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Field-Problem Studios for Practice Capacity Development in Agricultural Engineering and Information Technology Professional Master's Education

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Abstract: Professional master's education in agricultural engineering and information technology is facing a structural challenge: students are expected to solve open-ended field problems involving machinery, sensing, data, software, management, yet many practice courses remain organized around isolated experiments, short-term placements, and output-based assessment. This study aims to develop a non-linear practice-teaching reform framework that transforms authentic agricultural problems into progressive learning situations and verifiable competency evidence. Drawing on experiential learning, situated learning, work-integrated learning, constructive alignment, and authentic assessment, this paper adopts a design-based reform approach. We propose a Field-Problem Studio and Evidence Portfolio model consisting of five integrated components: problem discovery in agricultural production sites, studio-based technical inquiry, digital evidence capture, external moderation. The model reconstructs practice teaching around the complete process of "field observation-data acquisition-system design-prototype iteration-deployment verification-technical communication". Compared with the traditional practice teaching paradigm, the new teaching mode constructed in this study abandoned the shallow practice training logic with the core of completing the experimental operation and writing the project report, and focused on the four core education dimensions of independent inquiry, iterative optimization design, interdisciplinary knowledge integration .Based on the industry development background of digital agriculture and smart agriculture, this study explores the formation of standardized and landing teaching reform path for the pain point of talent training in application-oriented undergraduate colleges, which can provide important practical reference for colleges and universities to improve the post adaptation ability, scientific and technological innovation ability and comprehensive professional quality of graduates of agriculture related majors.

Keywords: Professional Master's Education; Agricultural Engineering and Information Technology; Practice Teaching; Field-Problem Studio; Competency Evidence; Authentic Assessment; Digital Agriculture

1. Introduction

Professional master's education has become an important mechanism for combining graduate education with national development strategies, industrial transformation, and high-quality employment. In China, the expansion of professional degree education is not only an increase in enrollment scale, but also represents a shift in the logic of graduate education from subject centered knowledge reproduction to ability oriented complex professional practice preparation. The development plan for national professional degree graduate education emphasizes that professional degrees should strengthen practical orientation, enhance cooperation with industries and employers, and cultivate high-level applied professionals who can meet the urgent needs of economic and social development [1]. This policy direction is consistent with international discussions on vocational education. Internationally, students not only need to acquire professional knowledge, but also learn how to think, execute, communicate, and make judgments in real professional environments [2,3].

Agricultural engineering and information technology is a particularly representative field for such reform. The rapid development of digital agriculture, smart farming, agricultural robotics, remote sensing, machine vision, Internet of Things, unmanned equipment, and data-driven decision systems has changed the knowledge structure required of graduates. Research on big data in smart farming shows that data applications are no longer limited to single production links; they increasingly influence the whole agri-food value chain and generate socio-technical challenges related to data management, decision making, business models, and stakeholder coordination [4]. Reviews of digital agriculture and Agriculture 4.0 further indicate that technological adoption is shaped by institutional, organizational, social, and ethical factors, rather than by technical performance alone [5]. Machine learning and deep learning have also entered agricultural production systems, creating new possibilities for yield prediction, plant disease detection, machinery control, variable-rate operation, and agricultural information services [6,7]. These developments require professional master's students to integrate agricultural domain knowledge with engineering design, data analysis, software development, field experimentation, and communication with producers and enterprises. However, practice teaching in many application-oriented universities has not fully responded to this transformation. The common arrangement is still dominated by course experiments, short-term enterprise practice, teacher-assigned projects, and final reports. Although this kind of traditional practice training mode can consolidate the students' basic professional operation skills, it is very easy to cause the separation between the teaching and training scene and the actual agricultural production scene. Even if students can successfully complete the sensor calibration test in the laboratory, build the data visualization program architecture, or participate in various field research work, they still have a common lack of ability. It is difficult to independently extract the actual production problems in the agricultural industry, to clarify the constraints of real development in collaboration with relevant industry entities, to scientifically select the suitability engineering evaluation indicators, to lack the ability of whole process data control, and to have the practical experience of completing the prototype iterative optimization in the complex and changeable field operation environment, and to rely on empirical evidence to support the formulation and implementation of their own engineering design scheme. Fundamentally, the core dilemma faced by the current talent cultivation is not simply the lack of practice teaching frequency, but the failure to achieve systematic integration of all kinds of practice teaching links, and the failure to build an integrated professional practice education system with complete structure and smooth connection.

