Research on the Internal Quality Assurance System for Practical Teaching in Emerging Engineering Education Specialties

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Abstract

Against the backdrop of the global technological revolution and the deep integration of artificial intelligence technologies, Emerging Engineering Education (3E) programs serve as a critical vehicle for cultivating future engineering and technological talent. Their teaching quality is directly related to China' s core competitiveness in the new round of global technological competition. Integrating artificial intelligence technology into the internal quality system of practical teaching for 3E programs is a core path for enhancing the quality of talent cultivation and adapting to the intelligent development of industries. This paper first elucidates the significant position of practical teaching in the construction of 3E programs and analyzes the current problems existing in the practical teaching of engineering majors. Subsequently, it proposes measures to construct a scientific, comprehensive, and intelligent internal quality assurance system for practical teaching, aiming to improve the effectiveness of practical teaching in 3E programs and provide solid talent support and intellectual guarantees for China' s industrial upgrading and high-quality economic development.

Full Text

Preamble

Research on the Internal Quality Assurance System for Professional Practical Teaching

1. Introduction

In the context of modern higher education, professional practical teaching serves as a critical bridge between theoretical knowledge and industrial application. As the demand for high-caliber, application-oriented talents continues to grow, the quality of practical teaching has become a core indicator of institutional effectiveness. Establishing a robust internal quality assurance system is not only a requirement for academic accreditation but also a fundamental necessity for the sustainable development of vocational and professional programs. This research explores the construction and optimization of such systems to ensure that practical training meets the evolving standards of the global labor market.

2. The Significance of Internal Quality Assurance in Practical Teaching

Practical teaching encompasses various activities, including laboratory experiments, internships, field studies, and graduation projects. Unlike theoretical classroom instruction, practical teaching is characterized by its diversity of environments, complexity of organizational management, and the involvement of multiple stakeholders (students, faculty, and industry mentors).

An effective internal quality assurance system provides a systematic framework to monitor these variables. It ensures that teaching objectives are aligned with professional competencies, that resources are allocated efficiently, and that the feedback loop between industry requirements and curriculum design remains closed. By implementing rigorous quality control, institutions can move from a model of passive management to one of continuous self-improvement.

3. Components of the Quality Assurance Framework

A comprehensive internal quality assurance system for practical teaching should be built upon several key pillars:

3.1 Standards and Objectives The foundation of the system lies in the definition of clear quality standards. These standards must be derived from professional competency requirements and national educational benchmarks. They should specify the expected learning outcomes for each practical module, the qualifications required for instructors, and the technical specifications for facilities and equipment.

3.2 Resource Management and Support Quality practical teaching is impossible without adequate infrastructure. This includes well-equipped laboratories, stable off-campus internship bases, and a "double-qualified" faculty team (possessing both academic credentials and industry experience). The system must include mechanisms for the regular maintenance of equipment and the professional development of teaching staff.

3.3 Process Monitoring and Control The core of the assurance system is the real-time monitoring of the teaching process. This involves: - **Pre-practice preparation:** Reviewing syllabi, safety protocols, and student readiness. - **In-practice supervision:** Regular inspections of laboratory sessions and site visits to internship locations. - **Post

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摘要

Introduction

Against the backdrop of the global technological revolution and the deep integration of artificial intelligence (AI) technologies, "New Engineering" disciplines have emerged as the critical vehicle for cultivating future engineering and technological talent. The quality of instruction within these disciplines directly impacts China' s core competitiveness in the new round of global technological competition. Integrating intelligent technologies into the internal quality assurance systems of practical teaching for New Engineering majors is a vital path toward enhancing talent cultivation and adapting to the intelligent development of industry.

Current Challenges in Practical Teaching

Practical teaching plays a foundational role in the construction of New Engineering disciplines. However, an analysis of current engineering programs reveals several persistent issues. Traditional practical teaching models often struggle to keep pace with rapid industrial shifts, frequently suffering from outdated experimental content, insufficient integration between theory and practice, and a lack of real-time monitoring mechanisms. Furthermore, the existing quality evaluation systems often rely on static, summative assessments that fail to capture the dynamic and personalized nature of student learning in an intelligent era.

Constructing an Intelligent Quality Assurance System

To address these challenges, this paper proposes the construction of a scientific and intelligent quality assurance system for practical teaching. By leveraging AI, big data, and cloud computing, universities can develop a multi-dimensional monitoring framework that tracks the entire lifecycle of practical instruction. Key measures include:

- **Data-Driven Monitoring:** Utilizing intelligent platforms to collect real-time data on student performance and laboratory resource utilization, allowing for agile adjustments to teaching strategies.
- **Adaptive Evaluation Models:** Implementing machine learning algorithms to provide personalized feedback and objective assessments of students' engineering competencies.
- **Resource Integration:** Building "smart laboratories" and virtual simulation platforms that bridge the gap between academic environments and industrial requirements.

