Exploration of Teaching the Practical Course "Tea Tree Breeding" from the Perspective of the Metaverse

Zeyan Zhao[1, a], Zhongtao Ji[2, b *], Xueying Zhang[1, c], Haitao Ren[1, d]

[1] College of Tea(Pu'er), West Yunnan University of Applied Sciences, Pu'er, China
[2] College of Physics and Electronic Engineering, Qujing Normal University, Qujing, China

[a]zhaoze_yan@126.com, *[b]jizt123@126.com, [c]2928641396@qq.com, [d]Ding@126.com

Abstract. This article takes the "Tea Tree Breeding" course in universities as an example to explore the optimization and practice of teaching methods for tea tree breeding empowered by the metaverse. It addresses the pain points of traditional tea tree breeding teaching, such as long breeding cycles, limited practical scenarios, expensive equipment and reagents, and the disconnect between theory and practice. Relying on the core technologies of the metaverse, this study constructs an immersive and interactive digital and intelligent teaching platform for tea tree breeding. This teaching model breaks through the limitations of season, region, time, and experimental conditions, reduces the teaching threshold of high-cost and high-risk breeding experiments, enhances students' understanding of theoretical knowledge and practical ability in tea tree breeding, and combines cutting-edge digital technology with traditional tea tree breeding teaching, creating a new teaching model of "combining virtual and real worlds, integrating theory and practice".

Keywords: Metaverse, Tea tree breeding, Digital innovation

1 Introduction

In the context of the new agricultural sciences, the practical teaching segment of "Tea Tree Breeding" serves as a crucial hub connecting theoretical cognition with industrial innovation. Through "learning by doing", students transform abstract genetic breeding principles into professional abilities to solve practical production problems, thus breaking down the barriers of the disconnection between theory and practice in traditional teaching. This approach aims to cultivate high-quality talents with innovative thinking and practical skills for the high-quality development of the tea industry.

The metaverse teaching platform sets up experiments such as "tea tree DNA extraction and detection", "pollen vitality determination", "individual selection", and "resistance determination" to consolidate students' foundation in molecular biology and statistics.

Emphasis will be placed on internships such as "sexual hybridization of tea trees", "collection and processing of tea fruits", "grafting improvement", and "tissue culture",

Z. Ge et al. (eds.), *Proceedings of the 2026 6th International Conference on Education, Information Management and Service Science (EIMSS 2026)*, Atlantis Highlights in Computer Sciences 25,
https://doi.org/10.2991/978-94-6239-766-8_22

to enable students to proficiently master conventional breeding and biotechnology breeding methods. At the same time, in response to the imbalance between production and marketing in the tea industry and the homogenization of varieties, students will be guided to conduct in-depth field investigations in farming, collect unique resources, and consider how to cultivate differentiated and distinctive varieties through artificial breeding methods, such as selecting early-growing varieties for specific industrial zones (such as early spring flat tea in southwestern Guizhou).

2 The Practical Demand of the Metaverse in the Teaching of New Agricultural Sciences

2.1 The Difficulties Faced in Practical Teaching of Tea Tree Breeding

Traditional tea tree breeding teaching often focuses on theoretical indoctrination, leading to students' lack of interest and difficulty in mastering core skills. Modern teaching reforms emphasize scientifically adjusting the teaching sequence according to the seasonality of tea tree growth, significantly increasing practical class hours, and constructing a full-chain practical content covering germplasm resource collection, evaluation, acclimation, and new variety breeding [1].

Taking a university in Yunnan as an example, "Tea Tree Breeding" involves six experiments, namely: description norms and application of tea tree germplasm resources, selection of excellent tea tree individuals using scoring method, selection method of tea tree individuals (chloroform rapid identification fermentation method), sexual hybridization technology of tea trees, tea seed germination, and determination method of tea tree plasma membrane permeability (conductivity determination method), as well as identification of tea tree stress resistance (indirect identification method of drought resistance and cold resistance). Due to insufficient funds and the high cost of testing equipment and reagents, it is impossible to meet the large-scale use, resulting in teaching effects that have not achieved the established goals of talent cultivation.

