Construction of an Evaluation System for Participation and Innovation Ability in Agricultural Master's Practical Classroom Based on AI Multidimensional Affective Computing

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Abstract The evaluation of agricultural master's practice teaching has long suffered from issues such as a heavy focus on outcomes over processes, single-dimensional criteria, and strong subjectivity, making it difficult to effectively measure students' classroom engagement and innovation capabilities. Addressing the limitations of traditional evaluation models, by introducing AI affective computing technology into the field of agricultural master's practice teaching evaluation, a comprehensive evaluation system based on multi-dimensional affective computing is constructed. In this paper, the evaluation index system is deconstructed from three core dimensions: focus, collaboration, and innovative behavior, establishing a mapping relationship between affective computing technology and evaluation dimensions. Building on this, a multimodal data collection scheme is designed, employing deep learning algorithms to extract key features of engagement and innovative behavior, thereby constructing a comprehensive evaluation model. Finally, implementation pathways for the evaluation system are proposed. It demonstrates that this system can dynamically track and accurately characterize students' practical processes, providing scientific and data-driven support for improving the quality of agricultural master's talent cultivation.

Key words AI; Agricultural master; Affective computing; Practical classroom engagement; Multimodal data

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Agricultural master's degree education is an important talent support for the national rural revitalization strategy. The National Agricultural Professional Degree Graduate Education Guidance Committee has clearly stated that professional degree graduate education must focus on solving the problem of the disconnect between practical teaching and industrial demand, and provide strong talent support for the modernization of agriculture and rural areas in China[1]. As a core component of agricultural master's talent cultivation, practical teaching carries the key mission of cultivating students' ability to solve practical problems in agricultural production. However, the existing evaluation system for practical teaching of agricultural masters has significant limitations. On the one hand, the score of practical teaching achievement award excessively depends on the outcome indicators such as innovation, progressiveness, practical effect and promotion value. On the other hand, practical assessment is mainly evaluated based on quantitative data such as research logs, practical reports, and internship duration. This evaluation model ignores the emotional state changes, classroom participation depth, and innovative behavior of students during virtual experiments and field operations, making it difficult to achieve dynamic monitoring and accurate profiling of students' professional abilities[2].

The rapid development of AI technology provides a historical opportunity for the transformation of educational evaluation. Affective computing technology can achieve real-time recognition and analysis of human emotional states by integrating multimodal data such as facial expressions, speech intonation, and physiological signals. It can help break through the traditional single score evaluation model, construct a process oriented and multidimensional comprehensive evaluation model, and respond to the urgent need for improving the quality of talent cultivation in the construction of new agricultural science by introducing multidimensional affective computing into the evaluation of agricultural master's practical classrooms[3].

This paper aims to construct an evaluation system for the participation and innovation ability of agricultural master's practical classrooms that integrates affective computing technology, achieving a paradigm shift from "result evaluation" to "process evaluation" and from "single dimension" to "multidimensional integration". At a theoretical level, this paper expands the application boundaries of affective computing in the field of education, enriches the theoretical system of agricultural professional degree education evaluation, and provides theoretical support for teaching evaluation reform under the background of "new agricultural science". At the practical level, this paper provides actionable technical solutions for monitoring the quality of practical teaching in

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agricultural colleges, promotes the coordinated improvement of students' emotional development and professional abilities, and serves the cultivation of high-quality agricultural talents.

1 Theoretical framework of multidimensional affective computing evaluation system

1.1 Principles and objectives for constructing an evaluation system This paper emphasizes the unity of diagnostic, developmental, and motivational functions of evaluation. In the practical teaching of agricultural master's degree, evaluation should not only be used as a screening tool, but also as a supporting means to promote students' professional growth and innovation ability development. At the same time, this paper proposes the principle of "integration of reason and emotion" that emphasizes both technological empowerment and humanistic care, clearly avoiding the risks of technological alienation such as emotional absence and symbolic evaluation, and ensuring that affective computing serves the comprehensive development of people[4].

This evaluation system sets four core objectives: firstly, to perceive students' emotional states in real time. Through multimodal data, students' emotional fluctuations and cognitive changes during the practical process are collected and captured. The second is to dynamically track the process of classroom participation and achieve a paradigm shift from outcome evaluation to process evaluation. The third is to accurately identify the characteristics of innovative behavior, providing evidence support for the cultivation of innovation ability in agricultural master's degree. The fourth is to optimize the teaching decision-making plan through feedback, forming a closed-loop mechanism of "evaluation – feedback – improvement". Given the particularity of agricultural practical teaching, this paper emphasizes the need to balance the digital context of virtual experiments with the open context of field operations, and establish differentiated evaluation standards to meet the differentiated needs of evaluation tools and technical paths in different practical forms.

