An Exploration of Pathways to Enhancing Educational Adaptability via an AI-Enabled System for Cultivating Process Skills

Wei Dong* and You-wang Dai

Dalian University of Science and Technology, Dalian 116052, China

*715296876@qq.com

Abstract. Grounded in the core tenet of "developing process skills and enhancing professional competence", an adaptive educational framework for constructing an "AI-Enabled System for Cultivating Process Skills" is introduced in this paper, taking into consideration the transformative impact of AI technology on occupational environments. This framework involves establishing a standardized workflow that seamlessly blends virtual and real-world elements through the integration of digital twin technology. It leverages an AI-assisted cognitive system to conduct personalized skills mapping analysis and fosters the integrated development of critical and algorithmic thinking through human-machine collaborative cognitive and metacognitive skills application and operational training. By harnessing the interplay between emotions and behaviors, it cultivates professional ethos and awareness, explores the developmental trajectories of technical professionals, and establishes an effective learning guidance mechanism. This framework is designed to nurture individuals with both "AI + major" expertise and moral integrity, who are proficient in applying intelligent tools and innovative methodologies while also adhering to the ethical standards of human-machine collaboration, thereby forming a three-dimensional capability structure that aligns with the demands of an intelligent society, encompassing "technical acumen, humanistic empathy, and innovative leadership". Empirical evidence indicates that this training model significantly enhances students' skills proficiency and professional qualities, better meeting the employment needs of enterprises.

Keywords: AI-Enabled, Educational Adaptability, Process Skills, Cognition, Metacognition.

1 Introduction

In the midst of the global surge of the AI era and the profound transformation of industrial landscapes and professional ecosystems by intelligent technologies, enhancing educational adaptability has become a critical avenue for nurturing compo-site professionals who possess both digital operational expertise and cross-disciplinary comprehensive competencies. Vocational education, as a vital segment of the educational framework, is dedicated to cultivating professionals endowed with practical operational

I. A. Khan et al. (eds.), *Proceedings of the 2026 5th International Conference on Educational Innovation and Multimedia Technology (EIMT 2026)*, Atlantis Highlights in Social Sciences, Education and Humanities 51,
https://doi.org/10.2991/978-94-6239-691-3_27

skills and comprehensive professional qualities. Therefore, strengthening adaptability in the AI era represents the linchpin for elevating the caliber of talent development within vocational education.

From the vantage point of policy evolution, the “Outline of China's Education Reform and Development” in 1993 articulated that vocational education “should proactively align with the demands of local development and the socialist market economy, cater to market needs, and contribute to social construction”. This marked the inaugural explicit reference to the adaptability of vocational education in a national policy document[1]. In 2022, the newly amended “Vocational Education Law of the People's Republic of China” came into effect, formally establishing the legal foundation for “enhancing the adaptability of vocational education”. This legislative milestone represents China's inaugural effort to chart the course for the adaptive evolution of vocational education through legal means, offering a robust framework for its alignment with the requirements of the intelligent industry and the cultivation of composite technical talents.

Nevertheless, research has unveiled persistent and pressing challenges in the advancement of vocational education. Firstly, the pedagogical scope in the majority of vocational education institutions remains insufficiently comprehensive, neglecting the integration of digital and intelligent elements, and thus failing to fully encapsulate the operational demands of production in the AI era. Secondly, the cultivation of professional competencies often concentrates exclusively on traditional operational skills, with inadequate emphasis on the effective manifestation of cognitive and metacognitive mental faculties. This disconnect undermines the synergy between technological application and cognitive development, thereby compromising the sustainable progression of professional abilities.

In academic circles, extensive research has focused on the two core dilemmas of vocational education in the AI era and explored corresponding solutions. Some studies have proposed promoting the in-depth integration of technology and teaching through approaches such as AI-driven personalized instruction and the establishment of intelligent training systems, thereby addressing the deficiencies in infrastructure and curriculum alignment[2]. Meanwhile, intervention methods including metacognitive strategy training and task-based teaching have been proven effective in enhancing students' self-regulatory and problem-solving capabilities[3], and the application of technologies such as VR and AR can also facilitate the coordinated development of technical skills and mental skills[4]. Overall, foreign research has developed diverse solutions centered on technology integration and mental skill cultivation, providing robust theoretical and practical support for resolving these two core challenges.