2.2 Advantages of Metaverse-Enabled Teaching

Based on digital technologies such as virtual reality, augmented reality, image recognition, and somatosensory interaction, the metaverse extends learning experiences from real-world physical perception to virtual somatosensory environments, presenting a 4D immersive learning experience for teaching. It gradually influences and changes teaching effectiveness and educational value, representing a coupling of educational innovation and transformation, and is an inevitable choice for the future development of new agricultural science education [2].

1)Somatic perception acceptance. In the metaverse, learners find themselves immersed in vast tea mountains or fully equipped laboratories. The somatic perception stimulation provided by the virtual environment triggers sensory acceptance, enabling knowledge transfer, and further forming a cognitive process through emotional internalization.

2)Human-Computer Interaction. In virtual space, learners perceive teaching content through senses such as vision, hearing, touch, and smell, and are systematically stimulated. This allows learners to acquire an intuitive, rich, and interactive learning experience, while enhancing their engagement and learning effectiveness [3]. By developing and designing interactive content and guided teaching activities, such as developing gene detection, DNA extraction, RNA extraction, RNA reverse transcription, DNA cloning, etc., the proportion of interactive content is increased, thereby constructing a more immersive and engaging intelligent meta-environment, achieving a deep integration of knowledge transfer and ability cultivation.

3)Scene navigation. Relying on the large model and intelligent agent of biotechnology related to "Tea Tree Breeding", learners in the metaverse can take on the avatar of digital humans to learn through virtual scenarios that have been demonstrated through big data, are indirect yet effective, and are experiential. These scenarios are rendered in real-time based on learners' intentions and the conclusions of virtual experiments, presenting simulations of any scene to verify experimental conclusions and enhance learning efficiency [4].

4)Learner identity authentication. As the frequency and duration of learning increase, learners and the metaverse form a virtual social relationship. To expand the space of virtual learning and create learning partners for artificial intelligence, and to form a learning team across different spaces and forms, the virtual identity of learners needs to be established, endowing them with a new identity that transcends the real world.As shown in Figure 1.

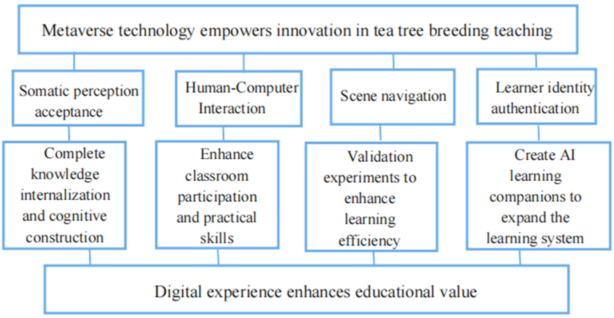

Fig. 1. Advantages of Metaverse-Enabled Teaching.

3 The Current Application Status of the Metaverse in Education and Agriculture

3.1 Theoretical Framework of Educational Metaverse and Transformation of Teaching Forms

As an important vision for future education, the education metaverse can break through traditional time and space limitations, provide more attractive, interactive, and personalized learning experiences, and thus solve the problem of lack of presence and depth of interaction in online education.

And multimodal data technology in it[5].The case study by Omar Tayan et al. (2025) shows that combining flipped classroom with AR/VR technology can significantly enhance the engagement and interactivity of college students[6].

3.2 The Specific Practice and Strategy of Metaverse in Subject Teaching

In specific cases of disciplinary application, focus on how to utilize the immersive nature of the metaverse to solve teaching difficulties in specific disciplines, especially in areas that require high contextualization, experimental operations, or cross-cultural understanding.

Liu Jiaqi and Wang Qiang (2023) focus on middle school chemistry teaching and propose using the educational metaverse to empower virtual experiments and educational games. They point out that virtual experiments have characteristics such as authenticity, generativity, and safety, which can effectively solve the limitations of traditional experiments[7]. AzinYazdi (2025) used bibliometric methods to analyze the intersection of mathematics education and the metaverse, and found that this technology significantly enhances the understanding of complex mathematical concepts by providing immersive experiences[8].

3.3 The Application of Metaverse in Modern Agriculture and Agricultural Machinery

The application of metaverse technology in the field of agriculture is a product of the deep integration of digital agriculture and virtual simulation technology, aiming to achieve digital mapping and intelligent management of the entire agricultural production process by building a parallel "agricultural metaverse" with the real world[9].

