Guangxi and intelligent planting of characteristic crops, resulting in a low degree of adaptation between talent cultivation and local industries[2].

2 Construction framework of the "integration of general and specialized education" curriculum system under the guidance of new agricultural science

Based on the above principles, a general and specialized integrated curriculum system is constructed with three dimensions: "general education, professional education, and integrated education", and four levels: "basic layer, core layer, expansion layer, and practical layer".

2.1 General education dimension It focuses on "broad foundation and strong literacy", and is divided into the basic layer and the expansion layer. The foundational layer includes public basic courses such as advanced mathematics, university physics, computer fundamentals, and English, which enhance students' scientific literacy and learning abilities. The expansion layer includes general elective courses such as "Agricultural Ethics and Rural Revitalization", "Introduction to Green and Low Carbon Development", and "Interdisciplinary Innovative Thinking", which integrate the cultivation of agricultural sentiment and contemporary literacy. At the same time, agricultural data analysis cases are added to "Advanced Mathematics", and agricultural software application teaching is strengthened in "Computer Fundamentals" to achieve the connection between general courses and professional needs.

2.2 Professional education dimension It focuses on "refined core and strong skills", and is divided into core layer and expansion layer. A dual core module of "Agricultural Fundamentals + Digital Technology" is built in the core layer: the agricultural fundamentals module includes courses such as plant physiology, soil and fertilizer science, and crop cultivation, which solidify the foundation of agricultural cognition; the digital technology module includes courses such as Internet of Things technology, agricultural big data analysis, and introduction to artificial intelligence, mastering the core technologies of smart agriculture. The expansion layer includes elective courses such as "Smart Breeding", "Smart Plant Protection", "Application of Agricultural Drones", and "Smart Agriculture Planning and Construction", to meet the personalized development needs of students.

2.3 Integrated education dimension It focuses on "breaking boundaries and strengthening capabilities", and runs through the basic layer, core layer, expansion layer, and practical layer. The basic layer includes the course "Introduction to Smart Agriculture" as an introductory course for the integration of general and specialized education, helping students establish a comprehensive understanding of "agriculture + technology" integration. The core layer sets up an interdisciplinary integration course group, such as "Agricultural Internet of Things System Integration" (integrating sensor technology and agricultural environment monitoring), "Intelligent Crop Growth Control" (integrating plant physiology and artificial intelligence algorithms), and "Smart Agriculture Project Management" (integrating management and agricultural planning knowledge). It opens a lecture on "Interdisciplinary Topics in Smart Agriculture" at the expansion level, inviting experts from enterprises and interdisciplinary teachers from universities to teach together. It builds a three-level practical system of "general practice + professional practice + integrated practice" at the practical level, to strengthen the cultivation of comprehensive application abilities.

3 Practical path of the "integration of general and specialized education" curriculum system

3.1 Reconstruction of modular course content According to the idea of "knowledge modularization and module integration", the course content is reconstructed. For example, by integrating the course of "Agricultural Information Technology and Big Data Application" with the course of "Crop Cultivation", a "Crop Growth Big Data Collection and Analysis" module is developed. Students can directly apply this module to the growth monitoring and precise regulation of rice, fruits and vegetables by learning sensor deployment, data collection, and growth model construction. By integrating "Modern Agricultural Facility Design and Construction" with "Smart Agriculture Planning and Construction", a case study of smart agriculture park planning in the hilly and mountainous areas of southeastern Guangxi is added to enhance local application capabilities. At the same time, it compiles the "Case Collection of Integrated General and Specialized Courses for Smart Agriculture", which includes more than

20 interdisciplinary teaching cases to provide support for course integration[3].

3.2 Innovation of diversified teaching modes

3.2.1 Project-based teaching. In the integrated curriculum, the "real project driven" model is adopted. For example, in the "Smart Agriculture Park Planning" course, students are organized to complete the smart planting park planning project of Yulin local agricultural cooperative in groups. From data collection, scheme design to equipment selection, the entire process integrates agricultural knowledge, planning technology, and management capabilities, achieving "learning by doing, applying by learning".