In China, Chen Lixiang introduced the paradigm of “developing process skills and enhancing professional qualities”[5], which is centered on augmenting the adaptability of vocational education. This paradigm encompasses systematic theoretical exploration, the formulation of concrete implementation strategies, and the generation of actionable insights. It not only resonates with central policy directives and the stipulations of the National Vocational Education Law but also precisely addresses the pragmatic needs of vocational education in the intelligent era.

Building upon this foundation, this paper is anchored in the core tenet of "developing process skills and enhancing professional literacy". By integrating the recon-figuring attributes of AI technology within professional contexts, it proposes an adaptive educational model aimed at constructing an "AI-Enabled System for Cultivating Process Skills". This model entails the establishment of a virtual-real integrated standardized work process through the adoption of digital twin technology, the utilization of AI-assisted cognitive systems for personalized skills mapping analysis, and the facilitation of the convergent development of critical thinking and algorithmic thinking via human-machine collaborative cognitive and metacognitive skills application and operational training. Furthermore, it nurtures a professional ethos and consciousness befitting the new era through the interplay of emotions and behaviors, delves into the growth trajectories of technical talents in the intelligent era, and institutes an efficacious learning guidance mechanism.

This model is designed to cultivate talents who embody both moral integrity and technical prowess, aligning with the "AI + major" ethos. These individuals not only command the application of intelligent tools and innovative methodologies but also possess a profound understanding of the ethical dimensions of human-machine collaboration, thereby forging a three-dimensional capability structure that meets the exigencies of an intelligent society, encompassing "technical acumen, humanistic empathy, and innovative leadership". Empirical evidence demonstrates that this training model substantially elevates students' skills proficiencies and professional qualities, more effectively satisfying the hiring prerequisites of enterprises, and offering a replicable and pragmatic pathway for the high-caliber development of vocational education in the intelligent era.

2 Construction of AI-Enabled System for Cultivating Process Skills

Centered on the cultivation of process skills, adaptive vocational education initially defines training objectives and subsequently integrates digital twin technology to create a standardized work process that seamlessly blends virtual and real-world elements, serving as an immersive learning environment. Leveraging AI-assisted cognitive systems, personalized skills maps are dynamically generated to precisely align with the learning modalities of process skills. Following this, through human-machine collaborative cognitive-metacognitive skills application training, students engage in iterative refinement within a closed-loop system of virtual-real tasks, fostering the convergence and evolution of critical thinking and algorithmic thinking. Ultimately, by leveraging observable and adjustable process skills components, the comprehensive realization and ongoing refinement of training objectives are attained (shown as Fig. 1).

2.1 Adaptive Objectives for Process Skills Development

Drawing upon the distinctive features of vocational education and the evolving demands of society, adaptive process skills training objectives are formulated by amalgamating multiple dimensions, encompassing knowledge adaptability, emotional adaptability, technical skills practice adaptability, reform and innovation consciousness adaptability, as well as the establishment and nurturing of professional ethos and consciousness.

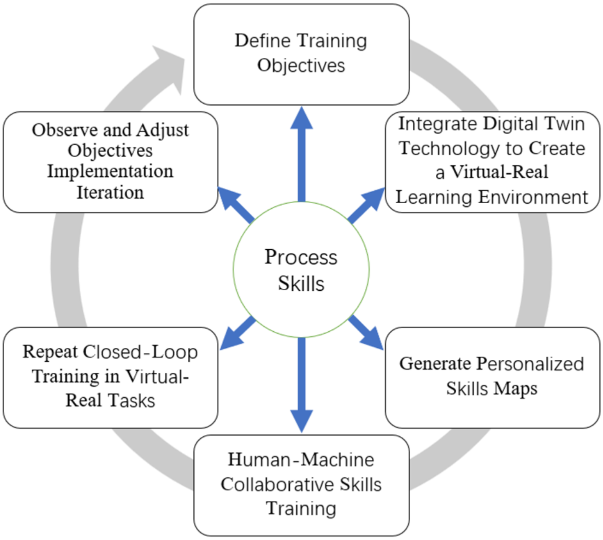

Fig. 1. AI-enabled system for cultivating process skills.

Knowledge Adaptability denotes an individual's proficiency in digitally processing information, comprehending the concepts, mechanisms, and applications of knowledge points pertinent to work processes, and cultivating critical thinking, learning management, and self-regulatory skills to address problem-solving needs.