Conclusion

The integration of intelligent technology into the practical teaching quality system is essential for optimizing the educational outcomes of New Engineering majors. By establishing a robust, technology-enhanced assurance framework, higher education institutions can significantly improve the efficacy of engineering training. Ultimately, these advancements will provide solid talent support and intellectual guarantees for China’ s industrial upgrading and high-quality economic development.

关键词

Internal Quality Assurance of Emerging Engineering Education

Emerging Engineering Education (3E) is a burgeoning concept aligned with the development of the Fourth Industrial Revolution. Its core connotation encompasses new engineering majors centered on Artificial Intelligence (AI), robotics, and other cutting-edge fields. The primary objective of 3E is to cultivate engineering talents capable of adapting to future technological advancements and industrial intelligence. Practical teaching serves as the nucleus of talent cultivation in these disciplines, significantly enhancing students’ perceptual understanding and engineering intuition. Furthermore, the integration of AI technology highlights the technical and intelligent characteristics of 3E, further elevating the importance of practical teaching components. Historically, engineering education has been dominated by theoretical instruction—a phenomenon often described as the “scientification” of engineering—where the quality of practical teaching lacks a robust assurance system. As the global competition for engineering and technological talent intensifies, practical teaching in 3E majors concerns not only the individual development of students but also the strength of national pillar industries. Consequently, it is imperative to construct an internal quality assurance system for 3E practical teaching with Chinese characteristics. Improving this system will bridge existing gaps in practical instruction, proactively align with engineering education accreditation standards, and facilitate the integration of industry-specific universities with regional economic development.

The Role of Practical Teaching in the Construction of Emerging Engineering Majors

Practical teaching plays a vital role in the development of Emerging Engineering Education. It enables students to better understand and master theoretical knowledge while honing their practical skills and innovative thinking, thereby providing a foundation for solving complex engineering problems. The role of practical teaching in 3E construction is primarily reflected in the following two aspects:

Integrating Theory with Practice

In 3E majors, theoretical and practical teaching are complementary. The integration of theory and practice is a fundamental pedagogical principle, with AI technology serving as a critical vehicle for connecting theory to reality and achieving the intelligent transformation of knowledge. Through practical teaching, students can better apply theoretical knowledge, achieving mastery through application and increasing their interest in learning. Practical instruction transforms theoretical concepts into operational capabilities, exercising students' hands-on skills. For instance, while students in AI majors master various algorithmic principles through classroom learning, they must also engage in practical sessions—writing code, processing real-world datasets, and building, debugging, and optimizing models—to truly understand the applicability of these algorithms in scenarios such as intelligent manufacturing.

Points of Improvement and Methodology

During this process, students not only consolidate their theoretical knowledge but also improve their ability to apply theory to practice. Their interest and initiative in learning are significantly enhanced. By aligning practical teaching with industry development, students can stay informed about the latest trends and the current status of industrial upgrading in China. This fosters a sense of mission and responsibility, stimulates learning motivation, and strengthens students' employability and awareness of future challenges.

Ability to Solve Complex Engineering Problems

Practical teaching simulates real working environments or provides hands-on training in authentic scenarios to address interconnected sub-problems. It emphasizes the comprehensive ability to apply acquired knowledge within a practical context. Real-world engineering problems require the synthesis of diverse knowledge areas, involving various technical and non-technical factors, and necessitate teamwork and innovative thinking. By fostering collaboration, stimulating innovation, and guiding students to explore new methods and technologies, practical teaching prepares them for professional demands. For example, in an industrial robot R&D project, team members may generate different ideas regarding mechanical structure design, sensor selection, and algorithm optimization. Through brainstorming and experimental validation, they eventually arrive at an optimal solution. This process greatly exercises the students' innovative capacity and collaborative skills—competencies that are essential for 3E students to adapt to rapid technological iterations, solve complex engineering problems, and achieve sustainable career development.

Problems in Practical Teaching for Engineering Majors

Current practical teaching in engineering majors faces numerous issues that directly impact instructional quality and effectiveness. A primary challenge is the insufficient integration of AI technology with practical teaching, which prevents these programs from meeting the intelligent talent cultivation goals expected of Emerging Engineering Education. This makes it difficult to effectively foster students' practical abilities and innovative spirit. Specific problems include:

Subordinate Status of Practical Teaching and Decoupling of Industry and Education

Influenced by traditional educational concepts, conventional teaching models place excessive emphasis on theoretical knowledge while neglecting the cultivation of practical skills. This imbalance negatively impacts student growth. In some engineering colleges, the practical teaching model remains rigid and monolithic, ignoring individual differences among students and lacking innovation and flexibility. Consequently, these programs fail to provide personalized instruction tailored to the specific needs of the students.