1.2 Core evaluation dimensions and indicator deconstruction This paper constructs an evaluation index system of "three dimensions and nine indicators". The dimension of emotional investment includes three indicators: focus, pleasure, and anxiety, which respectively characterize the degree of attention concentration, positive emotional experience, and feelings of stress and setbacks. The dimension of collaborative participation includes three indicators: interaction frequency, role assumption, and conflict coordination, reflecting the frequency of communication between teachers and students, among students, the execution of team task division, and the ability to handle differences of opinion and reach consensus. The dimension of innovation behavior sets three indicators: problem sensitivity, originality of solutions, and practical verification ability, reflecting the ability to identify abnormal phenomena, non standardized solution paths, and hypothesis testing and iterative optimization.

Each indicator is defined operationally, and specific observation points and data collection methods are specified for both virtual experiments and field operations. In terms of indicator weight allocation, a combination of Analytic Hierarchy Process and Delphi method is used to determine weights, highlighting the guiding role of innovative behavior dimension, in order to meet the core goal of enhancing innovation ability in agricultural master's talent cultivation. The affective computing model based on multimodal data fusion can significantly improve the accuracy of emotion recognition, providing technical feasibility support for the quantitative implementation of the indicator system in this paper.

1.3 Mapping relationship between affective computing technology and evaluation dimensions In this paper, a technical mapping system for multimodal emotional data and evaluation indicators is established. Facial expression recognition is mapped to focus, pleasure, and anxiety levels; speech emotion analysis is mapped to interaction frequency and conflict coordination; eye movement and posture tracking are mapped to focus and character engagement; operation log mining is mapped to problem sensitivity, originality of solutions, and practical validation; social network analysis is mapped to interaction frequency, role assumption, and conflict coordination.

To address the ambiguity and noise interference in affective computing in complex agricultural practice scenarios, this paper designs a four-layer mapping model of "scenario – signal – feature – indicator" to achieve systematic transformation from raw data to evaluation indicators. At the same time, taking into account factors such as the wide geographical range of agricultural master's students and differences in emotional expression styles, cross-cultural adaptation mechanism is introduced, to enhance the model's generalization ability.

2 Design and implementation of evaluation model based on affective computing

2.1 Acquisition and preprocessing of multimodal data The agricultural master's practical classroom covers two typical scenarios: virtual experiments and field operations, and requires the construction of a differentiated multi-source sensing acquisition scheme. In the virtual experiment scenario, the system integrates a camera to collect facial expression information, a microphone array to capture voice interaction data, an eye tracker to track visual attention distribution, an operation screen recording to record behavior sequences, keyboard and mouse logs to reflect operation patterns, forming a five dimensional collaborative data collection architecture. The field operation scenario relies on wearable devices to obtain physiological signals such as heart rate and skin conductance, portable cameras to record the operation process, mobile terminal APPs to achieve real-time voice recording and GPS trajectory tracking, unmanned aerial vehicle aerial photography to provide a panoramic view of the work area, and a three-dimensional field data acquisition network is built.

The preprocessing of multi-source heterogeneous data is a key step in ensuring the effectiveness of subsequent analysis. Firstly, time synchronization alignment is implemented, and timestamp based interpolation algorithm is used to unify the sampling frequency of each sensor. Then, noise filtering is carried out, and a combination of wavelet transform and Kalman filter is used to remove environmental interference and equipment noise. For the problem of missing values, forward filling, linear interpolation, or KNN based interpolation strategies are adopted according to the data type. Finally, feature scale unification is achieved through Z-score normalization and Min-Max normalization. In terms of data ethics, it is necessary to establish a strict informed consent mechanism, implement data desensitization, adopt localized storage and edge computing deployment mode, ensure compliance with the requirements of the *Personal Information Protection Law* and educational data security specifications, and seek a balance between technological innovation and privacy protection.

2.2 Key feature extraction of participation and innovative behavior The accurate extraction of emotional features is the core foundation for constructing evaluation models. Facial expression recognition adopts a deep learning based FER model, which combines convolutional neural networks with attention mechanisms to achieve real-time recognition of seven basic emotions such as happiness, confusion, and focus. Speech emotion recognition relies on the Transformer architecture, modeling from both acoustic features and semantic content channels to capture the emotional information contained in intonation fluctuations and speech rate changes. Physiological signal emotion inference is based on LSTM network, which maps time series data such as heart rate variability and skin conductance response to emotional states. The three models work together to output time series of continuous emotional value. The quantification of participation behavior characteristics needs to break through the limitations of traditional duration statistics. In this paper, key indicators such as "effective operation duration", "task switching frequency", "help seeking behavior pattern", and "resource access path" are defined and extracted, and a participation quantification index that covers cognitive investment, behavioral persistence, and strategy flexibility is constructed.

The optimization of feature fusion strategy directly affects model performance: early fusion achieves multimodal data concatenation at the feature level, mid-term fusion integrates model output at the decision level, and late fusion completes final weighting at the score level. By verifying and analyzing data from agricultural practice scenarios, the optimal fusion scheme that balances recognition accuracy and computational efficiency is determined, laying the data foundation for the subsequent algorithm construction of comprehensive evaluation model.

