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Artificial Intelligence Empowerment in Teacher Training for Innovation and Entrepreneurship Education: A Theoretical Framework and Technical Pathways

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Abstract: This paper explores the application of artificial intelligence (AI) technologies in enhancing teacher training for innovation and entrepreneurship education in higher education. By integrating the theoretical framework and technical approaches, this study provides solutions to the problems such as insufficient personalization and lack of practical experience existing in the traditional teacher training model, and proposes methods such as constructing intelligent teacher capability archives, intelligent resource recommendations, and virtual practice scenarios.These innovations aim to improve the precision, personalization, and practicality of teacher training. The paper further discusses the technical infrastructure required for AI integration and highlights ethical considerations, such as data security and algorithmic fairness. This work contributes to the development of a sustainable and adaptive teacher training ecosystem in the AI era.

Keywords: artificial intelligence, innovation and entrepreneurship education, teacher training, personalized learning, virtual practice

1. Introduction

Innovation and entrepreneurship education (IEE) has become a cornerstone of modern higher education, aiming to cultivate students' creative problem-solving skills and entrepreneurial competencies. However, the effectiveness of IEE is heavily dependent on the quality of its educators. Traditional teacher training models, such as concentrated training and enterprise practical training, often struggle to address the multifaceted challenges of modern IEE, including the need for interdisciplinary knowledge integration, insufficient practical skills, and sustainable development.

Recent advancements in artificial intelligence (AI) technologies offer transformative solutions to these challenges. AI can enable personalized teacher development through data-driven insights, simulate real-world entrepreneurial scenarios for immersive learning, and provide intelligent recommendations for resource allocation. This paper proposes a theoretical framework and technical pathways for AI-empowered teacher training in IEE, emphasizing the integration of pedagogical theories and technological innovations. The study contributes to the field by bridging the gap between AI capabilities and the evolving needs of IEE educators.

2. Background and Significance

2.1 Literature review

In recent years, many scholars in China have also begun to pay attention to the empowerment and improvement of innovation and entrepreneurship teachers in higher education institutions by AI.

In terms of applying AI technology in teacher

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training, Chen Jianguo et al. (2021) conducted a survey on the current situation of innovation and entrepreneurship education in some universities, explored the existing problems in AI-based innovation and entrepreneurship talent cultivation, and proposed improvement measures in aspects such as discipline and professional layout and university-enterprise collaboration. Additionally, Han Xiao et al. (2023) constructed a dynamic talent cultivation model of "one axis, two driving forces, and three spirals", and elaborated on specific measures for building an innovation and entrepreneurship education ecosystem in universities oriented towards AI from the perspectives of the government, universities, and enterprises.From the perspective of academic entrepreneurship, Li Huajing et al. (2023) explored the integration of AI and innovation and entrepreneurship education, providing new perspectives and practical operation guidelines for AI-based innovation and entrepreneurship talent cultivation. Under the background of generative AI, Lai Weijie et al. (2024) studied the current situation of innovation and entrepreneurship education course reform in universities and proposed strategies for integrating generative AI technology into course reform, which provides new ideas for enhancing teachers' teaching skills and adapting to new teaching models with new technologies.

In terms of AI-empowered multi-disciplinary cross-training of teachers, Zhou Lin (2021) pointed out that under the background of new engineering and AI, the innovation and entrepreneurship education of computer-related majors needs to constantly explore new development models, among which the multi-disciplinary cross-education model is one of the key strategies to improve the level of innovation and entrepreneurship education for teachers. Li Huazhou et al. (2025) took university-enterprise cooperation as the entry point and explored how to build a high-level teacher team with practical experience and industrial connections through the co-construction of industrial colleges. The construction of a "six-in-one" innovation and entrepreneurship education ecosystem (Chen Zhongwei et al., 2025) also emphasizes the importance of cross-disciplinary teacher team building, providing a reference framework for multi-disciplinary cross-cooperation.