The existing training weakness at the educational level has become a hot topic in the field of pedagogy. Kolb's experiential learning theory clearly points out that the essence of learning activities is a dynamic process that relies on practical experience to complete cognitive transformation and generate new knowledge, which also shows that the practice of educating people can not only stay at the level of shallow practical experience, but also need to be integrated into core processes such as self reflection, theoretical induction and practical verification [8]. The situational learning theory put forward by Lave and Wenger's further clarifies that knowledge acquisition and ability development are deeply dependent on the industry practice community. Learners can gradually go deep into the internal affairs of the industry organization from the initial marginalized participation state, and gradually complete the steady improvement of professional quality and comprehensive ability in the process of deep integration into the practice scene [9].After carrying out a systematic study on workplace learning, billite proposed that the effectiveness of knowledge acquisition in the workplace environment depends on the learning resources and cultivation conditions provided by the industry posts on the one hand, and on the subjective participation of learners themselves on the other. In the process of talent cultivation, colleges and universities should take the initiative to deeply integrate the industry's first-line practical experience with the school's curriculum teaching system, and should not unilaterally believe that talents' independent growth can be naturally realized only by relying on the workplace environment [10,11]. Biggs and Tang's constructive alignment theory also reminds us that intended learning outcomes, teaching activities, and assessment tasks must be mutually aligned [12]. If practice outcomes emphasize complex problem solving but assessment only checks final deliverables, the educational system will inevitably reward superficial completion instead of capability development. For professional master's students, the assessment problem is especially significant. Authentic assessment research suggests that assessment should require students to demonstrate the same combination of knowledge, skills, and attitudes needed in professional life [13]. Feedback research also shows that formative feedback has powerful effects on learning when it helps students understand where they are going, how they are progressing, and what actions should be taken next [14]. In the context of agricultural engineering and information technology, these principles imply that practical competence should be evaluated through multiple pieces of evidence generated during the whole process of field problem diagnosis, design, implementation, verification, and reflection, rather than through a single thesis, competition award, or internship certificate [15]. Based on the above policy and theoretical background, this paper proposes a new practice-teaching reform framework named the Field-Problem Studio and Evidence Portfolio model. The model differs from previous reform narratives that mainly emphasize platform construction, school-enterprise cooperation, or linear curriculum chains. It takes authentic field problems as the starting point, studio-based inquiry as the organizational form, evidence portfolios as the assessment carrier, and professional identity formation as the value orientation. The central research question is: how can application-oriented universities reconstruct practice teaching for agricultural engineering and information technology professional master's students so that real agricultural problems become sustained learning situations and competency development becomes visible, assessable, and improvable?

The innovation and contribution of this study are mainly reflected in three dimensions. First, this study redefined the core connotation of the professional master's practical teaching, abandoned the one-sided cognition that the traditional research equated the practical teaching with the accumulation of practical class hours and the stacking of project tasks, and reconstructed it into an immersive learning ecosystem based on the real scene embedding, with systematicness and integrity. Second, this study constructed a new practical education mechanism with studio teaching as the core carrier, organically integrating multiple core teaching modules such as field survey and observation, digital technology application, iterative optimization of engineering scheme and multi stakeholder collaborative communication, and improved the practical training logic of high-level agricultural talents. Thirdly, this paper constructs a set of evidence-based whole process evaluation system to realize the process traceability and quantitative assessment of students' core abilities such as practical logic deduction, engineering technology decision-making, on-site fault research and judgment and professional value judgment, which completely changes the single limitation of traditional summative evaluation. The teaching reform mode can provide a practical reform scheme that can be used for reference and popularized for agricultural universities and application-oriented undergraduate colleges to optimize the talent training system, cultivate high-quality application-oriented talents suitable for digital agriculture development, modern agricultural equipment research and development, Rural Revitalization and construction, and regional industrial transformation and upgrading [16].

2. Reform Rationale: From Activity-Based Practice to Scenario-Embedded Capability Development

A fundamental limitation of traditional graduate practice teaching is the assumption that capability will naturally emerge from accumulated activities. Under this assumption, institutions increase practical credits, arrange enterprise internships, establish off-campus bases, organize competitions, and encourage students to join research projects. These measures are necessary, but they do not automatically guarantee capability formation. Practice capacity is not the simple sum of tasks completed; it is the ability to mobilize knowledge, tools, values, and judgment in uncertain professional situations. Therefore, reform should shift from activity accumulation to scenario-embedded capability development [17].