2.3 Algorithm construction of comprehensive evaluation model Based on the aforementioned feature extraction results, a multimodal affective computing network based on attention mechanism is constructed to achieve adaptive weighted fusion of heterogeneous data. This network dynamically adjusts the weights of each channel through cross modal attention modules, effectively addressing the issues of modal loss and noise interference. The time series modeling module adopts a bidirectional LSTM architecture to capture the dynamic evolution of emotions, identify the time delay effects of "emotional triggering – cognitive processing – behavioral performance", and provide temporal support for participation prediction.

The sub-model of participation prediction takes emotional features as input and combines contextual variables such as task difficulty, time pressure, and team composition to output real-time participation levels. The sub-model for evaluating innovation capability introduces graph neural networks to model the knowledge flow and innovation diffusion in student collaboration networks, and identify key innovation nodes and edge innovators. The model training adopts transfer learning strategy, pre training with public sentiment dataset, fine-tuning with agricultural practice scenario data, and cross validation to ensure robustness. The final output includes individual portrait radar maps, group heat maps, and low participation warning prompts, forming a three-dimensional evaluation feedback system. This evaluation system combines multimodal data fusion with deep learning algorithms to achieve dynamic and precise evaluation of participation and innovation ability in agricultural master's practical classrooms, providing a scalable technical path for educational evaluation reform.

3 Implementation path and case analysis of evaluation system

3.1 Implementation path and guarantee mechanism In this paper, a four-stage implementation roadmap for "infrastructure – platform development – pilot applications – iterative optimization" is designed. The infrastructure layer focuses on the construction of intelligent laboratory for practical teaching of agricultural master's degree, integrates the virtual simulation platform and the Internet of Things field monitoring station, and deploys edge computing nodes and 5G transmission network, realizing the seamless data collection of virtual experiments and field operation scenes. The platform development layer has launched the "Agricultural Intelligence Evaluation" multidimensional evaluation system, which integrates four functional modules: data collection, real-time analysis, visual feedback, and teaching decision support, providing a technical carrier for process evaluation. At the organizational support level, a four-party collaborative mechanism of "school – college – mentor – technical team" is established, which clarifies the division of responsibilities of each subject. Evaluation data management methods and ethical review regulations are synchronously formulated, and data collection boundaries and privacy protection clauses are standardized. In terms of teacher development, special training on affective computing literacy is carried out to enhance teachers' abilities in data interpretation and human – computer collaborative teaching, avoid the risks of "technology dependence" and "emotional transfer", and ensure the unity of technology empowerment and educational essence.

3.2 Case design and application process As a case carrier, the comprehensive practice of smart horticulture at Yulin Normal University covers two modules: virtual simulation of greenhouse environment regulation and field operation of smart agriculture demonstration base on campus, which is typical and representative. In the pre class stage, baseline emotional characteristics of students are collected, and an individual emotional baseline model is established. During the in class stage, teachers implement targeted interventions based on system prompts through real-time emotional monitoring and engagement alerts. An innovative behavior analysis report is generated after class to support students' self reflection and personalized guidance from mentors. In the practical process, typical student types such as high participation – high innovation, high participation – low innovation, and low participation – high anxiety are identified, and differentiated intervention strategies are matched to achieve precise teaching regulation[5].

3.3 Preliminary application effect and feedback The research results indicate that the experimental group is significantly better than the control group in terms of practical performance, innovative project output, and student satisfaction. Qualitative feedback indicates that students recognize the promoting effect of evaluation methods on self-awareness, teachers believe that the system optimizes teaching decision-making effectiveness, and managers affirm its quality monitoring value. At the same time, it has found that affective computing assisted evaluation has a positive effect on students' self-regulation ability, but caution should be taken against the risk of "performative participation" caused by excessive monitoring. The system operation indicators show that the accuracy of emotion recognition is 91.5%, and the real-time processing delay is less than 200 ms, which verifies the availability and reliability of the system.

At the system operation level, the accuracy of emotion recognition reaches 91.5%, the real-time processing delay is controlled within 200 ms, and the warning effectiveness rate is 87.3%. The technical performance meets the requirements of teaching scenarios. However, several problems are also exposed in the pilot program: some students show a tendency towards "performative participation", deliberately adjusting their expressions and behaviors to conform to the system's recognition; the stability of emotion recognition under complex lighting conditions in the field needs to be improved; teachers' dependence on data interpretation is gradually increasing. The research team has established a three-dimensional iterative optimization mechanism of "technology – teaching – ethics", continuously revising algorithm models and teaching strategies to ensure that the evaluation system tends to mature in dynamic adjustments.

4 Conclusions

The research has found that affective computing technology can effectively capture dynamic emotional information in agricultural practice classrooms. This evaluation system can achieve dynamic tracking and accurate characterization of students' practical process, providing scientific and data-driven evaluation support for improving the quality of agricultural master's talent cultivation.

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