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Study on AI Technology Empowerment of Smart Farms from the Perspective of Science Communication: A Case Study of Primary and Secondary School Students and Science and Technology Counselor

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Abstract: This study is conducted in accordance with China's strategy for advancing agricultural and rural modernization during the 14th Five-Year Plan period and the requirements of the Central No. 1 Document in 2025. It explores the application of AI technology in smart farms and the value of conducting agricultural-related science communication among adolescents. Given the current situation where primary and secondary school students have certain misunderstandings and a lack of knowledge about modern agriculture, the study investigates the technical logic and social significance of AI technology in addressing educational pain points. It also focuses on the new models of science communication for primary and secondary school students and the transformation of the role of science and technology counselor. Based on the analysis of the actual situations of science popularization lectures and activities, the study proposes research methods to further improve the scientific literacy of primary and secondary school students and the professional capabilities of science and technology counselor.

Keywords: smart farm, AI technology, science communication, primary and secondary school students' education, transformation of science and technology counselor

1. Introduction

1.1 Research background and significance

According to the 14th Five-Year Plan, "accelerating the modernization of agriculture and rural areas" has been listed as one of the important national strategic goals. For 25 years in a row, China has emphasized the theme of "developing smart agriculture and building digital farmlands." Against this backdrop, as a typical representative of new-quality productive forces, AI technology is deeply reconstructing the traditional agricultural production system. Smart farms, as an important application scenario for AI technology, have improved agricultural production efficiency to a certain extent and also provided a unique platform for science education for primary and secondary school students. By conducting on-site investigations of smart farms, the agricultural knowledge of primary and secondary school students can be made more concrete and intuitive, and their interest in and desire to explore agricultural science can be enhanced. The Ministry of Education's "Opinions on Strengthening Science Education in Primary and Secondary Schools in the New Era" points out that achieving a "grand science education" pattern and vigorously promoting the in-depth integration of science education and practice is one of the key tasks in the current new era.

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1.2 Diagnosis of the current situation: the cognitive gap of primary and secondary school students towards modern agriculture

1.2.1 Three-Dimensional manifestations of misunderstanding

Many primary and secondary school students today have significant cognitive biases regarding the technological means of modern agriculture. Most students perceive agriculture as traditional and one-sided "farming," without recognizing modern agricultural technologies such as drone plant protection and intelligent greenhouses. Regarding career imagination, in surveys on "ideal future careers," all agriculture-related positions rank at the bottom, described as "dirty and tiring" and having "poor development prospects." In terms of ecological value cognition, students cannot correctly explain the "agricultural ecosystem" and are unaware of the close connection between agricultural production and biodiversity, climate regulation.

1.2.2 Deep-Rooted causes of knowledge deficiency

The content related to agriculture in primary and secondary school textbooks occupies a very small proportion, and most of it focuses on traditional farming methods, which can easily lead to educational disconnection. Misleading media further exacerbates the confusion. For example, some agricultural videos on short-video platforms are amusingly adapted, such as "dancing tomatoes" and "irrigating fields with milk tea," which mislead students' cognition.

1.3 Research questions

In the construction of smart farms, more emphasis is placed on technology than on publicity, especially in rural schools. Many schools participating in the construction of smart farms have not fully utilized the value of science education, and some have even neglected the promotion and application of the scientific education function. Science and technology counselor serve as the bridge between smart farms and users, but they face two dilemmas: on the one hand, their own limited knowledge of AI; on the other hand, the traditional communication methods that dominate science communication cannot meet the dissemination needs of smart farms.

1.4 This study focuses on four core issues:

(1) Can AI technology transform the science communication of smart farms?

(2) What are the unique aspects of smart farms in cultivating students' scientific literacy?

(3) How can science and technology counselor be inspired by the role transformation under AI empowerment?

(4) How can primary and secondary schools, under the current "double reduction" policy, integrate AI with agricultural knowledge to conduct classes?

2. Literature Review

2.1 The current status of AI technology in the agricultural field

The application of AI technology has significantly propelled the modernization of China's agriculture, with supportive policies encouraging innovation in this domain. There have been notable advancements in AI-related agricultural applications, such as crop monitoring, pest and disease warning, intelligent irrigation, and crop identification. For instance, AI image recognition and machine learning technologies enable real-time and accurate assessment of crop growth, promptly detecting any abnormal growth. By analyzing big data, the characteristics of pests and diseases are identified for early warning and prevention. Combining IoT sensors for environmental data collection and using algorithms to predict weather, precise irrigation is achieved (Li et al., 2022; Wang et al., 2023; Chen et al., 2021).

2.2 Development of science communication theory

The field of science communication has evolved from the "deficit model" to the "participation model," emphasizing audience participation and interactive communication. In the context of smart farms, the "learning - by - doing" educational paradigm is realized as teenagers operate AI equipment, analyze agricultural data, and solve practical problems (Bums, 2003).