The importance of this direction lies not only in optimizing agricultural production management processes, but also in playing a key role in the design, testing, and optimization of agricultural machinery. Through high-precision modeling and dynamic simulation, it reduces research and development costs, improves operational efficiency, and is a new trend in the development of smart agriculture[10].

3.4 Research Status of Digitalization and Informationization in Tea Tree Breeding

In the context of extremely abundant germplasm resources, using digital methods such as bioinformatics and genomics to deeply analyze tea germplasm can significantly shorten the breeding cycle and improve breeding accuracy. Zhang Hongxiu et al. (2024) systematically summarized the breeding techniques of recent decades in "Research Progress on Tea Tree Breeding", emphasizing the core applications of biotechnology such as whole genome sequencing and assembly, functional genomics, etc. in tea breeding.

They pointed out that these digital biotechnology have accelerated the pace of breeding excellent varieties[11].

Zhou Ziwei (2024) explored the specific application of agricultural computer information technology in tea planting through practical case analysis, and confirmed that this technology can effectively improve tea yield and quality[12]. The digital research in the field of tea tree breeding is at a critical stage of transitioning from "biotechnology dataization" to "intelligent breeding decision-making".

4 Innovative Paradigm of Practical Teaching in Tea Tree Breeding

Metaverse technology integrates AR, MR, AR, XR, big data, artificial intelligence, and other technologies. Leveraging its immersive, virtual-real fusion, and strong interactive features, it has created a low-cost, high-security, and repeatable virtual training environment, ushering in a new stage of virtualization and intelligence in tea tree breeding education. It transforms abstract theoretical concepts into visual virtual scenes, addressing the structural contradiction of "the disconnect between theoretical abstraction and practical operation, as well as resource scarcity and technological lag," thereby helping students make a leap from theoretical learning to practical innovation. Build an intelligent learning space, as shown in Figure 2.

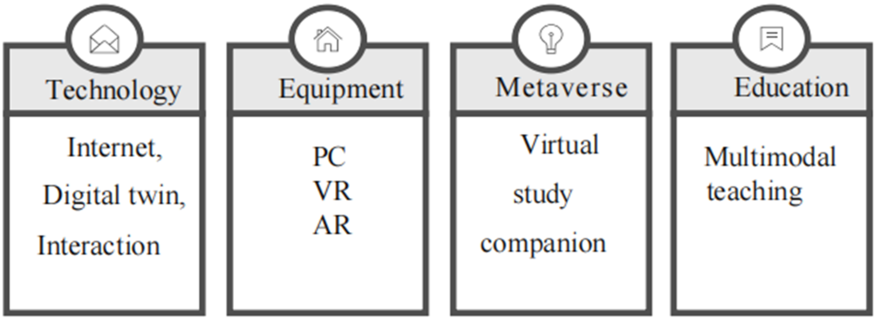

Fig. 2. Build an intelligent learning space.

4.1 Build a Virtual Teaching Platform for the Metaverse

Thanks to the continuous investment of the country in the digitalization strategy of education, the foundational conditions have been provided for the digital transformation of tea tree breeding education in the new agricultural discipline. The development platform utilizes software creation engines such as OpenSim and Unity 3D to build a metaverse virtual teaching platform and integrates with the port of the China Crop Germplasm Resources Information System (CGRIS).

The platform is primarily used to store and manage information on wild, local, selected, and introduced germplasm resources and genetic materials of tea crops, including germplasm investigation, introduction, preservation, monitoring, reproduction, identification, evaluation, and utilization data, crop variety pedigree, regional experiment, demonstration, and approval data, as well as crop fingerprint maps and DNA sequence data, providing learners with teaching information on crop varieties and biodiversity. The design of the educational metaverse platform for tea tree breeding practice courses includes four major modules:

1)Tea Tree Sample Database: In this module, the content related to tea trees in the China Crop Germplasm Resources Information System (CGRIS) port is primarily linked, presenting detailed information about crop roots, stems, leaves, flowers, and fruits in a 3D stereoscopic manner. Learners can click on the images with a joystick to enter the virtual living space of the samples and observe the plant characteristics and living environment up close.

2) Local tea tree gene bank: In this module, the main tea tree gene data and detailed information of the local area are collected and stored. With the deepening of research, the data in this module is continuously updated.

3) Tea Tree Breeding Experiment Platform (including tea tree DNA extraction and detection, pollen vitality determination, individual selection, resistance determination, etc.): Learners entering the metaverse teaching space can select breeding varieties through a controller, and the system will fuse genetic material through specific biotechnology.