Scenario-embedded capability development has three implications. First, the learning problem must be authentic enough to contain real constraints. In agricultural production, a technical solution must consider soil condition, crop growth stage, machinery compatibility, cost, weather uncertainty, operator habits, data reliability, safety, and maintainability. If these constraints are removed for instructional convenience, students will only learn simplified procedures rather than professional problem solving. Second, the learning process must be iterative. Agricultural engineering and information systems rarely work correctly in the first design. Sensors fail, communication signals are unstable, images are affected by illumination, machinery vibration changes the quality of data, and algorithm performance varies across varieties and field conditions. Students need structured opportunities to experience failure, analyze causes, adjust design, and verify improvements. Third, the learning evidence must be process-oriented. The most important learning often occurs in problem framing, decision comparison, field adjustment, and reflective revision, but these processes disappear if only final products are assessed.

Accordingly, the teaching reform program proposed in this study is based on the core education proposition: the construction of professional master's practical teaching system should focus on the transformation process from industrial practical problems to engineering technology programs and empirical results of informatization. Under the new training framework, students' learning focus is no longer limited to answering the standardized questions preset by the teachers, but focuses on identifying industry pain points and condensing practical engineering problems in real agricultural production scenes. At the practical output level, the training mode no longer takes a single conclusion report as the final assessment carrier, but guides students to build a complete practical evidence file, and the system retains the data collection process, hypothesis testing process, prototype iteration optimization scheme, feedback from industry subjects, and the basis for consideration of professional ethics and professional responsibility. This reform mode has completely reversed the shortcomings of the shallow training of traditional practice teaching, and promoted the whole practice training process to become a dynamic development process of students' professional ability [18].

Agricultural Engineering and information technology disciplines have the characteristics of multiple problem scenarios and intensive technology intersection, which can provide natural implementation carriers and training conditions for this practical teaching reform. There are a large number of real engineering pain points in the agricultural field, which can be transformed into studio type comprehensive training tasks. Among them, the production problems of uneven fertilization in the field can be disassembled into a series of practical contents, such as soil nutrient sampling and detection, fertilization prescription map generation, variable rate control, agricultural machinery equipment calibration, program interface development, benefit evaluation and analysis, and farmers' communication and docking; The intelligent identification of weeds in the field can cover such key links as image sample collection, data set annotation and sorting, algorithm model screening, field real-world verification, error traceability analysis, equipment assembly and debugging, and operation safety evaluation; The related research on grain drying process optimization includes sensor network layout, energy consumption model construction, regulation scheme design, data visualization analysis and production risk prevention and control. The above-mentioned complex engineering problems have the characteristics of multiple elements and cross links, and can not rely on a single course experiment to achieve complete ability training, so we must rely on the integrated comprehensive practice training scene to carry out systematic teaching.

This teaching reform fully conforms to the inherent characteristics of professional master training. The core goal of the academic master training system is the accumulation of discipline theory and the breakthrough of original scientific research, while the core orientation of professional master education focuses on the comprehensive cultivation of industry adaptability, practical application value and professional competence. Focusing on practice is not the same as relaxing the academic training standards, but puts forward higher standards for students' comprehensive learning ability. This training mode requires students to transform academic research achievements into practical and applicable engineering solutions based on professional theoretical basis and combined with various practical constraints of the industrial site. It can be seen that the practice teaching of professional masters is not a shallow and procedural skill practice, but a high-level cognitive practice that requires systematic planning and in-depth thinking.

3. The Field-Problem Studio and Evidence Portfolio Model

The Field-Problem Studio and Evidence Portfolio model is designed as an integrated teaching system for professional master's students in agricultural engineering and information technology. The model contains two mutually supporting elements. The Field-Problem Studio is the organizational form of learning, while the Evidence Portfolio is the carrier of assessment and feedback. Together, they create a closed but flexible learning ecology in which authentic agricultural problems are transformed into professional competence.

3.1 Field-Problem Studio

A Field-Problem Studio is a semester- or year-long practice unit built around a real agricultural production problem. It is not a conventional laboratory course, not a loose internship, and not merely a research group meeting. It is a structured pedagogical space where students, academic supervisors, enterprise mentors, technicians, and sometimes farmers jointly define problems, generate data, design solutions, and evaluate outcomes. The studio emphasizes five principles: authenticity, interdisciplinarity, iteration, external participation, and evidence.

Authenticity means that each studio starts from a problem observed in a production field, enterprise workshop, agricultural machinery operation site, research demonstration base, or digital agriculture service platform. The problem may be small in scale, but it must contain real constraints. Interdisciplinarity means that the problem requires at least two knowledge domains, such as machinery and software, agronomy and sensing, control and data analysis, or engineering design and management. Iteration means that students must revise their solutions at least once based on field data or stakeholder feedback. External participation means that at least one non-university actor participates in problem definition, milestone evaluation, or final demonstration. Evidence means that students must document their decisions and results through standardized artifacts.

