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AI Literacy in Vocational Education: A Framework for Teacher Professional Development

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Abstract: The application of artificial intelligence in education prompts an evolution in the professional competencies required of teachers. Current discussions on teacher AI literacy are predominantly situated within the context of general education, failing to capture the unique characteristics of vocational education, such as industry-education integration and school-enterprise collaboration. Consequently, a specific framework for vocational college teachers is absent, and existing research has not addressed this need. This study, grounded in empowerment theory, constructs an AI literacy framework for vocational college teachers. It elaborates on the competency dimensions related to human-computer collaboration, including the use of AI to understand industry demands, design instructional scenarios, and align curriculum with workplace requirements. The research further analyzes the practical constraints on literacy enhancement from the perspectives of policy environments, institutional support mechanisms, and teacher cognition, proposing corresponding developmental pathways. This study aims to provide a theoretical reference and practical guidance for the professional development of educators in the vocational sector.

Keywords: Artificial Intelligence Literacy; Vocational College Teachers; Human-Computer Collaboration; Industry-Education Integration

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1.Introduction

The advancement of artificial intelligence is reshaping the educational ecosystem, influencing pedagogical practices and teacher roles [1]. Teacher artificial intelligence (AI) literacy is consequently regarded as a key competency supporting the digital transformation of education [2]. Existing research on teacher AI literacy frameworks has predominantly centered on general education, without adequately addressing the specific requirements of the vocational education context [3]. Vocational education, oriented toward industry-education integration, requires that teacher AI literacy extend beyond general technological application skills to encompass practical dimensions such as industry data analysis, the integration of authentic projects, and the dynamic adjustment of talent development programs [4]. Teachers in vocational colleges currently face multiple challenges in developing their AI literacy. These challenges include insufficient policy and resource support [5], weak school-based collaborative mechanisms [6], and inadequate cognitive and skill preparedness among educators [7]. These factors collectively constrain the effective implementation of AI within vocational education.

This study therefore constructs an AI literacy framework tailored for vocational college teachers and explores its developmental pathways. It addresses the following core questions: What dimensions should this literacy encompass? What practical dilemmas impede its advancement? Through what mechanisms can its cultivation be effectively supported? The investigation of these questions is intended to provide a theoretical reference and practical framework for teacher professional development in the age of artificial intelligence.

2.Constructing the Teacher AI Literacy Framework

2.1 The Human-Computer Collaborative Relationship from the Perspective of Empowerment Theory

The conceptual foundation for a teacher AI literacy framework rests upon an examination of the relationship between educators and technology in the age of artificial intelligence. This study moves beyond both the pessimistic narrative of "technological replacement" and the uncritical optimism of "technological solutionism." It is instead grounded in empowerment theory, which frames artificial intelligence as a tool for enhancing the professional capabilities of teachers. The core of this perspective is the establishment of a new human-computer collaborative relationship, wherein the dynamic between a teacher and AI is not one of control and subordination but rather a complementary and symbiotic partnership [8].

Artificial intelligence is not intended to replace the charisma, emotional insight, and creative thinking inherent to educators. On the contrary, by assuming responsibilities such as knowledge retrieval, data analysis, and routine task processing, AI can free teachers from cumbersome administrative work. This enables them to focus on core professional activities like instructional design, personalized guidance, and substantive teacher-student interactions [9]. In this synergistic relationship, the teacher acts as the agent guiding the technology, while AI functions as the medium through which their pedagogical wisdom and effectiveness are extended. The two components form an integrated system, with the ultimate objective of fostering the holistic and personalized development of students [10].

2.2 Definition and Core Framework of Teacher AI Literacy

Based on the aforementioned empowerment perspective of human-computer collaboration, the concept of teacher AI literacy extends beyond the simple operation of technology. It is defined as a comprehensive system of competencies that enables teachers to work effectively, critically, and ethically within an AI-driven educational environment [3]. A consensus in international scholarship suggests that AI literacy should encompass multiple dimensions, from knowledge comprehension to ethical judgment [11]. Integrating established theoretical models, such as the AI literacy competency framework proposed by Long and Magerko (2020) and Chiu's (2021) perspectives on sustainable AI curriculum planning, while specifically addressing the "vocational" and "practical" characteristics of vocational education, this study constructs a core AI literacy framework for vocational college teachers that comprises five dimensions:

(1) AI Cognition and Attitude

A teacher's cognition and attitude toward artificial intelligence form the internal motivation for their application of AI technologies. This dimension requires educators to understand not only the basic concepts of artificial intelligence but also its potential applications and inherent limitations within the educational domain [12]. Building on this understanding, teachers are expected to cultivate an orientation that is both open and prudent, balancing the active acceptance of technological empowerment with a critical awareness of AI systems and their effects [13]. This combination of cognition and attitude lays the groundwork for continuous learning and the effective application of AI in professional practice.

