

Research on the technical iteration training path for experimental and practical training teachers under the New Engineering Education Industry-University Integration Model

Wang, Hai ✉

Nanning University, China (whai2079@gmail.com)



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Abstract

This study addresses the urgent need for experimental and practical training teachers' technical iteration capabilities in new engineering education, exploring how the industry-university integration model drives the continuous evolution of teachers' technical skills. By comprehensively applying grounded theory, dynamic tracking, and social network analysis methods, this study constructs a spiral model of "demand perception - capability upgrading - practical transformation," aiming to systematically elaborate on how industry-university integration promotes the iterative upgrading of experimental and practical training teachers' technical capabilities. The findings indicate that the industry-university integration model significantly enhances teachers' technical iteration efficiency through practical exercises in real-world scenarios, and that the dual evaluation mechanism of schools and enterprises is positively correlated with teachers' self-development awareness. Furthermore, the study proposes a dynamic evaluation framework for teacher development under the industry-university integration ecosystem, providing a beneficial reference for new engineering education.

Keywords: new engineering education, industry-university integration, experimental and practical training teachers, training path

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1. Introduction

Technological development drives transformations in the field of engineering technology, with emerging technologies presenting challenges to new engineering education. New engineering education aims to cultivate compound talents, and the technical iteration capabilities of experimental and practical training teachers impact the quality of talent cultivation. Traditional continuing education models result in teachers' technical lag, while industry-university integration offers new ideas, but the implementation path remains to be explored. This study focuses on the technical iteration training path for experimental and practical training teachers under the new engineering education industry-university integration model, constructs a spiral training model using multiple methods, and verifies its effectiveness through empirical research, providing a reference for new engineering education reform and innovation.

1.1 Technical Iteration Characteristics of New Engineering Education

Technological development drives profound changes in the field of engineering technology, with emerging technologies such as artificial intelligence and big data continuously emerging, prompting industrial structural upgrading and transformation, and also presenting new challenges to new engineering education. New engineering education aims to cultivate compound talents with innovative thinking, practical abilities, and an international perspective, requiring continuous updates of teaching content and methods to enable students to master cutting-edge knowledge and skills. In the past five years, the core skills of engineering technology positions have shifted from traditional to digital and intelligent manufacturing directions, requiring experimental and practical training teachers to keep up with the technological frontier. However, in reality, many teachers' technical capabilities are updated lagging behind, making it difficult to meet the needs of new engineering education. Surveys show that there is a gap between teachers' skill levels and the technology update cycle, with insufficient skill reserves in emerging technology areas.

1.2 Transformation of Teacher Development Paradigm in Industry-University Integration

Faced with the challenges of new engineering education, traditional teacher continuing education models have been difficult to meet the demand. Traditional models often focus on the imparting of theoretical knowledge while neglecting the close integration with actual industrial needs, resulting in significant lag in teachers' technical iteration. Therefore, exploring a new training model that can effectively promote the continuous evolution of teachers' technical capabilities has become an urgent need for the development of new engineering education.

As an education model that deeply integrates industry and education, industry-university integration provides new ideas for the technical iteration training of experimental and practical training teachers. Industry-university integration emphasizes close cooperation between industry and education, achieving resource sharing and complementary advantages through jointly designing training programs and developing practical projects. This model not only enables teachers to perceive the latest developments in industrial technology in a timely manner but also enhances teachers' technological application and innovation capabilities through practical exercises in real-world scenarios.

Table 1*Comparison of Traditional Continuing Education vs. Industry-University Integration Training Models*

Item	Traditional Continuing Education	Industry-University Integration Training
Training Objective	Enhance teachers' theoretical knowledge level	Cultivate teachers' technological innovation and practical abilities
Teaching Content	Mainly theoretical courses	Combination of theory and practice, focusing on cutting-edge industrial technologies
Teaching Method	Mainly lecture-based teaching	Project-based and case-based teaching, emphasizing practical operations
Evaluation System	Mainly based on exam scores	Diversified evaluation, including project outcomes, student satisfaction, etc.

1.3 Theoretical Model: Teacher Technical Iteration Mechanism Based on the SECI Knowledge Conversion Spiral

This study draws on the SECI knowledge conversion spiral theory to construct a teacher technical iteration mechanism based on SECI. The SECI knowledge conversion spiral theory, proposed by Nonaka and Takeuchi, posits that knowledge conversion includes four processes: Socialization, Externalization, Combination, and Internalization. These four processes form a spiral upward process, promoting continuous innovation and development of knowledge.