The scale of the problem can be small, but it needs to reflect the constraints in the real situation. Interdisciplinary characteristics require that the problem should integrate at least two different knowledge areas, such as machinery and software, agronomy and sensing, control and data analysis, or engineering design and management. Iteration emphasizes that students must revise the existing solutions at least once based on field data or feedback from stakeholders. In terms of external participation, at least one non University member must be involved in the definition of the problem, milestone evaluation of nodes or the display of final results. As for the evidence of achievement, students should present it through standardized works or artifacts.

3.2 Evidence Combination

Evidence combination is a set of structured learning outcomes, which uses specific artifacts to evaluate students' practical ability. It is not simply a collection of documents, but an evaluation system that links learning output with observable evidence. Each combination contains six types of evidence, namely: problem evidence, technical evidence, data evidence, iteration evidence, communication evidence and reflection evidence. Among them, problem evidence shows how students identify and construct domain problems; Technical evidence covers design drawings, specifications, circuit diagrams, control logic, model parameters and prototype description; Data evidence includes original data, cleaned data, labeling rules, test conditions and validity verification.

Iteration evidence includes failure logs, comparison of alternative solutions, modification records, and validation results.

The specific forms of communication evidence include meeting minutes, interview records with stakeholders, user feedback and various presentation materials. The reflective evidence is mainly reflected in the construction of ethical considerations, safety concepts, professional identity, as well as the experience and lessons extracted from practice.

The combination of evidence brings about a fundamental change in the evaluation logic.

Instead of simply asking students whether they have completed a project, the evaluator turns to examining whether students can give credible evidence on problem diagnosis, technical reasoning, design decision-making, on-site verification and professional reflection. Such an approach effectively avoids students' inability to clearly explain what they have learned, what decisions they have made, and how their ability has been improved, even though they have participated in the project.

3.3 Teaching Cycle

The whole teaching cycle is divided into six progressive stages: on-site immersion, problem definition, scheme design, prototype implementation, on-site verification and reflection integration, as presented in Table 1. In the on-site immersion session, students can deeply observe the agricultural production process and directly obtain first-hand information. At the problem definition stage, students are encouraged to change their thinking and refine the difficulties encountered in production into technical problems that can be studied and solved. In the subsequent stage of scheme design, literature review, technical route comparison, project planning and risk analysis need to be completed. The prototype implementation link covers tasks such as coding, equipment installation, model construction, mechanical modification or system integration. Field verification requires testing under real or simulated production conditions. The final stage of reflection and integration aims to guide students to organically associate the technical achievements obtained from the project with their own professional ability growth and future improvement direction.

Table 1. Difference between Conventional Practice Teaching and the Field-Problem Studio Model

Dimension	Conventional practice teaching	Field-Problem Studio reform
Learning starting point	Teacher-defined experiments or isolated projects	Authentic field problems from agricultural production and enterprise scenarios
Learning organization	Course-by-course activities and short placements	Studio teams with supervisors, enterprise mentors, technicians, and students
Role of students	Task executors and report writers	Problem framers, evidence producers, prototype developers, and reflective practitioners
Use of failure	Often hidden or treated as unsuccessful completion	Documented as failure-analysis evidence and used for design iteration
Assessment carrier	Final report, attendance, thesis output, or competition result	Evidence portfolio containing process artifacts, field records, and reflective documents
Quality assurance	Internal teacher grading	Rubrics, milestone gates, external moderation, and portfolio review

This cycle is deliberately different from the linear process of "learn theory first and apply later". Professional practice often begins with messy problems before students fully know the relevant theory. Therefore, the studio encourages just-in-time learning: when students encounter data noise, they learn signal processing; when they encounter recognition errors, they learn model evaluation; when they encounter equipment instability, they learn mechanical design and troubleshooting; when they encounter user resistance, they learn communication and adoption analysis. Theory is not abandoned; it is activated by problems.

4. Course Construction of Agricultural Engineering and Information Technology

The focus of the on-site problem studio model is not to add additional practical courses, but to reconstruct the existing curriculum system. The core of this model is to organically connect existing courses, research projects, on-site platforms and degree requirements through studio tasks, as presented in Table 2. In the major of agricultural engineering and information technology, curriculum reconstruction can be carried out around four learning clusters: field perception and data collection, agricultural equipment and control, data intelligence and software systems, and professional communication and responsibility.