实验

The practical teaching process often follows rigid, established procedures, making it difficult to meet the personalized development needs of students. There is a severe disconnection between industry and education, manifested in professional talent cultivation goals, practical teaching content, mechanisms, and graduation requirements. This leads to a significant deficiency in the cultivation of students' engineering practice abilities. In engineering talent training, the lack of authentic engineering environments results in superficial practical teaching. Consequently, training objectives are decoupled from the needs of industrial intelligence upgrades, and the curriculum system fails to match job requirements, leaving professional talent cultivation unable to satisfy the demands of social intelligence development.

Investment in practical teaching funds is insufficient, and management methods remain outdated. Influenced by regional economic development levels and the institutional status of universities, practical teaching budgets in some local engineering colleges are extremely tight. These limited funds struggle to support the modernization and sustainable development of practical teaching, leading to lagging equipment updates, insufficient venues, and a shortage of operational funds. Original production internships are often downgraded to mere observation tours. The lack of investment in software and hardware infrastructure means that the equipment and resources required for professional practical teaching cannot meet pedagogical needs. Furthermore, management lacks intelligent tools, resulting in low efficiency that cannot adapt to the requirements of intelligent practical teaching.

Assessment standards are ill-defined, and evaluation methods are highly subjective. Because practical teaching takes various forms, it is difficult to measure all formats using a unified, quantifiable standard. Consequently, subjective judgment by teachers plays a disproportionately large role in assessments. When evaluating students' practical operational skills, the objectivity of the evaluation is often compromised by the teacher' s personal experience, knowledge level, and individual preferences.

In group practice projects, "free-riding" may occur among individual students. When faced with a large number of students, it is difficult for instructors to accurately judge each student' s specific contribution. There is also a lack of attention paid to students' thought processes during practice and their problem-solving steps after encountering difficulties. As a result, students may perform tasks perfunctorily simply to complete the assignment.

Teacher incentive mechanisms are inadequate, and there is a shortage of "double-qualified" (academic and industry-experienced) teachers. Teachers guiding practical instruction in engineering colleges generally lack sufficient engineering practice experience. Furthermore, as artificial intelligence (AI) technology advances rapidly, most teachers only master traditional engineering theories, making it difficult to conduct practical teaching integrated with AI. This fails to meet the requirements for intelligent practical teaching in Emerging Engineering Education (3E). Since the quality of practical teaching does not directly affect the immediate interests of teachers, and incentive methods are limited—primarily consisting of credit-hour fees and year-end bonuses—teachers lack the initiative and enthusiasm to invest in practical teaching, especially intelligent instruction. The source of "double-qualified"teachers is also narrow, consisting mostly of Master' s and Doctoral graduates from traditional universities who lack engineering experience. Training opportunities for these teachers are insufficient, the training systems are incomplete, and the results are often unsatisfactory. Channels for university-enterprise joint cultivation of "double-qualified" teachers have not yet been fully established.

There is a lack of internship and training platforms. Weak cooperation between universities and enterprises results in an insufficient number of internship bases, leaving students without the necessary opportunities and conditions for engineering practice training. This shortage of training platforms has become increasingly prominent, affecting the quality of practical teaching in engineering majors. Without internships, students cannot apply their knowledge in real or simulated scenarios, leading to a disconnect between theory and practice. Many engineering colleges are forced to concentrate large numbers of students in a few partner enterprises, resulting in poor internship outcomes. Engineering training centers lack sufficient advanced instrumentation; existing equipment is outdated and prone to frequent failure, hindering the normal conduct of practical teaching. Engineering colleges urgently need to expand and improve the construction of internship and training platforms.

The evaluation system is incomplete and lacks the integration of AI-enabled empowerment, which has become a core issue facing current practical teaching. The existing system lacks specific, multi-dimensional evaluation indicators and implementation methods. Evaluation standards lag behind the development of informatization and intelligence, making it difficult to conduct diversified evaluations of practical teaching quality. There is a lack of process-based and performance-based assessments; evaluations focus too heavily on final results and fail to comprehensively reflect students' efforts and growth during the practical process. Monitoring is also insufficient, focusing more on teaching order and teacher behavior while lacking effective attention to student learning outcomes and classroom engagement. Without focusing on the cultivation of core competencies for engineering students, the results of practical teaching evaluations cannot be fed back into the talent cultivation process in a timely manner. This prevents the formation of a continuous improvement quality assurance mechanism and precludes targeted optimization for weaknesses in AI technology integration.