3.2.2 Interdisciplinary teaching team teaching. It should establish an interdisciplinary teaching team consisting of "agricultural teachers, information technology teachers, and enterprise experts" to jointly undertake integrated curriculum teaching. For example, the "Smart Plant Protection" course is taught by agricultural teachers to explain the occurrence patterns of pests and diseases, information technology teachers to impart intelligent recognition technology, and enterprise experts to share drone prevention and control practices, achieving the organic integration of multidimensional knowledge.

3.2.3 Blended online and offline teaching. It should utilize resources such as MOOCs and virtual simulation platforms to build a blended online and offline teaching model. For example, in the course of "Agricultural Internet of Things Technology", students learn sensor principles and protocol stack development online, and deploy nodes and debug systems offline in the smart agriculture laboratory[4]. By simulating intelligent control scenarios of crops under extreme weather conditions through a virtual simulation platform, it could compensate for the limitations of field practice.

3.3 Upgrading of practical teaching system Building a "three-layer and three-category" practical platform: the basic layer is the campus smart agriculture laboratory (equipped with sensor networks, drone training systems, and big data analysis platforms); the core layer is the school – enterprise joint construction practice base (cooperating with more than 10 units such as Yulin Agricultural Science Research Institute and Guangxi Smart Agriculture Technology Co., Ltd.); the expansion layer is the practice point of rural revitalization (focusing on characteristic agricultural villages in southeastern Guangxi). The three types of platforms are responsible for basic experiments, project training, and on-the-job internships, achieving practical coverage from virtual to real, from campus to field[5].

Designing a "tiered" practical project: it conducts general education practice in lower grades (such as agricultural cognitive internship, data collection training); professional practice in middle grades (such as IoT system development, crop intelligent monitoring experiments); integrated practices in higher grades (such as smart agriculture project design and enterprise on-the-job internships). For example, during their graduation internship, students participate in a smart irrigation system upgrade project at a fruit and vegetable base in Yulin. They comprehensively apply mathematical modeling, sensor technology, and crop physiology knowledge to complete the entire process from demand analysis to system implementation.

3.4 Construction of guarantee mechanism Teacher team construction: it should implement the "Interdisciplinary Teacher Training Program", encourage agricultural teachers to continue information technology courses, and encourage information technology teachers to practice in agricultural enterprises. It should introduce composite talents with both agricultural and technological backgrounds, hire enterprise technical backbones as part-time teachers, and form a "three integration" teaching team.

Curriculum evaluation reform: it should establish a diversified evaluation system of "knowledge + ability + literacy", and adopt a combination approach of "process evaluation + summative evaluation". The process evaluation includes classroom performance, project reports, practical operations, *etc.* (accounting for 60%), and the final evaluation adopts interdisciplinary comprehensive case assessment (accounting for 40%), focusing on evaluating students' integration and application abilities.

Dynamic adjustment mechanism: it should establish a curriculum construction guidance committee composed of university teachers, enterprise experts, and industry association representatives, conduct annual research on industry demand and technological development trends, and dynamically adjust curriculum modules and teaching content, to ensure the timeliness and adaptability of curriculum system.

4 Practice effectiveness and reflection

4.1 Practice effectiveness Since the implementation of the "integration of general and specialized education" curriculum system reform in 2023, the smart agriculture major at Yulin Normal University has completed two sessions of teaching practice for students, and significant results have been achieved.

4.1.1 Improving the quality of talent cultivation. The students' interdisciplinary application ability has significantly improved, and they have won 12 awards in the National Smart Agriculture Skills Competition and Guangxi College Students' Agricultural Creative Design Competition. The employment rate of graduates has reached 92%, with over 70% of them employed in local smart agriculture enterprises and agricultural management departments in Guangxi. The satisfaction rate of employers has reached 89%, an increase of 18 percentage points compared to before the reform.