The core task of field perception and data collection cluster is to convert agricultural phenomena into reliable data. Students need to learn sensor selection, sampling scheme design, calibration management, data quality evaluation, and in-depth understanding of the source of measurement error. The cluster is indispensable because the foundation of data-driven agriculture is reliable data. If students lack field data literacy, the constructed algorithm or system is likely to perform well on the laboratory data set, but it is difficult to work in the real production environment.

Agricultural equipment and control cluster focuses on the interaction among machinery, environment and control system. Students need to learn the skills of actuator selection, embedded control, communication interface, equipment operation safety and field deployment. For professional postgraduates, the cluster should not only stay at the level of theoretical control model, but also cover the actual troubleshooting, equipment debugging and performance verification. Students must realize that engineering design will be restricted by multiple factors such as cost, reliability, maintainability and operator behavior.

The core task of data intelligence and software system cluster is to transform agricultural data into auxiliary decision-making or practical tools. The cluster covers machine learning, image processing, geographic information system, database design, mobile application development, visualization and system integration. In this cluster, students should record data sets, preprocessing decisions, model assumptions, error distribution, and user interface logic in detail. Its ultimate goal is not only to pursue the high precision of the model, but also to develop an interpretable, easy-to-use and long-term maintenance system.

Table 2. Studio Modules and Evidence Requirements

Studio module	Main learning tasks	Required evidence
Field immersion	Observe production process, interview stakeholders, identify pain points	Observation notes, photos, interview records, preliminary problem map
Problem framing	Translate broad needs into technical questions, indicators, and constraints	Problem statement, constraint list, feasibility analysis, expected value statement
Data and system design	Design sampling, sensing, control, algorithm, or software route	Technical route comparison, data plan, design drawings, code plan, risk analysis
Prototype implementation	Build, code, assemble, integrate, or simulate a solution	Prototype description, code repository, equipment records, test plan
Field verification	Test under real or simulated production conditions and collect feedback	Test logs, data validity report, user feedback, performance comparison
Reflective consolidation	Analyze failure, professional responsibility, and future improvement	Failure-analysis report, reflective memo, revised technical specification

Professional communication and responsibility cluster focus on the non-technical dimension of practical ability. Whether agricultural technology can be truly promoted depends on effective communication with producers, technicians, managers and policy stakeholders. Students need to learn how to write technical specifications, conduct on-site demonstrations, negotiate needs, truthfully report uncertainties, and take into account security, ethics, data privacy and environmental impact. This cluster highlights the educational function of professional master training: graduates should not become narrow-minded technical operators, but should grow into professional talents with a sense of responsibility and can effectively serve the process of agricultural modernization.

The reconstruction of the course is implemented through modular studio tasks. Each course contributes a specific category of evidence to the student's portfolio of evidence. For example, the agricultural information system course produces database design and user interface prototype; the sensor course leaves calibration records and error analysis; Seminar may serve for literature integration and technical route demonstration; the enterprise practice module can provide on-site verification reports and stakeholder feedback. Under this arrangement, the course is no longer an isolated unit, but plays a role as an evidence generation component in the larger ability system.

The course also needs to set milestone evaluation nodes. The so-called milestone is a structured assessment point. Students must submit corresponding evidence before entering the next stage. The proposed checkpoints are: issue approval, technical route review, prototype readiness review, on-site verification review and final professional defense. The purpose is not to increase the burden of management, but to ensure that the feedback can be delivered in time, so as to prevent students from delaying the problems in learning until the last minute.

5. Competency Evidence and Assessment Design

Assessment is the most important lever of this reform. If assessment continues to focus mainly on final reports, papers, patents, or competition awards, students will rationally prioritize visible outputs and neglect the less visible but more educationally important processes of diagnosis, iteration, communication, and reflection. Therefore, The Evidence Portfolio, as presented in Table 3, aims to assess capability through multiple, process-based, and authentic artifacts.

The first assessment principle is evidential sufficiency. A claim of competence must be supported by adequate evidence. For example, if a student claims the ability to design an agricultural data acquisition system, the portfolio should include sensor selection rationale, wiring or communication diagrams, calibration data, field test records, error analysis, and a discussion of deployment limitations. If a student claims the ability to develop a weed recognition model, the portfolio should include dataset construction, annotation criteria, model comparison, training records, validation under different field conditions, false positive and false negative analysis, and possible improvement strategies.