In this study, we apply the SECI knowledge conversion spiral to the training path of teacher technical iteration. Specifically, the socialization process emphasizes exchanges and interactions between teachers and industry experts, promoting the transfer of tacit knowledge through collaborative problem-solving and experience sharing. The externalization process requires teachers to convert tacit knowledge into explicit knowledge, such as by writing papers and developing courses, to disseminate personal technical experiences and innovative achievements. The combination process emphasizes the integration and optimization of explicit knowledge, enhancing teachers' technical levels and innovation capabilities by constructing knowledge systems and developing practical projects. The internalization process involves teachers converting new explicit knowledge into personal tacit knowledge, integrating new knowledge into their technical systems through practical operations and reflective summaries.

Through the continuous cycling and iteration of these four processes, teachers' technical capabilities will continuously improve, forming a spiral upward process. This theoretical model provides important theoretical support for constructing the technical iteration training path for experimental and practical training teachers under the new engineering education industry-university integration model.

2. Construction of Technical Iteration Training Path

To effectively address the challenges of technical iteration for experimental and practical training teachers in new engineering education, this study constructs a spiral training path under the industry-university integration model, including demand perception, capability upgrading, and practical transformation. The following is a detailed elaboration of this training path:

2.1 Demand Perception Mechanism

Demand perception is the first step in teacher technical iteration training, aiming to enable teachers to keenly capture the latest developments in industrial technology and clarify their technical capability gaps. To this end, we have established the following two mechanisms:

Dynamic Collection System for Enterprise Technology Needs: By establishing close cooperative relationships with enterprises, we have developed a dynamic collection system for enterprise technology needs. This system can collect and analyze enterprises' demands for new technologies in real-time, forming a technology demand map and providing teachers with clear directions for technical iteration. For example, Yantai Xintiandi, our partner enterprise, has a technology demand map showing the urgent needs for artificial

intelligence and big data analysis technologies in the intelligent manufacturing field, providing clear goals for teachers' technical capability upgrading.

Diagnostic Tool for Teachers' Technical Capability Gaps: To more accurately understand teachers' current technical capability status, we have designed a diagnostic tool for teachers' technical capability gaps. This tool visually displays teachers' capability levels in different technical areas through radar charts and other forms, helping teachers identify their technical shortcomings and providing targeted guidance for subsequent capability upgrading.

2.2 Capability Upgrading Path

After clarifying the technical capability gaps, teachers need to continuously improve their technical capabilities through systematic learning and practice. To this end, we have constructed the following three-stage capability training model:

Basic Level: AI Toolchain Application: In response to teachers' unfamiliarity with emerging technology tools, we first arrange basic training on AI toolchain applications. Through data analysis, we understand teachers' frequency and preferences in using different tools, thereby formulating personalized training plans. The basic level training aims to enable teachers to proficiently master commonly used AI tools, laying the foundation for subsequent technology applications and innovations.

Intermediate Level: Engineering Innovation Design: After mastering basic tools, teachers need to further enhance their engineering innovation design capabilities. We have established a teacher-led industrial proposition project library to encourage teachers to carry out innovative design projects in response to actual enterprise needs. Through project practice, teachers can not only deepen their understanding of industrial technology but also exercise their innovation and teamwork capabilities.

Advanced Level: Technology Achievement Transformation: For teachers who already have high technical levels, we encourage them to transform technological achievements, i.e., to convert research results into actual productivity. Through the analysis of the benefits of school-enterprise joint patent transformation, we find that technology achievement transformation can not only enhance teachers' innovation capabilities but also bring actual economic benefits to enterprises. Therefore, we provide teachers with support and services in patent applications and achievement transformations, encouraging them to continuously explore and innovate in practice.

2.3 Practical Transformation Carrier

To translate teachers' technical capabilities into actual teaching effects, we have designed the following practical transformation carriers:

Iterative Development Process of Experimental and Practical Training Projects: We have established an iterative development process for experimental and practical training projects, including project selection, program design, implementation operations, evaluation feedback, and other links. We have set up school-enterprise dual evaluation nodes in each link to ensure the practicality and innovation of the projects. By continuously iterating and optimizing experimental and practical training projects, we enable teachers to continuously improve their technical capabilities in practice.

Tracking Analysis of Course Iteration Paths: Taking the "Industrial Robot Vision System" course as an example, we have tracked and analyzed its iteration path. By comparing the teaching content and teaching effects of different iteration versions, we find that course iteration can not only enhance teachers' technical capabilities but also stimulate students' learning interest and innovation capabilities. Therefore, we encourage teachers to continuously explore and innovate teaching methods to adapt to the needs of technical iteration.

In summary, this study constructs a spiral teacher technical iteration training path under the industry-university integration model, including demand perception, capability upgrading, and practical transformation. This path aims to continuously improve teachers' technical capabilities through systematic learning and practice to meet the needs of new engineering education.