(2) AI Knowledge and Skills

This dimension pertains to the teacher's capacity to operate and apply artificial intelligence tools in practical instructional settings, a prerequisite for effective human-computer collaboration. Educators should be familiar with the core functions of common AI educational tools (e.g., intelligent tutoring platforms, generative AI systems) and master practical skills such as prompt optimization, interpretation of output, and preliminary data analysis [14]. These competencies directly determine a teacher's ability to integrate AI technology effectively into instructional design, classroom interaction, and learning assessment.

(3) AI Pedagogical Application and Innovation

Reflecting the practice-oriented nature of teacher AI literacy, this dimension focuses on the ability to translate AI-related

knowledge into actual teaching behaviors. Teachers are expected to systematically integrate artificial intelligence tools into key pedagogical stages, including instructional design, scenario creation, skills training, and formative assessment [15]. This capability should then evolve into pedagogical innovation, where educators leverage AI tools to creatively solve practical problems within their specific disciplines or professions, thereby promoting the optimization of teaching strategies and models.

(4) AI Ethics and Security

This dimension provides the ethical foundation for the appropriate and compliant use of artificial intelligence. Teachers should be able to identify and address critical ethical issues such as data privacy protection, algorithmic transparency, fairness in decision-making, and technological reliability [16]. In their practice, educators are responsible for guiding students toward a critical understanding of AI technology. They must consistently adhere to student-centered educational principles in human-computer collaboration [1], ensuring that the application of AI aligns with educational ethics and social responsibility.

(5) Empowerment through Industry-Education Integration

This dimension embodies the distinctive characteristics of AI literacy for vocational college teachers, emphasizing their role in aligning education with industry. Teachers are required to utilize artificial intelligence to analyze industry dynamics and shifting skill demands, while integrating authentic enterprise projects and practical scenarios into the instructional process [17]. This capability extends to the collaborative development and dynamic optimization of talent development programs. By leveraging AI tools, teachers can achieve a precise alignment between curriculum content and job requirements, thereby enhancing the industry adaptability of the graduates.

3.Practical Dilemmas in Enhancing AI Literacy for Vocational College Teachers

3.1 Issues in Policy Support and Resource Allocation

At the macro level, inadequacies in policy guidance and resource allocation constrain the effectiveness of system-wide implementation.

Absence of policy and standards. A standard framework for teacher AI literacy at the national or industry level is largely absent within the vocational education sector [4]. This absence results in ambiguous objectives for teacher training and insufficient criteria for assessment, leading to fragmented practical explorations across different locales. While scholars have called for the development of specific guidelines, a binding and directive top-level design has not been established. Consequently, policies that link AI literacy to incentive systems, such as professional title evaluations, are difficult to implement effectively.

Structural disparities in resource investment. Disparities exist in the allocation of AI infrastructure and dedicated funding across regions and institutions [18]. For instance, vocational colleges in economically developed regions have greater access to opportunities for collaborating with enterprises to establish “AI training labs,” whereas institutions in remote areas may lack the conditions needed to access fundamental AI tools [19]. This uneven distribution of resources places educators in certain institutions at a disadvantage from the outset.

3.2 Limitations in Institutional Support and Collaborative Mechanisms

At the institutional level, the insufficient efficacy of support systems is a key factor impeding the implementation of policy.

Disconnect between school-based training and practice. Existing institutional training often remains generalized, concentrating on the operation of generic tools without adequate integration into the instructional contexts of specific vocational fields, such as CNC machining, elder care, and culinary arts [20]. Such a training model is ill-equipped to address the concrete problems teachers face in their practice, indicating an absence of mechanisms driven by authentic problems.

Insufficient collaborative innovation among industry, academia, and research. The characteristic of industry-education integration in vocational education has not been sufficiently manifested in AI pedagogical applications. Collaboration between institutions, enterprises, and research organizations often remains at a superficial level; technology platforms provided by companies may be incompatible with the curriculum, and educators rarely participate in the early design of these products, which results in a misalignment between the tools and pedagogical requirements.

Absence of evaluation and incentive mechanisms. Current systems for teacher performance appraisal and professional title

review generally fail to incorporate AI literacy and its associated pedagogical innovations as key metrics [21]. When the efforts made by educators in this area do not receive institutional recognition, their intrinsic motivation can be undermined.

3.3 Individual Teacher Cognition and Practical Constraints

At the individual teacher level, barriers arise from the interplay of internal cognitive and affective factors with external practical conditions.