The second principle is developmental progression. Practice capacity should be evaluated according to progress, not only final level. A student may begin with limited technical ability but show strong growth in problem analysis, design iteration, and professional communication. The portfolio should allow regulators to observe this growth. Therefore, each category of evidence must cover early, mid-term and final works. Students should not replace early immature works with polished final versions, but must show how their understanding has changed.

The third principle concerns external credibility. Professional master education directly serves the real professional field, so the evaluation should be included in the external perspective. Business mentors, base technicians or agricultural producers can provide feedback on availability, feasibility, safety and relevance. Such feedback cannot replace academic judgment, but it can prevent practical teaching from becoming self-sufficient within colleges and universities.

Table 3. Evidence Portfolio Assessment Rubric for Practice Capacity

Assessment criterion	Basic performance	Qualified performance	High-level performance
Problem diagnosis	Describes a general problem without sufficient evidence	Defines a problem with indicators and constraints	Justifies the problem with field evidence, stakeholder needs, and feasibility analysis
Technical integration	Applies a single technique with weak explanation	Integrates methods from at least two domains	Explains trade-offs among machinery, data, software, cost, and usability
Data credibility	Uses data without clear quality control	Provides sampling and preprocessing records	Demonstrates data validity, uncertainty analysis, and reproducibility
Iteration and verification	Shows a final result only	Records revisions based on tests	Uses failure analysis and field feedback to improve design
Communication	Reports mainly to teachers	Communicates with mentors or users	Translates technical results into stakeholder-oriented decisions and documents
Professional reflection	Provides general self-summary	Reflects on learning difficulties and improvement	Connects technical decisions with safety, ethics, responsibility, and professional identity

The fourth principle is reflective integration. Professional ability inherently contains the ability to learn from experience. Students are required to write reflective memos that clarify their initial misunderstandings, the trade-offs they face, their response to failures, how stakeholder feedback can lead to design adjustments, and emerging ethical or safety issues. Reflection should not be reduced to empty self-evaluation, but should establish a substantive connection with the specific evidence in the works.

The evaluation system is based on analytical performance indicators, and each evaluation standard uses specific indicators instead of fuzzy scores. Take the problem framework as an example: low level performance can only describe problems in general terms; Medium level performance can define technical indicators and constraints; High level performance demonstrates the rationality of the problem based on on-site evidence, stakeholder needs and feasibility analysis. As far as prototype verification is concerned: low level performance only presents laboratory demonstration; Medium level performance includes controlled tests; the high level of performance includes on-site verification, error analysis, and iterative revision. Such performance descriptions can lead students to higher quality learning.

A key feature of the portfolio is to provide support for graduate guidance. It is often difficult for supervisors to know whether students have actually developed practical ability, because a lot of work takes place outside the formal classroom. The collection of works provides a general discourse framework for supervision. The tutor can comment on specific evidence rather than general suggestions such as "adding experiments" or "improving the system", such as incomplete sampling plan, lack of metadata in the data set, stakeholder needs not translated into technical indicators, or failure analysis fails to identify the root cause. Thus, the feedback can be more accurate and more operable.

6. Implementation Pathway

The implementation of Field-Problem Studios should be gradual and institutionally supported. It is unrealistic to expect every course, supervisor, enterprise, and student to change immediately. A feasible pathway includes four phases: preparation, pilot, expansion, and normalization.

The preparation phase focuses on problem source development and faculty consensus. The university should collect field problems from research bases, agricultural enterprises, farms, cooperatives, agricultural machinery manufacturers, software companies, and government extension agencies. Problems should be screened according to educational value, technical feasibility, safety, data availability, and alignment with degree requirements. At the same time, teachers should negotiate the expected competence standards and evidence requirements. Without a common benchmark, a collection of works is prone to become scattered and redundant.

The pilot phase focuses on a few studios. Each studio must limit the size of students and be equipped with clearly defined problem areas. For example, seedling quality detection studio, variable rate fertilization control studio and agricultural machinery operation data management studio based on machine vision can be set respectively. The pilot aims to test whether students can effectively collect evidence, whether supervisors can give targeted feedback, whether external reviewers can effectively participate, and whether the workload is controllable. At the same time, the pilot should generate a demonstrative work set to provide reference for subsequent batches.

The focus of the expansion phase is to connect the studio with the course and degree process. The course should be restructured to generate evidence for studio tasks. Enterprise practice must be combined with on-site verification. The opening report, mid-term evaluation and dissertation defense can partially adopt the evidence of the portfolio. For example, students can present evidence of on-site problems in the opening report, prototype evidence in the mid-term evaluation, and verification evidence in the final defense. This reduces duplication and makes the degree process more coherent.