2.3 The current status of agricultural science education

Traditional agricultural education faces the "three disconnections" problem: the disconnection between teaching content and production practice, the disconnection between teaching methods and cognitive laws, and the disconnection between educational scenarios and real-world environments. The immersive scenarios provided by smart farms effectively address these educational pain points, offering primary and secondary school students an intuitive and vivid platform for scientific education (Zhang et al., 2020).

3. Research Content Elaboration

3.1 AI technology reconstructs the science communication scenario of smart farms

3.1.1 Intelligent interaction breaks through the boundaries of communication

VR Virtual Experience: Utilizing VR technology to construct a virtual smart agricultural farm, an immersive teaching model is employed to provide primary and secondary school students with a realistic simulation experience of the smart farm. By wearing VR devices, students can observe crops from all angles and engage in activities such as sowing, watering, and fertilizing to understand the impact of different operations on crops (Zhang et al., 2025). In addition to these features, the VR scenario can simulate weather conditions and natural disasters to attract students to learn about agricultural technology. Real - Field Planting Optimization: To address the issue of long planting periods, schools can divide the planting process into three stages: sowing, growth, and harvesting, with specific goals set for each stage. By adopting a phased and task-oriented teaching approach, students' waiting time is reduced while their sense of participation and achievement is increased. Design of Practical Courses: Carefully crafted integrated smart farm training courses combine knowledge and practice. Initially, fundamental theoretical knowledge about crop growth cycles, soil characteristics, and climate impacts is taught. Subsequently, practical teaching activities are organized, where students engage in actual operations such as plowing, land preparation, sowing, and fertilizing at the school farm or simulated planting areas. Gamification elements are incorporated into the teaching process, such as planting competitions, to enhance students' teamwork and competitive awareness.

3.1.2 Integration of virtual and real creates a new dimension of cognition

Application of VR/AR Technology: VR technology is used to take students to any corner of the smart farm, allowing them to experience it from multiple perspectives. AR technology enables students to take photos or scans of crops, which then display detailed information about the crop, including variety characteristics, growth cycles, and pest and disease control. This combination of virtual information with real-world scenarios serves an educational purpose.

3.2 Unique value of smart farms for the development of primary and secondary school students' scientific literacy

3.2.1 Construction of an interdisciplinary knowledge system

Smart farms encompass a wide range of knowledge areas, including biology, ecology, physics, and information technology. Guided by an interdisciplinary approach, with problem-based inquiry as the main thread and literacy evaluation as support, a theoretical framework and practical strategies for interdisciplinary project-based learning are formed. This provides strong support for the development of students' comprehensive literacy and innovation capabilities (Huang, 2024). Primary and secondary school students participating in smart farm activities can directly learn about the biological knowledge related to crop growth, understand the food chain and material cycles within agricultural ecosystems, and grasp the physical and information technology knowledge behind smart irrigation and temperature control. This broadens students' horizons and constructs an interdisciplinary knowledge system.

3.2.2 Incubator for practical skills and innovative thinking

Smart farms provide a platform for primary and secondary school students to engage in practice, operation, and innovative exploration. By personally planting and raising crops, students develop practical skills. Observing, recording, and analyzing crop growth fosters scientific observation and analytical abilities. Addressing issues such as pest and disease control and resource allocation encourages students to propose innovative solutions, thereby developing their innovative and problem-solving capabilities. Research on smart farm education projects indicates that 68% of students choose to propose innovative solutions, compared to only about 12% in traditional agricultural education groups (Liu et al., 2022).

3.2.3 Cultivation of scientific attitudes and values

Smart farms significantly contribute to cultivating students' scientific attitudes and values. By participating in agricultural production, students experience the hard work of planting and the joy of harvesting, understand the concept that science and technology are the primary productive forces, and develop respect for science and a spirit of exploration in their daily lives. They gain a deeper appreciation for farming, love and respect for agriculture, and enhanced social responsibility and environmental awareness. For example, after participating in a rice-harvesting activity themed "Cherish Every Grain of Food," 41% of students reported reducing food waste (Liu et al., 2022).

3.3 Role transformation of the science and technology counselor empowered by AI

3.3.1 From knowledge transmitters to technology integrators

To achieve effective science communication in AI - empowered smart farms, science and technology counselor must be both learners and users of AI technology. They need to acquire knowledge of AI technology, become familiar with its applications and operations, and learn to collect and analyze data using smart devices. For example, based on AI-analyzed data on students' learning situations, counselor can identify students' knowledge weaknesses and promptly adjust their teaching content and methods.

3.3.2 From activity organizers to innovative planners

Science and technology counselor should become planners and leaders of innovative communication approaches. They should use AI resources and innovative methods to design more creative and attractive science-popularization activities. For example, they can design interactive games or virtual experiments that utilize AI technology, allowing students to explore independently. During activities, counselor should act as guide, encouraging students to identify and actively attempt to solve problems, thereby fostering students' innovative and practical abilities.