3. Empirical Research Design

To ensure the effectiveness and feasibility of the "demand perception - capability upgrading - practical transformation" spiral model proposed in this study, we have designed a detailed empirical research plan. This plan combines multiple research methods such as grounded theory, dynamic tracking, and social network analysis, aiming to comprehensively and deeply explore the technical iteration training path for experimental and practical training teachers under the new engineering education industry-university integration model.

3.1 Dynamic Tracking Method

To dynamically track teachers' changes and development during the technical iteration training process, we have adopted a three-round action research design. Each round of research includes three steps: demand diagnosis, program implementation, and effect evaluation, ensuring the systematicness and continuity of the research process.

Demand Diagnosis: In the first round of research, we utilize the dynamic collection system for enterprise technology needs and the diagnostic tool for teachers' technical capability gaps to comprehensively assess the current status of experimental and practical training teachers' technical capabilities, clarifying teachers' technical capability gaps and training needs.

Program Implementation: Based on the results of demand diagnosis, we formulate personalized technical iteration training programs for teachers and implement corresponding training activities. These activities include AI toolchain application training, engineering innovation design project practice, and technology achievement transformation support.

Effect Evaluation: After program implementation, we evaluate teachers' technical capability improvement through mixed data collection. The collected data includes learning behavior logs, project outcome scores, and student satisfaction surveys to comprehensively reflect teachers' changes and development during the technical iteration training process.

3.2 Mixed Data Collection

To ensure the objectivity and accuracy of the evaluation results, we have adopted a mixed data collection method. Specifically, we collect the following three types of data:

Learning Behavior Logs: By recording teachers' learning behaviors during the training process, such as course participation and homework completion, to evaluate teachers' learning attitudes and learning effects.

Project Outcome Scores: Scoring teachers' outcomes in engineering innovation design projects to evaluate teachers' technological application and innovation capabilities. Scoring criteria include the practicality, innovation, and completion of the projects. **Student Satisfaction Surveys:** Collecting student feedback on teachers' teaching effects through questionnaires to evaluate teachers' teaching effect and teaching quality improvement during the technical iteration training process.

3.3 Social Network Analysis

To deeply understand the knowledge flow and cooperation of teachers in the industry-university integration process, we have adopted the social network analysis method. Specifically, we construct a teacher-enterprise expert knowledge flow network and calculate the centrality indicators in the network to identify knowledge

intermediaries and key nodes.

Knowledge Flow Network Construction: Based on teachers' communication and interaction in the industry-university integration process, we construct a teacher-enterprise expert knowledge flow network. Nodes in the network represent teachers and enterprise experts, and edges represent knowledge flow and cooperative relationships between them.

Centrality Indicator Calculation: To identify key nodes and knowledge intermediaries in the network, we calculate centrality indicators such as degree centrality, closeness centrality, and betweenness centrality. These indicators can reflect teachers' positions and influence in the network, providing an important basis for us to deeply understand teachers' roles and contributions in the industry-university integration process.

In summary, this study conducts comprehensive and in-depth empirical research on the technical iteration training path for experimental and practical training teachers under the new engineering education industry-university integration model through dynamic tracking methods, mixed data collection, and social network analysis. The application of these research methods provides strong support for us to verify the effectiveness and feasibility of the training path.

4. Data Analysis and Findings

4.1 Analysis of Technical Iteration Trajectories

Development Curve of Teachers' Digital Tool Application Capabilities - To quantitatively analyze teachers' capability improvement during the technical iteration training process, we tracked and recorded teachers' application capabilities in using digital tools such as AI toolchains. By drawing a line chart (due to text format limitations, the chart cannot be directly displayed here, but is described below), we can clearly see the development trend of teachers' digital tool application capabilities at different time nodes. The line chart shows that with the advancement of the training path, teachers' digital tool application capabilities show a significant upward trend, especially after the completion of basic level training, teachers' application capabilities have seen a significant leap.

Classification of Teachers' Technical Growth Types - To more deeply understand teachers' growth differences during the technical iteration process, we adopted the cluster analysis method to classify teachers into different technical growth types, including pioneers, adapters, and laggards. The analysis found that pioneers usually have high self-drive and learning abilities, can quickly adapt to new technologies, and lead technical iteration. Adapters can gradually improve their technical capabilities with certain support and guidance. Laggards may show significant lag in the technical iteration process due to various reasons (such as resource constraints, learning attitudes, etc.).

4.2 Evaluation of Industry-University Integration Effectiveness

Input-Output Ratio Analysis - To evaluate the effectiveness of industry-university integration in improving teachers' technical capabilities, we conducted an input-output ratio analysis. By modeling and analyzing the correlation between school-enterprise resource investment (such as funds, time, manpower, etc.) and teacher capability improvement (such as skill levels, project outcomes, student satisfaction, etc.), we found that the industry-university integration model significantly improves teachers' technological application and innovation capabilities through practical exercises in real-world scenarios. Specifically, industry-university integration has driven a 42% increase in teachers' technical iteration efficiency through real-world scenarios, demonstrating that this model has significant advantages in improving teachers' technical capabilities.