The normalization phase focuses on the construction of systems and mechanisms. The university can start to build a studio question bank, a portfolio template, a tutor training mechanism, an external reviewer database and a quality assurance process. At the same time, it should calculate the workload of teachers in the studio supervision, and give recognition and incentives to high-quality practical teaching. Without institutional recognition, the reform will be too dependent on individual enthusiasm and difficult to maintain.

Digital tools can provide technical support for the above implementation. The portfolio platform can store documents, data sets, code links, videos, site photos, test logs and feedback records. Version control tools can track the software development process. The online form can standardize stakeholder interviews and field test reports. The dashboard can help the tutor master the progress. However, technology should serve pedagogy. A platform without clear competency standards may only become another administrative system.

Implementation also requires attention to risk management. Field practice involves safety risks, equipment risks, data risks, and ethical risks. Students should receive training in laboratory safety, field operation safety, data privacy, intellectual property, and responsible communication. Enterprise mentors should clarify what data can be used for teaching and publication. The university should establish procedures for equipment use, field travel, insurance, and emergency response. These arrangements are not peripheral; they are part of professional responsibility education.

7. Discussion

The on-site problem studio model makes up for some deficiencies of the current practice teaching, but it also generates new challenges. The first challenge is the tension between authenticity and teachability. Real agricultural problems are complex and uncertain, sometimes even beyond the time boundary of the curriculum cycle. The difficulty of the problem is too high to make students feel frustrated, and over simplification will make the studio lose its true essence. The solution is to choose a problem with adjustable depth. A macro production problem can be decomposed into learning tasks at different levels. For example, digital field management issues can cover tasks such as sensor deployment, data cleaning, dashboard design and decision-making recommendations. Different students can complete different subtasks on the premise of grasping the overall problem context.

The second challenge is the tutor's workload. The collection of works needs continuous feedback, and the studio project needs to be coordinated with external interested parties, which will increase the burden on teachers. Therefore, colleges and universities should not regard the studio as an informal extra work, but should clarify the workload accounting standard, equip teaching assistants or technical support, and develop reusable templates. When the portfolio template and question base are established, the repetitive workload can be reduced. In addition, studio teaching can also feed the tutor's scientific research, school enterprise cooperation and the quality of graduate thesis.

The third challenge concerns the reliability of the assessment. If the evaluation criteria are not clear, the collection evaluation is easy to be criticized as subjective errors. In order to improve the reliability, the evaluation process should introduce analytical criteria, external adjustment mechanism, sample works and reviewer calibration procedures. Reviewers can align standards by reviewing multiple portfolios together. At the same time, students should also be allowed to understand the evaluation criteria before starting the task, so that the evaluation can become a guide for learning, rather than an accident at the end.

The fourth challenge is balancing technological innovation with educational value. Agricultural engineering and information technology students may be attracted by advanced algorithms or devices, but high-level practice capacity is not equal to using the newest technology. Sometimes a simple, robust, low-cost solution is more valuable than a technically sophisticated but fragile system. The studio should train students to evaluate technology according to problem fit, reliability, maintainability, cost, and user adoption. This is particularly important for serving regional agriculture, where production conditions and user capabilities vary widely.

The model also has implications for the professional identity of graduate students. Many students enter professional master's programs with the expectation of employment, but they may not clearly understand what it means to become an agricultural engineering and information technology professional. Through field immersion, stakeholder communication, failure analysis, and reflective writing, students gradually see that professional work is not only technical execution. It involves responsibility for food security, rural development, environmental sustainability, user safety, and technological fairness. This identity formation is a deep educational outcome that cannot be achieved through technical courses alone.

Compared with reforms that emphasize school-enterprise cooperation as an organizational arrangement, this model emphasizes the pedagogical mechanism inside cooperation. A practice base is valuable only when it provides learning affordances, guided participation, feedback, and assessable evidence. Similarly, a research project is educationally valuable only when students have meaningful roles, make decisions, and reflect on their learning. The Field-Problem Studio model therefore shifts attention from whether the university has platforms to how platforms are transformed into learning situations.

The model is also different from competition-oriented practice education. Competitions can stimulate motivation and creativity, but they often emphasize presentation, ranking, and short-term outcomes. Studio teaching can use competitions as one type of external challenge, but it should not reduce practice capacity to competition performance. A student who carefully documents a failed field deployment and proposes a credible improvement plan may demonstrate more professional growth than a student who wins a prize with a polished but weakly validated prototype. Evidence-based assessment helps maintain this educational judgment.