Emotional Adaptability signifies the capacity to enhance cognitive operations and interpersonal communication skills through the application of interpersonal communication concepts, methods, and techniques, thereby fostering harmonious relation-ships.

Technical Skills Practice Adaptability refers to the ability to gather and organize information utilizing digital technology based on work objectives or blueprints, apply methodological skills to assess the safety, reliability, and cost-effectiveness of resource allocation in work processes, filter relevant knowledge points, and execute cognitive operations.

Reform and Innovation Consciousness Adaptability involves comprehending the essence and significance of reform and innovation through knowledge points, identifying gaps in self-knowledge and action based on the three pillars of professional innovation and entrepreneurial consciousness among university students, perceiving deficiencies in the complementary relationship between reform and innovation of these pillars, stimulating cognitive thinking, and continuously reflecting on the rationale behind actions.

Professional Ethos and Consciousness Adaptability pertains to understanding the connotations and significance of the spirit of exemplary workers and craftsmen, identifying discrepancies between core values such as dedication, excellence, focus, and innovation inherent in typical craftsmanship and one's own knowledge and behavior, appreciating the significance of these values in one's professional journey, and inspiring determination and ambition.

2.2 Integration of Digital Twin Technology and Knowledge Graphs

Constructing a digital support system for vocational education with digital twin technology and knowledge graphs as the cornerstone, deeply integrating core skills application elements, and aiding students in refining their cognitive structures and elevating their comprehensive competencies through systematic cognitive and meta-cognitive operations. Specifically, leveraging the AI-assisted cognitive system to generate a knowledge graph[6], which capitalizes on its structural modeling advantages to visually interconnect the core elements, progression benchmarks, and inherent relationships of cognitive and metacognitive skills, emotional and social skills, technical and practical skills, as well as innovation and transformation skills, enabling students to clearly discern the logical sequence and enhancement trajectory of skills development; digital twin technology precisely replicates enterprises' real production scenarios and workflows, establishing an immersive practice platform that fuses virtual and real elements, guiding students to undertake cognitive and metacognitive practical training in a highly simulated environment, concurrently bolstering learning planning and self-regulatory abilities, interpersonal communication and collaboration skills, complex problem-solving abilities, as well as innovative thinking and value creation awareness.

In practical applications, digital twin technology can capture critical data such as students' operational behaviors and decision-making pathways in real-time. By integrating the intelligent analysis and reasoning capabilities of knowledge graphs, it can pinpoint students' cognitive deficiencies and skills weaknesses accurately, and iteratively refine cognitive training programs in reverse. Simultaneously, knowledge graphs can deliver personalized learning resources and metacognitive enhancement guidance based on students' learning progress and ability profiles. The two form a synergistic closed loop, facilitating the precise refinement and dynamic upgrading of cognitive structures. The enterprise-centric and socialized implementation of cognitive and metacognitive systems rely on knowledge graphs to deeply map the competency requirements of industry positions, connect cutting-edge trends in industrial development, and utilize digital twin technology to achieve full-process virtualized simulations in real work scenarios for enterprises[7]. This implementation pathway of "technology empowerment + integration of job and curriculum" not only achieves precise alignment between learning and application scenarios, constructs a vocation-al education model that meets the development needs of the new era but also pro-vides core support for the sustainable career construction and advancement of technical and skilled personnel.

2.3 Core Components of Adaptive Process Skills

In the work process, process skills typically encompass cognitive and metacognitive skills, emotional and social skills, technical and practical skills, as well as innovation and change skills[2]. Among these, cognitive and metacognitive skills under-score the development of critical thinking, learning management, and self-control abilities, serving as the cornerstone and foundation for the holistic development of process skills.

Cognition involves the in-depth processing of various information entering the mind, enabling one's understanding of things to progressively deepen from the superficial to the profound, and from the exterior to the core, ultimately fulfilling the task of recognizing the essential attributes of things[8]. Meta-cognition, conversely, pertains to an individual's knowledge of their own cognitive processes and their ability to regulate these processes. Both the knowledge and control of thinking and learning activities belong to mental skills and complement each other[8]. According to Bloom's hierarchical classification of the cognitive domain[9], cognition corresponds to the levels of knowing, understanding, and applying, while metacognition corresponds to the levels of analyzing, synthesizing, and evaluating. When students internalize knowledge through learning, it transforms into their cognitive structure.