3.3.3 From sole educators to integrators of science and humanities

Counselor should advocate for the integration of science and humanities and guide students to dialectically view the application and potential negative impacts of AI technology. They should pay attention to the humanistic aspects of technology and its associated social values. For example, by telling stories about the development of agricultural technology, counselor can cultivate students' humanistic spirit and sense of responsibility, and integrate scientific and technological education with humanistic quality education.

3.4 Pathways for primary and secondary schools to conduct smart farm classes under the "Double Reduction" policy

3.4.1 Curriculum design: integration of multiple disciplines and emphasis on practicality

The curriculum design for smart farm classroom teaching should break down disciplinary barriers and implement interdisciplinary teaching. For example, the application of sensors in information technology, the principles of simple machines in physics, and plant growth in biology can be organically integrated. Taking tomatoes as an example, students need to understand the entire growth process and photosynthesis of tomatoes, the physical knowledge of designing an irrigation system, and the information technology knowledge of detecting environmental parameters. Teachers should adhere to a practice-oriented approach in teaching, designing numerous hands-on activities (such as sowing, fertilizing, and pest and disease control) to cultivate students' practical abilities and their skills in observing, analyzing, and solving real-world problems. At the same time, layered courses should be set according to students' cognitive levels and interests at different ages. In lower grades, the focus is on basic cognition and simple operations, while in higher grades, emphasis is placed on inquiry-based learning and practical innovation.

3.4.2 Teaching model: combination of diversity and personalization

A variety of teaching methods should be employed to enhance students' interest. Under the project-based learning model, teachers can propose challenging project tasks, such as "Designing an Energy-Efficient Smart Farm Planting Scheme." Students complete the entire process of research, planning, implementation, and evaluation in groups, thereby improving their teamwork and project management skills (Zhang et al., 2025). Under the inquiry-based learning model, students independently identify problems, design experiments, collect data, and draw conclusions (for example, investigating plant growth under different light intensities). The teaching model combines online and offline approaches, with online resources such as agricultural science popularization videos and virtual experimental platforms, and offline activities such as field teaching and hands-on experiments to promote interaction among teachers and students and among students themselves. Personalized learning guidance should be provided based on students' individual interests and learning styles. For example, students who are good at drawing can be assigned to create agricultural science-popularization posters, while those who like programming can be taught about agricultural IoT programming.

3.4.3 Resource integration: collaboration between schools and the community to enrich teaching resources

Utilize all available spaces within the school (including vacant land and rooftops) to create various forms of smart farms using modern technology. Equip these farms with smart irrigation, temperature control, and monitoring devices to provide students with practical experience. Fully leverage the potential of in-school teachers by establishing interdisciplinary teacher teams to conduct smart farm classroom teaching and research. Strengthen the integration of external resources by collaborating with local agricultural research institutions and farms. Invite agricultural experts to give lectures at school and participate in practical activities. Organize student visits to farms to experience modern agriculture. Partner with technology companies to introduce advanced agricultural technology products and techniques into learning and practical life. Use internet platforms to gather high-quality agricultural science - popularization websites and online courses from across the country.

3.4.4 Evaluation system: diversification, focus on process and growth

Establish a comprehensive evaluation system to assess students' participation in smart farm classroom teaching from multiple dimensions. The evaluation content includes knowledge mastery, practical ability, innovation ability, and teamwork skills. A variety of evaluation methods are used, including teacher evaluation, student self-evaluation, and peer evaluation. Teachers focus on assessing students' enthusiasm during the learning process and their ability to solve problems. Student self-evaluation and peer evaluation encourage self-reflection and mutual learning. At the same time, student learning portfolios should be established to record and display students' various works, experimental reports, and reflective diaries from smart farm classes. This makes the process of students' growth and progress visible and motivates more students to actively participate in smart farm classroom studies, thereby comprehensively improving students' overall quality.

4. Conclusion

The study demonstrates that the smart farm empowered by AI technology is a novel means of introducing adolescents to the science classroom. It also serves as a crucial venue for imparting scientific knowledge to students, fostering their practical abilities, and shaping their ethical views. Establishing a systematic growth-capability framework is conducive to facilitating the transformation of the role of science and technology counselor, which to a large extent, determines the quality of educational outcomes.

Further research can be conducted to explore the patterns of cognitive development of students of different ages when they enter the smart farm, the factors influencing their career choices after long - term involvement in smart farm projects, and the effective design of a rational allocation system for educational resources between urban and rural areas regarding smart farms.

AI technology is revolutionizing agricultural production methods and opening up new horizons for science communication. To cultivate talents that meet the demands of agricultural modernization, it is essential to establish a smart - farm education system that integrates the concept of coordinated development among "technology - education - society."

Conflict of Interest

The author declares that she has no conflicts of interest to this work.

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