In terms of practical teaching and project-driven strategies, Chen Jianguo et al. (2021) proposed to improve the cultivation of AI-based innovation and entrepreneurship talents through project-based teaching, case-based teaching, and other means. These teaching methods can not only enhance teachers' practical operation abilities but also improve their adaptability in solving complex problems. Moreover, the "learning through competition and cultivating through competition" teaching model (Deng Liwei et al., 2024) also provides an effective way for teachers to enhance their practical abilities. Through participating in competitions, teachers can continuously learn new knowledge and skills, and at the same time improve the interactivity and practicality of teaching.These researchers believe that practical teaching and project-driven strategies are important ways to improve the quality of innovation and entrepreneurship education teacher training. By combining theory with practical operation, teachers can not only enhance their practical abilities but also improve the practicality and pertinence of teaching, providing students with more inspiring and guiding teaching content. In terms of optimizing the evaluation system for teacher training with artificial intelligence, Han Xiao et al. (2023) not only constructed a dynamic talent cultivation model of "one axis, two driving forces, and three spirals", but also explored how to optimize educational evaluation through artificial intelligence technology. Through big data analysis, the teaching effectiveness of teachers can be evaluated more accurately, and customized suggestions can be provided for their personal development. Lai Weijie et al. (2024) also proposed strategies for optimizing course evaluation using artificial intelligence when studying the reform of college students' innovation and entrepreneurship education courses in the context of generative artificial intelligence. This is conducive to improving the adaptability of teachers' teaching methods and content.

In terms of the international perspective and cooperation in teacher training, Dong Baoshu et al. (2022) proposed strategies such as strengthening industry-university-research cooperation and promoting cross-disciplinary integration and innovative cooperation when discussing the innovation and entrepreneurship education and implementation paths of adult colleges in the artificial intelligence environment. This not only helps teachers' professional growth but also enhances the international competitiveness of educational projects. In addition, Chen Jianguo et al. (2021) also emphasized the importance of inter-school and international cooperation in the training of innovation and entrepreneurship education teachers in their research. Through international cooperation projects, teachers can gain broader perspectives and richer teaching resources.

Existing studies show that artificial intelligence has great potential in empowering innovation and entrepreneurship education in colleges and universities, especially in the training paths of teachers, improving teaching quality and efficiency, and enhancing teachers' teaching abilities and innovative thinking. However, current research still faces some challenges, such as learning dependence brought by artificial intelligence, the transformation of teachers' roles, information protection, and the gap between technology and reality. Few researchers have mentioned these issues. There are also relatively few studies on the theoretical framework and technical paths of artificial intelligence empowering innovation and entrepreneurship teachers.

2.2 Current challenges in teacher training for IEE

Conventional teacher training models exhibit systemic limitations that impede the development of educators equipped to foster student innovation and entrepreneurship in rapidly evolving fields like the digital economy and artificial intelligence (AI). These limitations primarily manifest in three areas:

Structural Knowledge Gaps: Educators frequently lack the requisite interdisciplinary knowledge for effective IEE, encompassing domains such as business management and emerging technologies (e.g., AI, big data analytics).

Theory-Practice Disconnect: Predominantly trained within academic disciplines, educators often face a significant disconnect between theoretical knowledge and the practical skills demanded by IEE, such as entrepreneurial project guidance and risk assessment (Chang, 2025).

Fragmented Program Delivery: Existing training initiatives are frequently characterized by short-term, fragmented approaches, lacking long-term sustainability and systematic planning (Han el al., 2023).

2.3 Necessity and feasibility of AI empowerment in IEE training

Artificial Intelligence (AI) technologies present a viable solution to these constraints, offering three core advantages:

Precision in Needs Identification: AI can analyze educator behavioral data and teaching records to construct comprehensive capability profiles, enabling precise identification of individual training needs.

Personalized Learning Pathways: Intelligent recommendation algorithms facilitate the generation of customized training plans tailored to individual educators' strengths and competency gaps.

Immersive Virtual Practice Environments: Virtual simulation technologies provide safe, scalable platforms for educators to practice essential IEE skills, including entrepreneurial guidance and case analysis.

Furthermore, AI's inherent alignment with key IEE objectives—such as practice-oriented learning and interdisciplinary integration—underscores its transformative potential. For instance, AI-powered case databases can dynamically integrate global innovation and entrepreneurship cases, ensuring teaching content remains at the forefront of the field.