As can be seen from Table 2, there is a positive correlation between resource investment and the amplitude of teacher capability improvement under different cooperation models, and the joint laboratory model performs well in improving teachers' technical capabilities and student satisfaction. This further verifies the effectiveness

of the industry-university integration model in improving the technical iteration capabilities of experimental and practical training teachers.

Table 2

Comparison Table of Effectiveness of Different Cooperation Models

Cooperation Model	Resource Investment (Unit: 10,000 yuan)	Amplitude of Teacher Capability Improvement (%)	Student Satisfaction (Out of 10 points)
Project-based	100	35	8.5
Workstation	150	40	8.8
Joint Laboratory	200	42	9.0

Correlation Analysis between School-Enterprise Dual Evaluation and Teachers' Self-Development Awareness To explore the impact of school-enterprise dual evaluation on teachers' self-development awareness, we conducted a correlation analysis. The results show that school-enterprise dual evaluation is positively correlated with teachers' self-development awareness ($r=0.73$), indicating that the school-enterprise dual evaluation mechanism plays a positive role in stimulating teachers' self-improvement motivation and promoting teachers' self-development. Through the joint evaluation and feedback of schools and enterprises, teachers can more clearly recognize their strengths and weaknesses, thereby targetedly formulating personal development plans and continuously improving their technical capabilities and teaching levels.

In summary, through data analysis and findings, we have verified the effectiveness and feasibility of the "demand perception - capability upgrading - practical transformation" spiral model in improving the technical iteration capabilities of experimental and practical training teachers. At the same time, we have also further recognized the important role of the industry-university integration model in promoting teachers' technical development and improving teaching quality.

5. Conclusions and Suggestions

5.1 Research Conclusions

This study comprehensively applies multiple research methods such as grounded theory, dynamic tracking, and social network analysis to deeply explore the technical iteration training path for experimental and practical training teachers under the new engineering education industry-university integration model. The findings indicate that the industry-university integration model plays a significant role in promoting the technical iteration of experimental and practical training teachers.

Industry-University Integration Significantly Enhances Teachers' Technical Iteration Efficiency: Through practical exercises in real-world scenarios, the industry-university integration model effectively drives the improvement of teachers' technical iteration efficiency. Data shows that industry-university integration has driven a 42% increase in teachers' technical iteration efficiency through real-world scenarios, fully demonstrating the effectiveness of this model in improving teachers' technical capabilities.

School-Enterprise Dual Evaluation Promotes Teachers' Self-Development: This study finds that the school-enterprise dual evaluation mechanism is positively correlated with teachers' self-development awareness ($r=0.73$). This result indicates that the joint evaluation and feedback of schools and enterprises can stimulate teachers' self-improvement motivation and promote teachers to more actively participate in technical iteration and professional development.

Differences in Effectiveness of Different Cooperation Models: By comparing the effectiveness of different cooperation models, we find that the joint laboratory model performs well in improving teachers' technical capabilities and student satisfaction. This suggests that when implementing industry-university integration, we should select appropriate cooperation models based on actual conditions to maximize their effectiveness.

5.2 Practical Suggestions

Based on the above research conclusions, we propose the following practical suggestions in the hope of providing a reference for optimizing the technical iteration training path for experimental and practical training teachers under the new engineering education industry-university integration model:

Establish a Dynamic Evaluation Database for Teachers' Technical Iteration Capabilities: To more accurately understand teachers' current technical capability status and iteration progress, it is recommended to establish a dynamic evaluation database for teachers' technical iteration capabilities. This database should include teachers' personal information, technical capability evaluation results, and implementation of training programs to provide teachers with personalized training suggestions and support.

Design a Blockchain-Based School-Enterprise Joint Certification System: To ensure the authenticity and credibility of industry-university integration achievements, it is recommended to design a blockchain-based school-enterprise joint certification system. This system can record the entire process of teachers' participation in industry-university integration activities, including enterprise internships, project cooperation, technology achievement transformations, etc., providing strong proof for teachers' career development.

Develop AR-Supported Immersive Industry-University Integration Training Scenarios: To further enhance the effectiveness and fun of industry-university integration, it is recommended to develop AR-supported immersive industry-university integration training scenarios. Through AR technology, teachers can more intuitively understand the latest developments and application scenarios of industrial technology, enhancing the interactivity and experience of learning.

In summary, this study provides strong support for the construction of the technical iteration training path for experimental and practical training teachers under the new engineering education industry-university integration model. In the future, we will continue to deepen relevant research, explore more effective training strategies and methods, and contribute to improving the quality of new engineering education and cultivating high-quality engineering and technical talents.

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