To construct a quality assurance system for practical teaching in Emerging Engineering Education, the core problems identified must be analyzed and their corresponding solutions integrated as key elements of the system. First, the status of practical teaching must be elevated, and the integration of industry and education must be strengthened. Teaching managers and faculty at all levels must transform their talent cultivation concepts and recognize the vital role of practical teaching in developing applied and innovative talents. Universities can help faculty and students fully understand the importance of practical teaching by organizing seminars and inviting external certification experts for lectures. The philosophy of practical teaching should be integrated into the curriculum, increasing its proportion within the overall system. Platforms for industry-education integration should be built to jointly establish research bases and industry colleges. Talent cultivation plans should be revised based on market demand and industry standards, facilitating two-way personnel exchanges that allow students to visit enterprises and engage with authentic, intelligent engineering practice scenarios. Furthermore, investment in practical teaching funds must be increased and funding sources expanded. To improve the quality of practical teaching in Emerging Engineering Education, colleges need to allocate more funds to these programs.

Furthermore, colleges must reasonably plan the use of funds to provide precise support for intelligent practical teaching. Departments should conduct detailed demand analyses for every link of practical teaching—such as experimental materials, internship transportation, and equipment maintenance—and prepare detailed budgets to reduce unnecessary expenditures. Universities should also optimize the budget preparation process to ensure funds are effectively utilized to enhance teaching outcomes. Multiple channels should be explored to broaden funding sources, including strengthening cooperation with industry enterprises. Enterprises can support practical teaching by donating equipment, establishing special funds, or sponsoring projects. Universities can also apply for special practical teaching grants from government departments to obtain support from education and science sectors. Engaging with alumni to introduce the practical teaching plans and funding needs of Emerging Engineering Education majors can attract targeted donations. Additionally, universities should establish a performance evaluation mechanism for fund usage, regularly auditing the alignment between fund allocation and practical teaching outcomes to adjust investment directions in a timely manner. Simultaneously, cross-departmental resource sharing within the university should be promoted to improve the efficiency of equipment and venue usage, achieving a dual promotion of financial investment and educational effectiveness. Finally, practical teaching models must be innovated and assessment methods reformed. Tailored to the actual needs of Emerging Engineering majors and students, project-based and case-based learning should be introduced to enhance the relevance and effectiveness of instruction. Assessments should emphasize students' practical skills and comprehensive literacy, utilizing diverse evaluation methods such as project reports and hands-on demonstrations to ensure fair results. In developing student competency plans, colleges should explore project-driven methods to improve innovation capabilities, reforming assessment methods to balance formative evaluation with summative assessment and group contribution.

结果

Through a diversified assessment and evaluation approach, comprehensive files such as experimental reports are utilized to fully understand the development process and trajectory of each student's practical abilities. To cultivate a "double-qualified" teaching team with high intelligent literacy, a new student-centered teaching reform model based on comprehensive school-enterprise cooperation has been constructed. By implementing a joint training and mutual hiring mechanism, school-enterprise mentor teams are formed to jointly develop practical teaching plans and programs, facilitating resource sharing and complementary advantages. This cooperation provides students with increased opportunities to engage with real-world engineering problems, thereby enhancing their practical capabilities and driving reform in practical teaching. Furthermore, the institution has formulated policies to improve teachers' professional skills and practical guidance abilities, increasing efforts to train and recruit faculty for practical teaching. By establishing a robust incentive mechanism, teachers are encouraged to actively commit to practical instruction. A professional growth mechanism aligned with the construction of New Engineering disciplines has been established to provide institutional guarantees for the continuous improvement of teachers' intelligent literacy, ultimately building a team of "double-qualified" teachers characterized by strong practical abilities and high intelligent literacy.

Universities must prioritize laboratory construction by increasing investment, enhancing the sophistication of experimental equipment, and actively resolving issues arising in laboratory management to provide material support for practical teaching. It is essential to strengthen the sharing and integration of laboratory resources to improve utilization efficiency. Universities should also proactively establish connections with industry enterprises to launch collaborative research and development projects, where enterprises provide internship positions and opportunities for practicing real-world projects. Furthermore, universities should actively seek special funding from relevant government departments to build on-campus engineering training centers equipped with advanced machinery that simulates authentic work environments. Strengthening the construction of on-campus internship and training bases, and improving both on- and off-campus internship systems, will facilitate the creation of leading domestic bases for engineering practice and innovation education. By establishing long-term and stable cooperative relationships with enterprises and public institutions, more internship opportunities can be provided to students. Finally, a quality assurance system for New Engineering practical teaching should be constructed, centered on AI-enabled technology, full-process quality monitoring, and continuous improvement.