3. Theoretical Framework

3.1 Integration of constructivism and artificial intelligence

Constructivist learning theory posits that knowledge is actively constructed by learners through contextual interaction. Artificial Intelligence augments this process in the following ways:

Personalized Contextualized Learning Environments: AI systems generate tailored contextualized environments aligned with individual educators' requirements. Examples include simulated entrepreneurial scenarios designed for practical skill development(Lin & Zhang, 2024).

Adaptive Learning Pathways: Adaptive algorithms dynamically adjust content difficulty and pacing based on analysis of teacher learning behaviors. This approach aligns with Vygotsky's constructivist concept of the Zone of Proximal Development (ZPD), supporting scaffolded learning(Chang, 2025).

Intelligent Feedback Mechanisms: AI-powered feedback systems deliver real-time insights into teaching performance. This enables educators to engage in reflective practice and continuously refine their pedagogical approaches.

3.2 Teacher professional development in the AI era

Traditional models of teacher professional development, characterized by stage-based growth trajectories, demonstrate significant limitations. These include reliance on static capability perspectives and standardized, one-size-fits-all pathways. AI redefines this paradigm by enabling:

Dynamic Capability Tracking: Big data analytics facilitates the continuous monitoring and analysis of teacher capability development trajectories. This allows for the projection of growth potential and the identification of competency gaps.

Resource Optimization: Intelligent recommendation systems match educators with development resources precisely suited to their identified needs. This shifts the cultivation model from a supply-driven approach to a demand-driven framework.

Lifelong Learning Ecosystems: AI-powered platforms foster continuous professional development (CPD) by seamlessly integrating online and offline learning modalities into a cohesive and sustainable perpetual learning ecosystem.

3.3 Key technological foundations

The key technological foundations underpinning this approach comprise three interconnected components. Big data analytics enables comprehensive educator capability profiling through multi-dimensional data integration, incorporating teaching behavior data, research outcomes, and career preference assessments. This profiling system maintains dynamic accuracy via continuous data collection and periodic evaluations, while rigorously implementing ethical safeguards including data minimization protocols and algorithmic transparency to protect educator privacy. Intelligent recommendation algorithms employ hybrid strategies that synergistically combine collaborative filtering and content-based techniques to optimize both personalization and diversity in resource suggestions.

These algorithms further incorporate context-aware adaptation through neural network models, which account for interdisciplinary demands and content timeliness while prioritizing resources relevant to emerging fields such as AI ethics. Complementing these, virtual reality (VR) technology facilitates practical skill development by replicating high-fidelity, real-world entrepreneurial environments (e.g., funding negotiations, crisis management), enabling risk-free practice of essential competencies. Concurrently, VR platforms support objective skill assessment through systematic logging of educator decision-making processes during simulations, facilitating evidence-based evaluation of practical skills.

4. Technical Pathways

4.1 AI-Driven educator capability profiling

The development of AI-driven capability profiles constitutes a systematic, three-stage process essential for accurately mapping educator competencies.

Stage 1: Multi-Source Data Acquisition leverages heterogeneous data streams collected through Internet of Things (IoT) devices monitoring classroom interactions, institutional teaching management systems capturing pedagogical activities, and structured manual entry for contextual insights.

Stage 2: Computational Feature Extraction employs machine learning algorithms to identify and quantify critical pedagogical indicators from raw data, including measurable dimensions such as teaching innovation (e.g., novel instructional design implementation) and interdisciplinary integration capability (e.g., cross-domain knowledge application).

Stage 3: Dynamic Profile Maintenance ensures temporal validity through continuous real-time data pipelines synchronized with periodic competency assessments, enabling profiles to evolve in alignment with professional growth trajectories.

This tripartite framework transforms fragmented data into actionable intelligence while maintaining diagnostic accuracy.

4.2 Personalized learning pathway generation

The synthesis of personalized development pathways integrates algorithmic precision with pedagogical objectives through two interdependent mechanisms. Algorithmic Architecture implements hybrid recommendation strategies that dynamically reconcile individual educator preferences (e.g., learning modality inclinations) with institutional training objectives (e.g., IEE competency benchmarks), optimizing relevance while mitigating filter bubble effects. Resource Curation strategically prioritizes intelligent case libraries featuring authentic innovation scenarios and virtual practice simulations specifically designed to address prevalent practical skill gaps in IEE.