4) Offspring trait visualization platform: The backend of this system is equipped with biotechnology AI large model functionality. Upon receiving instructions from the console, the backend biotechnology large model will automatically generate offspring plant samples based on data from the gene library and sample library. Learners can observe and collect trait data in the virtual domain. As shown in Figure 3.

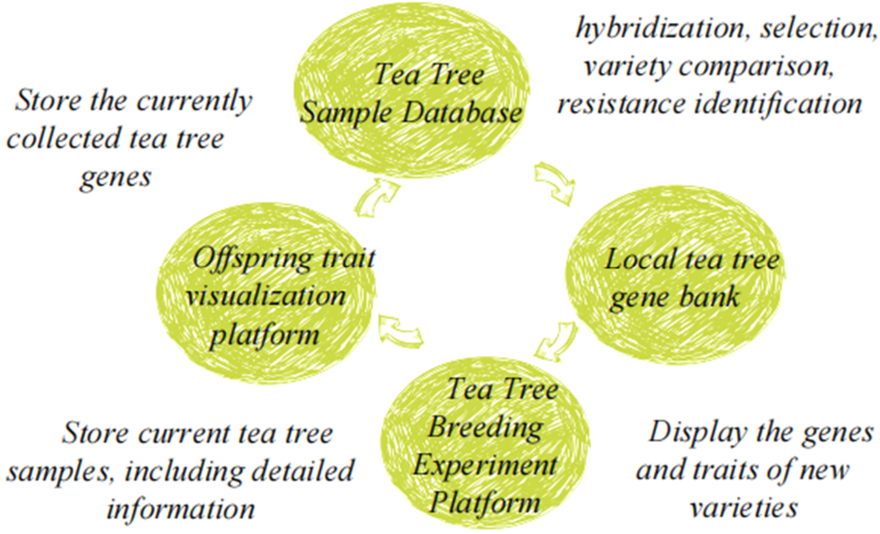

Fig. 3. Virtual operation module for tea tree breeding.

4.2 Diversification of Teacher Roles

The metaverse-based practical teaching platform for tea tree breeding promotes teaching activities to be more learner-centered, with a more personalized and innovative learning process. Due to the increase in learning frequency, the traditional binary relationship of "teacher-student" in the classroom is gradually being replaced by a new type of collaborative interaction among multiple subjects, including "human-machine-object-scene" in virtual settings [13].

Teachers are no longer merely disseminators of knowledge, but rather guides and facilitators of students' knowledge acquisition. In the future, teachers will need to possess stronger innovative consciousness and digital innovation skills. Leveraging data, they will gain insights into learners' interest preferences, learning objectives, and attitudes towards learning. Through intelligent assessments and personalized guidance, they will help students grasp and understand knowledge points, greatly expanding the breadth and depth of practical teaching.

4.3 Embodied Teaching Methods

With the continuous deepening of the empowerment of the metaverse, it is required that teachers' teaching abilities and digital literacy must be updated simultaneously. Especially under the guidance of embodied cognition theory, relying on the data from the Chinese Germplasm Resource Bank and the empowerment of metaverse technology, a practical teaching platform for tea tree breeding is established. Students can complete the entire chain of experimental operations, such as the collection and sorting of trait data, learning sampling strategies, management and effectiveness testing of core germplasm, and genetic analysis, in a virtual environment without being restricted by time, space, and season. Through this immersive, project-based learning, knowledge impartation, ability cultivation, and innovation consciousness shaping are effectively integrated, promoting the comprehensive development of students' overall quality.

5 Conclusion

As a comprehensive development direction of the new generation of information technology, metaverse technology, with its characteristics of virtual reality integration and human-machine collaboration, is profoundly empowering the multi-dimensional development of agriculture and the tea industry. By integrating virtual and real worlds, the metaverse addresses the pain points of seasonal, geographical, temporal, and experimental condition constraints in tea tree breeding practice courses.

It breaks through the limitations of traditional offline teaching, constructs a mechanism for breeding simulation and skill training that combines virtual and real worlds, and solves the problem of disconnection between talent cultivation and industry needs. At the same time, it provides innovative paths for digital cultivation, brand intellectual property, and immersive marketing experiences, greatly enriching the expression of tea culture and promoting the deep integration of "tea + culture + tourism", thereby facilitating the intelligent upgrading of the tea industry.