An intelligent quality assurance system for New Engineering practical teaching is essential to ensure the steady improvement of educational quality. This involves establishing quality standards for practical teaching based on professional talent cultivation goals, and developing specific evaluation indicators and methods for different practical stages. These include scoring standards for experimental reports, detailed assessment rules for internships and training, and grading criteria for curriculum designs to ensure objectivity and an intelligence-oriented approach in quality evaluation. Refining the monitoring mechanism for practical teaching quality is a critical component of the internal quality assurance system. By formulating and improving practical teaching regulations and utilizing technologies such as artificial intelligence and big data, a full-process, intelligent monitoring platform can be built. This platform enables real-time assessment and comprehensive monitoring of practical teaching content and student operations. Furthermore, guidance during the practical process should be strengthened; instructors can use the intelligent monitoring platform to identify problems in student operations in a timely manner and provide targeted guidance. By integrating student evaluations, routine teaching inspections, and social evaluations, a diversified assessment framework is formed to comprehensively and accurately reflect the effectiveness of practical teaching.

During the development of New Engineering disciplines, a long-term mechanism for the continuous improvement of teaching quality must be established. Effective measures should be taken to promptly address problems and weaknesses in practical teaching based on quality standard requirements. The quality assurance system should perform continuous tracking and monitoring of the quality of talent cultivation. Through quality monitoring, the attainment of practical teaching objectives and overall cultivation goals is evaluated, leading to the formulation of rectification plans and measures. This creates a closed-loop quality assurance system where feedback actively informs and enhances practical teaching quality. Regular verification should be conducted to determine whether talent cultivation goals have been met, with a specific focus on the effectiveness of integrating AI technology to improve practical teaching quality. Relevant evidence must be provided to demonstrate that evaluation results are utilized for the continuous improvement of practical teaching, ensuring that the quality assurance system remains consistently aligned with the requirements of talent cultivation for New Engineering disciplines.

结论

Establishing a Continuous Improvement Mechanism for Emerging Engineering Education

The integration of Artificial Intelligence (AI) technology into the internal quality assurance of practical teaching for Emerging Engineering Education (3E) is of profound significance. This integration is essential for enhancing overall teaching quality and fostering students' hands-on skills, innovative thinking, and ability to solve complex engineering problems. As the 3E philosophy deepens and new programs continue to be established, the intelligent upgrading of industries has imposed higher requirements on the quality of practical education.

To effectively address current challenges in practical teaching and bridge the gap in the deep integration of AI technology, several strategic measures must be implemented. These include elevating the status of practical teaching, strengthening industry-education integration, and deepening the alignment with intelligent content. Furthermore, it is necessary to increase funding for practical education, innovate intelligent teaching models, and reform assessment methods to incorporate dimensions of intelligence.

Building a robust internal quality assurance system also requires strengthening the development of "double-qualified" teaching staff (those with both academic and industry expertise) and enhancing their digital literacy. Simultaneously, institutions must improve intelligent laboratories and internship training bases. By implementing these measures, universities can construct a comprehensive quality assurance system for practical teaching that is deeply infused with AI technology.

In the era of intelligence, the construction of Emerging Engineering majors should maintain a continuous focus on industry trends and educational reform trajectories. It is imperative to constantly explore new strategies for the deep integration of AI technology and practical teaching to ensure the sustainable improvement of educational outcomes.

方法

The optimization of the internal quality assurance system for practical teaching provides a strong guarantee for cultivating engineering and technological talents who meet the developmental requirements of the new era. Furthermore, it contributes significantly to achieving national scientific and technological self-reliance, the intelligent upgrading of industries, and high-quality economic development.

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Abstract

Against backdrop global scientific technological revolution integration artificial intelligence technologies, emerging engineering majors, carrier cultivating future engineering technological talents, directly China competitiveness round scientific technological competition.

Integrating artificial intelligence technologies internal quality system practical teaching emerging engineering majors approach improving quality talent cultivation adapting intelligent development paper first elaborates important position practical teaching construction emerging engineering majors, analyzes existing problems practical teaching current engineering majors, proposes measures build scientific, comprehensive intelligent internal quality assurance system practical teaching. enhance effectiveness practical teaching emerging engineering majors, provide solid talent support intellectual guarantee China industrial upgrading high-quality economic development. words merging ngineering ractical teaching; nternal uality ssurance ystem; rtificial ntelligence

Note: Figure translations are in progress. See original paper for figures.