3 Practice of an Adaptive Vocational Education and Training Model Centered on Process Skills Cultivation

The ultimate objective of fostering process skills through personalized learning approaches is to facilitate the integrated development of critical and algorithmic thinking. This is achieved through cognitive and metacognitive skills application and operational training within a human-machine collaborative framework. The operational procedures are outlined as follows:

3.1 Information Preparation

Prior to initiating any cognitive operation, it is imperative to clearly define the goals and objectives, thereby providing a definitive direction for information preparation. Based on the cognitive operation requirements, anticipate the type and volume of information needed, establishing a foundation for subsequent information gathering and organization. Subsequently, employ information collection methods such as literature reviews, online searches, and expert consultations to acquire pertinent information and materials. Categorize, filter, and organize the collected data to ensure its accuracy and completeness.

3.2 Plan Formulation

The cognitive operation plan should embody principles of personalized learning, interactive learning, and learning activities grounded in real-world production pro-jects. It should incorporate cognitive operation learning plans that achieve the set objectives by selecting at least two of the following learning stages: utilizing digital technology for information collection and analysis, comprehending and analyzing work processes at various levels, acquiring skills in management and control, empathy and self-efficacy, technical practice, innovation and reform, professional ethics and awareness, as well as formative assessment and metacognitive monitoring procedures.

3.3 Operation Execution

During cognitive operation execution, maintain a high degree of concentration and minimize external distractions. Adhere to the cognitive operation plan, conducting operations related to project resource allocation, safety, reliability, and economic efficiency (in line with design specifications), among other relevant knowledge points. For knowledge points categorized by technical attributes, functions, and forms, employ methodological skills to dissect the "what" and "why." Utilize drawings, if available, to guide operations. Furthermore, adapt operation strategies and methods in real-time based on the prevailing circumstances to enhance the efficiency and quality of cognitive operations.

3.4 Metacognitive Monitoring

Throughout cognitive operation execution, continuously monitor one's thought processes, strategy utilization, and other cognitive facets. Leverage these observations to obtain timely feedback and rectify any inappropriate operational strategies, there-by refining the accuracy of cognitive operations. Upon completion, conduct a com-prehensive summary and reflection on the entire process, scrutinizing the reasons behind successes and failures to glean insights for future cognitive operations.

3.5 Evaluation and Enhancement

Establish specific evaluation criteria aligned with the objectives and requirements of cognitive operations, such as completion time and accuracy rate. Collect data on the efficacy of cognitive operations through testing and questionnaires. Subsequently, perform statistical analyses on the gathered data to assess the effectiveness of cognitive operations and pinpoint existing issues and deficiencies. The evaluation should focus on the nomenclature and operational mechanisms of key equipment in the project, as well as the comprehension of equipment safety, reliability, economic efficiency, and operational maintenance knowledge points. Based on the evaluation outcomes, propose targeted improvement suggestions to guide future cognitive operations.

4 Experimental Result

This study employed a comparative experimental design. A total of 200 trainees who participated in vocational skills training in the same year were randomly assigned to two groups: 100 trainees in the experimental group (EG) received training under an AI-enabled process skills development system, whereas the remaining 100 trainees in the control group (CG) were instructed using a conventional training system. Identical assessments were administered to measure the attainment of process-oriented skill objectives. The skill achievement outcomes are shown as Fig. 2.

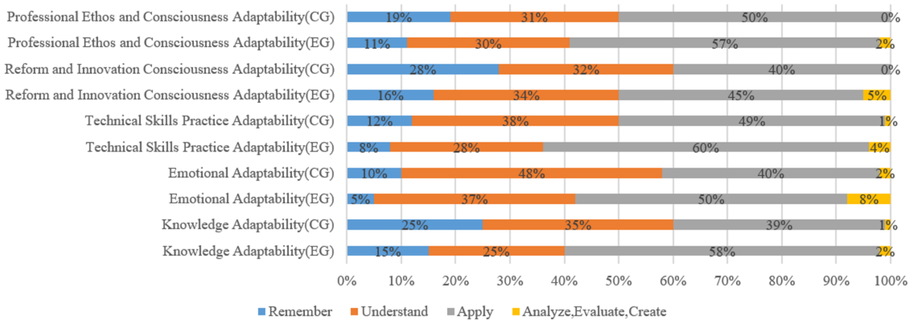

Fig. 2. Comparison of process skill achievement between the two groups.