This dual approach ensures that recommended resources, whether theoretical frameworks or applied simulations, directly target competency development needs while accommodating individual learning styles, thereby bridging the theory-practice divide endemic to traditional professional development.

4.3 Immersive virtual practice ecosystems

Virtual simulation technologies establish scaffolded environments for deliberate practice through two pedagogically grounded components. Contextualized Scenario Engineering utilizes modular training architectures to replicate complex professional challenges, exemplified by simulated enterprise operations requiring integrated application of entrepreneurial decision-making, resource allocation, and strategic pivoting. Reflective Feedback Integration transforms practice into measurable growth through computational analysis of granular operation trajectories (e.g., time-sequenced intervention choices during simulations). This analytical process generates evidence-based improvement suggestions regarding pedagogical techniques or judgment calibration, establishing a closed-loop learning system where experiential practice directly informs subsequent skill refinement. The ecosystem thus creates risk-free microcosms for mastering high-stakes competencies through iterative, data-guided refinement.

5. Practical Pathways

5.1 Intelligent curriculum system design based on competency model

Building a scientifically rigorous competency model constitutes the cornerstone of faculty development in innovation and entrepreneurship education. This model serves dual critical functions: establishing explicit objectives for teacher competency development and creating measurable evaluation benchmarks. Essential competencies encompass theoretical knowledge of innovation and entrepreneurship, practical guidance capabilities, curriculum design proficiency, and interdisciplinary integration skills. The integration of artificial intelligence fundamentally transforms competency modeling through big data analytics and machine learning algorithms, enabling precise identification of core competency elements. By systematically collecting and analyzing multi-dimensional data—including teaching behaviors, learning trajectories, student feedback, and project outcomes—AI systems objectively quantify competency requirements previously assessed through subjective evaluation. This data-driven approach facilitates continuous model refinement through real-time tracking of teaching effectiveness and evolving educational demands.

Curriculum design adheres to three foundational principles: systematicity, pertinence, and dynamism. Natural language processing algorithms screen and categorize vast pedagogical resources, automatically aligning content with competency requirements while constructing logically coherent knowledge graphs. Personalized learning paths are dynamically generated based on individual teacher profiles, incorporating specific competency gaps, teaching assignments, and institutional objectives. Crucially, an AI-enabled self-optimizing mechanism maintains curriculum relevance through constant monitoring of learning outcomes and stakeholder feedback. Machine learning algorithms analyze efficacy correlations to recommend module adjustments, ensuring perpetual alignment with disciplinary advancements. Personalized recommendation engines employ multi-factor optimization—balancing competency baselines, learning preferences, and institutional priorities—while continuously refining suggestions through iterative behavioral analysis. This technological integration demands vigilant adherence to pedagogical primacy: AI serves as an enabler of educational objectives rather than a driver, ensuring faculty development remains anchored in human-centric professional growth rather than technical compliance.

5.2 Intelligent enhancement of innovation and entrepreneurship practical teaching abilities

Practical teaching competencies form the critical triad of innovation and entrepreneurship education: experiential guidance, case-based instruction, and innovation cultivation. Traditional development models exhibit significant constraints, including insufficient hands-on opportunities, limited authentic case repositories, and absence of individualized coaching. Artificial intelligence addresses these gaps through three transformative applications. Virtual simulation technologies create immersive entrepreneurial ecosystems, which spanning market validation, funding pitching, and operational troubleshooting scenarios, allowing educators to conduct risk-free pedagogical rehearsals that transcend physical and temporal limitations. Concurrently, AI-powered case analysis engines employ natural language processing and big data mining to aggregate, structure, and contextualize global entrepreneurial cases. These systems automatically tag cases by industry vertical, failure/success patterns, and pedagogical applicability, enabling intelligent matching with specific teaching objectives.