In the practical course of tea tree breeding, the metaverse leverages the integration of technologies such as VR, AI, and digital twins to construct high-precision "digital tea gardens" and "gene expression simulators". These tools simulate the growth performance of tea tree germplasm resources under different climatic, soil, and pest conditions, significantly reducing the years or even decades required for traditional breeding. Through deep data mining, excellent genotypes with stress resistance, high aroma, or specific nutritional components can be quickly screened in virtual space, enabling precise optimization and rapid iteration of breeding schemes.

In the tea industry, by building a digital ecosystem, brand value can be enhanced. For instance, Xinyang Tea Industry has proposed paths such as "Metaverse Tea Tourism" and "Blockchain NFT Traceability", effectively addressing the issues of product homogeneity and fragmented brand management in the market. Simultaneously, the Metaverse demonstrates immense potential in advancing a low-carbon economy, reshaping the international trade landscape, and fostering high-quality development in the tea industry through the "synergy of three teas".

Acknowledgment

We sincerely appreciate the financial support from the Teaching Quality Engineering Project entitled Research on the Teaching Design of Pu'er Tea Metaverse Learning Space (Grant No. 25JG07(AI)).

This study was funded by [Teaching Quality Engineering Project] “Research on the Teaching Design of Pu'er Tea Metaverse Learning Space” (Grant numbers [25JG07(AI)]).

References

1. Zhu Shigui, Fang Wanping. Current Status and Prospects of Basic Research on the Application of Chinese Tea Science [J]. Acta Agriculturae Jiangsu, 2008, (4): 522-526
2. Pan Yue, Yi Chunshi. Discussion on the Construction of Virtual Simulation Experiment Curriculum System in Agricultural and Forestry Colleges and Universities under the Background of New Agricultural Sciences [J]. Higher Agricultural Education, 2023(4): 98-104
3. Liu Geping, Wang Xing, Gao Nan, et al. From Virtual Reality to Metaverse: New Directions for Online Education [J]. Modern Distance Education Research, 2021, 33(6): 12-22
4. Zhai Xuesong, Chu Xiaoyan, Gu Jianmin, et al. From Knowledge Sharing to Knowledge Co-creation: A Decentralized Knowledge View of the Educational Metaverse [J]. Journal of East China Normal University (Educational Science), 023, 41(11): 27-37
5. Liu Yufei, Huang Jiahui The Application and Prospect of Metaverse in Education [J]. Science, Education and Culture Review, 2024, (17)
6. Omar Tayan,Abdelaziz I. Hammouri,Sanaa Askool, Hanadi Aljohani, Barakat Makrami. Flipped and Immersive Student Learning Strategy using Metaverse, Augmented & Virtual Reality in Higher Education: a Case Study of Student and Faculty Perspectives[J]. TechTrends, 2025.
7. Liu Jiaqi, Wang Qiang Reflections on the Application of Educational Metaverse in Middle School Chemistry Teaching [J]. Education and Equipment Research, 2023, (04)

8. Azin Yazdi.Exploring the intersection of metaverse and mathematics: a visual analysis of bibliometric networks[J].Discover Education, 2025.
9. Ali Abdari, Alex Falcon, Giuseppe Serra. Searching Agricultural Learning Experiences in the Metaverse via Textual and Visual Queries Within the AgriMusproject[J].International Journal on Digital Libraries, 2025.
10. M. Ángeles López Cabarcos, Juan Piñeiro Chousa.Illusion or reality? Building a metaverse community focused on value creation in the agricultural sector[J].International Journal of Information Management, 2024.
11. Zhang Hongxiu, Wang Lingyi, Sun Yangyang, He Yuanqing, Xu Lirong, Liu Shengrui Progress in Tea Breeding Research [J]. Journal of Tea Industry, 2024, (05)
12. Zhou Ziwei Application Analysis of Agricultural Computer Information Technology in Tea Planting [J]. Agricultural Engineering Technology, 2024, (20)
13. Sun Tianlinzi, Zhang Liang. From "Body Technology" to "Technological Body": The Constructive Shift of Metaverse Learning Space from the Perspective of Phenomenology [J]. Modern Distance Education Research, 2025, 37(3): 21-29