The experimental results show that the EG has a significantly higher proportion of achieving high-level objectives in all skill assessments than the CG.

5 Conclusion

The AI-enabled system for cultivating process skills centered on process skills cultivation has demonstrated remarkable efficacy in applications. It not only significantly enhances students' professional skills sets and overall professional qualities but also fully ignites their enthusiasm for learning and proactive exploration. Critically, this model precisely caters to the industrial development and corporate employment demands of the AI era, nurturing "AI + major" composite talents capable of swiftly adapting to intelligent professional environments and effectively meeting corporate needs for individuals possessing technical acumen, humanistic empathy, and innovative leadership.

However, the implementation of this model is not without challenges. There remains a pressing need to delve deeper into issues such as designing practical teaching activities that closely mirror AI production realities, fostering the seamless integration of theoretical knowledge with intelligent practical applications, constructing a diversified student learning outcome evaluation system compatible with this model, and how to conduct effective training for teachers and achieve systematic and sustainable optimization. These areas necessitate ongoing refinement and optimization in subsequent research endeavors.

Overall, the AI-enabled system for cultivating process skills centered on process skills cultivation represents a pioneering effort by vocational education to align with the developmental imperatives of the intelligent era. It heralds a significant trend in the high-quality evolution of education in the years to come. In the current digital age, characterized by the profound integration of teaching resources and data, this model aligns with societal transformation trends. It offers students a multifaceted learning experience that seamlessly blends virtual and real-world elements with human-machine collaboration, empowering them to autonomously enhance their comprehensive abilities. The competency structure of talents cultivated through this model is highly congruent with socio-economic development needs, truly embodying the educational ethos of "learning for practical application". Looking ahead, this educational model will continue to play a pivotal role in facilitating individuals' self-awareness, bolstering their job market competitiveness, and fostering harmonious development between education and industry.

References

1. Li Zhijun, Yi Xiaoyi, Li Lineng. The Evolution of Historical Discourse and Contemporary Pathways for Enhancing the Adaptability of Vocational Education. Education and Occupation, pp. 29–36, August 2022.
2. Amir Yunus, Peng Rend Gay, Oon Teng Lee. From Co-Design to Metacognitive Laziness: Evaluating Generative AI in Vocational Education. arXiv, 2025. https://doi.org/10.48550/arXiv.2512.12306
3. Xiaotian Wang, Nirat Jantharajit, Sarit Srikhao. Unlocking Learning Potential: The Impact of Integrated Cognitive Strategies on Vocational Students' Academic Performance. Journal of Education and Learning, Vol. 15, No. 1, 210-216 (2026). https://doi.org/10.5539/jel.v15n1p208
4. Finseth, T., Lubold, N., Goel, D., Alcañiz, M., & Lohre, R. Editorial: Adult Acquisition, Development, or Maintenance of Cognitive and Emotional Skills Through Virtual Reality. Frontiers in Virtual Reality, 6, 1642586 (2025). https://doi.org/10.3389/frvir.2025.1642586
5. Chen Lixiang. Understanding the Changes in the World of Work and Enhancing the Adaptability of Vocational Education. Education and Occupation, pp. 5–13, August 2023.
6. Peng, C., Xia, F., Naseriparsa, M. et al. Knowledge Graphs: Opportunities and Challenges. Artif Intell Rev 56, 13071–13102 (2023). https://doi.org/10.1007/s10462-023-10465-9
7. Mishra, A., El Barachi, M., Kumar, M. (eds) Transforming Industry using Digital Twin Technology. Springer, Cham. https://doi.org/10.1007/978-3-031-58523-4_9
8. Shaohan Jiang, Fanru Sun, Peijun Yuan, Yi Jiang, Xiaohong Wan. Distinct Genetic and Environmental Origins of Hierarchical Cognitive Abilities in Adult Humans. Cell Reports, Volume 43, Issue 4114060, April 23, 2024, https://doi.org/10.1016/j.celrep.2024.114060
9. Bloom, B. S., Krathwohl, D. R., & Masia, B. B. Bloom's taxonomy of educational objectives. Pearson Education, 1984.