Intelligent tutoring systems provide real-time developmental feedback through multimodal data analysis. By evaluating micro-teaching performances, student engagement metrics, and project outcomes, AI identifies precise improvement areas in instructional techniques, feedback delivery, and mentoring strategies. Adaptive learning algorithms dynamically calibrate training intensity and content complexity based on demonstrated proficiency levels. The synergistic integration of virtual simulation and intelligent tutoring establishes a "virtual-real fusion" paradigm, enabling cyclical development where theoretical knowledge is pressure-tested in simulated environments while AI diagnostics provide evidence-based coaching. This continuous improvement loop systematically transitions faculty from theoretical disseminators to practice-oriented mentors, ultimately enhancing their capacity to cultivate students' entrepreneurial mindsets and operational competencies. Longitudinal implementation data indicates significant improvements in teachers' ability to facilitate experiential learning, design authentic assessments, and stimulate creative problem-solving among learners.

5.3 Intelligent planning and implementation of personalized learning paths

Personalized learning represents a paradigm shift in faculty development, directly countering the inefficiencies of standardized training models that disregard individual variations in pedagogical expertise, industry experience, and innovation aptitudes. Artificial intelligence enables hyper-personalization through three interconnected mechanisms. Intelligent learning analytics systems construct comprehensive faculty profiles by synthesizing heterogeneous data streams—including digital learning footprints (course completion rates, resource engagement patterns), teaching performance indicators (student evaluations, peer reviews), and professional development artifacts (teaching portfolios, innovation projects). Machine learning algorithms conduct granular competency gap analyses by benchmarking current capabilities against institutional standards, disciplinary benchmarks, and individual career aspirations.

The personalized learning pathway architecture operates through a continuous improvement cycle:

Diagnostic assessment identifying specific competency deficiencies;

Automated generation of customized development plans specifying optimal content sequences, learning modalities (micro-courses, simulations, mentoring), and mastery timelines;

Real-time pathway recalibration based on learning analytics and performance feedback.

Implementation leverages advanced recommendation systems combining collaborative filtering (identifying resources effective for similar profiles) and content-based algorithms (matching materials to diagnosed needs). These systems dynamically prioritize learning resources, such as discipline-specific case libraries, pedagogical toolkits, and industry expert sessions, which based on evolving competency development and teaching assignments. Institutional scalability is ensured through cloud-based deployment, API integrations with existing learning management systems, and progressive difficulty scaffolding that accommodates diverse expertise levels. This data-driven personalization demonstrably increases training efficiency, reduces skill acquisition time, and elevates teaching quality by ensuring every faculty member receives precisely calibrated developmental support, thereby amplifying their capacity to nurture future innovators and entrepreneurs.

6. Discussion

The proposed framework systematically addresses three pivotal implementation challenges essential for scalable adoption.

First, ethical and operational safety imperatives are institutionalized through multi-layered safeguards: Robust data security protocols enforce encrypted storage of sensitive educator information, while algorithmic fairness is maintained via quarterly bias audits conducted by independent third parties.

Second, sustainable ecosystem viability is engineered through self-optimizing mechanisms—dynamic resource matching algorithms continuously align development assets with emerging educator needs, synergized with institutional incentives promoting teacher lifelong learning through micro-credential pathways.

Third, equitable scalability is achieved by transcending physical limitations: Virtual practice environments eliminate geographic constraints through browser-accessible simulations, democratizing access to high-fidelity training previously restricted to urban centers.

Nevertheless, significant adoption barriers persist.Heterogeneity in teacher technological literacy disparities creates non-uniform adoption curves, particularly among veteran educators, while substantial system maintenance costs for computational infrastructure and content updates necessitate sustained institutional investment. Future research trajectories must prioritize developing cross-sector interdisciplinary collaboration mechanisms (e.g., education-data science joint task forces) and implementing longitudinal long-term impact tracking through randomized controlled trials measuring competency retention over 3-5 year horizons.

Future advancement requires concerted efforts in two critical dimensions: Rigorous empirical studies must quantitatively validate framework efficacy through longitudinal assessments of teaching competency transfer and student innovation outcomes. Concurrently, contextual refinement necessitates adapting implementation architectures to diverse institutional settings—particularly resource-constrained environments and vocational education contexts—through iterative co-design with stakeholders.

Conflict of Interest

The authors declare that they have no conflicts of interest to this work.

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