4.1.2 Abundant achievements in curriculum construction. Two school-level quality courses, including "Introduction to Smart Agriculture" and "Agricultural Internet of Things Technology", have been established. Three integrated textbooks for general and specialized courses have been developed, and four virtual simulation experimental projects have been developed. The "Interdisciplinary

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tion of concrete.

3.3 Intensified test To better explore the promoting effect of nanomaterials on cement-based materials and study their influence law on polymer mortar, nano-SiO_2 is added to cement in the test. After curing to the specified age, XRD and TG tests are conducted on the reaction products. The details are as follows, where group PC1 is the control group (without nano-SiO_2 added) and group PC4 is the test group.

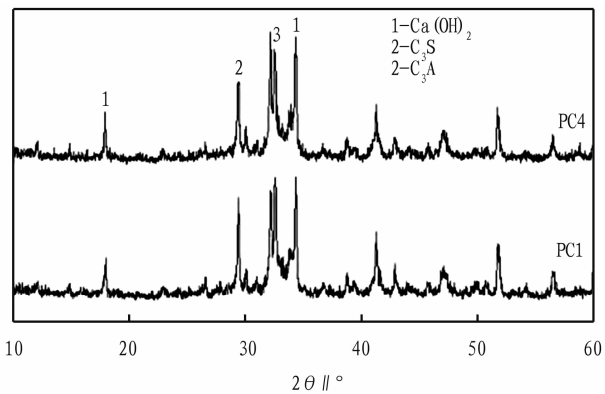

Fig. 1 XRD pattern of cement paste with nano-SiO_2 added

As can be seen from Fig. 1, compared with the blank sample group PC1, in the cement paste samples of group PC4 with nano-SiO_2 added, the diffraction peak of the hydration product $Ca(OH)_2$ is enhanced, while the diffraction peak of C_3S in the cement clinker reactants is reduced. This indicates that the introduction of nano-SiO_2 promotes the hydration rate of C_3S, generates more hydration product C-S-H, which fills the pores of the cement stone, and ensures the improvement of the strength and durability of the entire system.

3.4 Test summary Performance tests including penetration depth, adhesion, and water absorption rate are carried out on the above 3 categories, totaling 11 types of materials. For cementitious capillary crystalline materials, XYPEX exhibits better performance than other materials. For silane-based materials, considering penetration depth and water absorption rate, the high-performance ultra-nano silane impregnant has outstanding performance. For coating materials, the composite coating has good comprehensive performance. The composite material with nano-SiO_2 added has further improved strength and durability.

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Integration Curriculum Group" has been approved for the Guangxi Higher Education Teaching Reform Project.

4.1.3 Deepening the integration of industry and education. It jointly established 12 practical bases with enterprises, and collaborated on the development of 8 horizontal projects. Students have participated in more than 20 real projects of enterprises, achieving a positive interaction among "teaching – research – industry".

4.2 Problems and reflections Although the reform has achieved phased results, there are still some urgent problems to be solved: firstly, the quantity and quality of interdisciplinary teachers still need to be improved, and the integrated teaching ability of some teachers needs to be strengthened. Secondly, the depth of curriculum integration is insufficient, and some courses still exhibit a "surface integration" phenomenon, lacking substantial content integration. Thirdly, the integration of practical teaching resources is insufficient, and the sustainability and depth of school – enterprise cooperation need to be expanded.

In the future, Yulin Normal University will deepen reforms in three aspects: first, it should improve the teacher training mechanism. Through interdisciplinary training, school – enterprise joint training and other methods, teachers' integrated teaching ability could be enhanced. Secondly, it should promote the deep integration of course content and develop more interdisciplinary core courses and case resources. The third is to deepen the integration of industry and education, and jointly build industrial colleges and shared practical teaching platforms, thereby achieving dynamic adaptation of curriculum system and industry needs, and cultivating more high-quality compound smart agricultural talents for the construction of new agricultural science and rural revitalization.

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