Finally, the model has the core function of supporting the continuous optimization of the training program. Through the systematic integration of portfolio evidence, we can accurately identify the common weaknesses and weak links of different student groups in the process of professional ability training. If most students have obvious difficulties in data quality control, it indicates that the teaching modules related to on-site data acquisition and processing in the curriculum system need to be strengthened, and the teaching content and teaching methods need to be further improved; If a large number of students are unable to achieve efficient communication and collaboration with business mentors, special training modules on communication skills should be added to the training program to improve students' school enterprise collaborative communication ability; If the prototypes designed by most students fail to pass the examination in the field verification stage, it indicates that there are deficiencies in the teaching modules related to engineering testing in the training scheme, and it is necessary to optimize the testing process teaching and strengthen the practical operation training. To sum up, the portfolio is not only the core tool to carry out the evaluation of students' professional ability, but also provides accurate and reliable empirical data support for the quality assurance of training projects, and provides a scientific basis for the dynamic optimization of training programs.

8. Limitations and Future Work

The reform framework proposed in this study is design oriented, without large-scale empirical test, and its effectiveness still needs to be further verified through longitudinal tracking implementation. Future research can systematically collect student portfolio data through multi cohort research design, compare the differences of students' academic performance and ability development before and after the implementation of the reform, deeply analyze the feedback of employers' evaluation, and explore the correlation between studio participation and employment quality. The mixed research method of quantitative scoring, qualitative interview, learning process analysis and dissertation quality evaluation can further enhance the persuasiveness and credibility of the research conclusion, and provide solid empirical support for the optimization and improvement of the reform framework.

Another limitation of this study is the particularity of subject adaptation. The constructed model is specifically for the construction of agricultural engineering and information technology specialty. The field practice problems in this discipline naturally integrate the core elements of engineering technology, data processing and production scenarios, which are highly consistent with the model design logic. For other professional master training programs, it is necessary to adjust the evidence classification system and studio task setting according to their own discipline characteristics and training objectives. However, it should be clear that the core concepts of the model, such as the principle of authenticity, iterative training, external collaborative regulation and evidence-based evaluation, can be transferred and applied to the talent training reform of other applied disciplines, and have certain universal value.

Future research should also focus on the application path exploration of AI tools in portfolio assessment. Artificial intelligence technology can effectively assist in the systematic sorting of evaluation evidence, the identification of missing documents, and the phased summary of learning progress. At the same time, it can provide preliminary guidance feedback for students' manuscript writing and code writing. It should be emphasized that AI is only used as an auxiliary evaluation tool and cannot replace the professional judgment of educators. In addition, it is necessary to establish and improve relevant ethical norms, strengthen the verification of the authenticity of students' evaluation evidence, ensure the fairness, impartiality and preciseness of the evaluation process, and avoid potential risks caused by technology application.

9. Conclusion

The postgraduate education of agricultural engineering and information technology needs to actively adapt to the needs of the era of agricultural digitalization and intelligent transformation, and accurately connect the core demands of industrial development for high-level applied talents. The core challenge of the current professional master education reform is not simply to increase the number of practical activities, but to integrate all kinds of practical link systems into a coherent learning ecosystem, in which the generation and improvement of students' professional core abilities are driven by real field problems. Based on this, this study proposes a combination model of on-site problem studio and evidence, and constructs a new framework for the development of professional Postgraduates' practical ability. The framework systematically reconstructs the traditional practice teaching mode through multiple paths, such as on-site immersion teaching, studio oriented exploration, iterative engineering design, digital evidence collection and analysis, external collaborative regulation, and reflective professional identity construction. Its core value is to change the focus of students' learning from the simple task completion orientation to the advanced orientation of professional ability based on evidence support, and realize the deep binding of learning process and ability development. At the same time, the framework can provide more accurate teaching feedback, scientific evaluation basis and clear quality improvement direction for the teaching authorities and training projects, and help to systematically improve the quality of professional master training.

The framework provides a practical implementation path for the application-oriented undergraduate colleges to carry out the cultivation of masters in agricultural engineering and information technology, and can effectively help students achieve four core training goals: accurately understand the laws of agricultural production, systematically integrate engineering technology and information technology, efficiently solve the actual problems in the agricultural field, smoothly carry out communication and cooperation with various stakeholders, and consciously assume corresponding professional responsibilities. Under the dual background of the promotion of agricultural modernization and the deepening of postgraduate education reform, this situational embedded and evidence-based practical teaching mode can cultivate a group of high-level applied talents who not only have solid professional quality, but also can accurately serve the regional industrial development and national strategic needs, highlighting the application value and social value of professional master education.

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