Concerns over agency and technological anxiety. Teachers exhibit complex attitudes toward AI. Some educators fear that an over-reliance on technology may diminish their pedagogical agency, reducing them to executors of algorithms. Others experience anxiety and resistance due to a lack of familiarity with the technology [22]. This apprehension that the role of technology might supersede the core tenets of education, coupled with uncertainty about their professional roles in this new environment, constitutes a profound psychological barrier.

Time and energy constraints. Vocational college teachers typically manage heavy workloads, encompassing teaching, practical training supervision, and administrative duties, which leaves them with limited discretionary time for systematically learning new technologies and engaging in pedagogical innovation [23]. In the absence of measures to alleviate these responsibilities, the imperative to enhance AI literacy can be perceived as an additional burden.

Differences in adaptability and cognitive inertia. A teacher's age and prior experience correlate with their level of AI literacy. Some older educators or those from non-technical disciplines may adapt to new technologies at a slower pace [24]. Without targeted support, these teachers may be more inclined to adhere to familiar pedagogical models.

4.Strategies for Enhancing the AI Literacy of Vocational College Teachers

The cultivation and advancement of teacher AI literacy necessitate a systematic approach characterized by multi-level coordination. Grounded in a tripartite framework involving government, institutions, and educators, the enhancement of literacy for vocational college teachers should integrate the distinctive features of vocational education. This requires a mechanism that organically links macro-level guidance, meso-level support, and micro-level practice.

4.1 The Governmental Level

The government should exercise its macro-regulatory function to construct a standard system and policy environment for teacher AI literacy that aligns with the developmental needs of vocational education in the age of artificial intelligence. In terms of standard-setting, drawing on the experience of developing the Competency Standards for Primary and Secondary School AI Teachers, a collaborative effort involving vocational education steering committees, industry enterprises, and research institutions should be undertaken to formulate Developmental Guidelines for the AI Literacy of Vocational College Teachers. These guidelines ought to highlight the unique characteristics of vocational education, encompassing dimensions such as AI cognition, technological integration, pedagogical innovation, and ethical security. They should also specify the core competency requirements for teachers in different professional categories regarding AI application, thereby providing a basis for teacher training and evaluation[25]. To enhance the scientific validity and applicability of these standards, the development process should involve broad participation from stakeholders, including vocational college teachers, corporate technology experts, and students.

Ensuring effective implementation requires the establishment of inter-departmental coordination mechanisms, coupled with increased financial investment and resource allocation. To mitigate regional and institutional disparities, dedicated support funds should be established for vocational colleges in less developed areas, such as the central and western regions and rural locales. This includes constructing regional, shared "AI training bases" to facilitate the joint development and sharing of quality curriculum resources, technological tools, and practical case studies[22]. Concurrently, participation in the formulation of and collaboration on international standards in artificial intelligence should be encouraged to align domestic literacy standards with global benchmarks, enhancing the openness and modernization of vocational education.

4.2 The Institutional Level

As pivotal actors bridging policy with practice, institutions should integrate internal and external resources to construct an AI literacy development ecosystem that is centered on practice and organized by professional disciplines. Guided by the concept of "core practices," institutions should move beyond traditional, unidirectional training models to design modular, workshop-

style, school-based training content centered on authentic instructional scenarios [26]. For instance, training for equipment manufacturing disciplines could focus on AI applications such as intelligent fault diagnosis and virtual simulation. In contrast, for modern service-oriented professions, the emphasis would be on the pedagogical integration of AI for customer data analysis and personalized service recommendations. This approach reinforces the capacity of teachers to translate AI tools into pedagogical practice through "learning by doing."

In terms of support mechanisms, institutions should actively collaborate with research organizations, universities, and AI enterprises to establish a multi-party collaborative network involving government, institutional, industry, and corporate partners. AI-focused professional learning communities for teachers can be fostered by organizing their participation in industry practices, co-developing instructional resources, and conducting interdisciplinary research activities. Institutions with available resources can establish "AI pedagogical innovation studios." These studios, led by key teachers, would focus on overcoming challenges in technological integration within specific disciplines and foster a developmental atmosphere of mentorship and mutual support.

4.3 The Teacher Level

As the primary agents of their literacy enhancement, teachers must proactively expand their cognitive boundaries and construct, through practice, pedagogical concepts and competency structures appropriate for the age of artificial intelligence. On a cognitive level, educators should maintain awareness of AI policy directives and technological frontiers. By engaging with industry reports and participating in professional development, they can systematically grasp the developmental trends and potential impacts of AI in education. It is necessary to cultivate an educational philosophy of "human-computer collaboration," viewing artificial intelligence rationally as a supportive instructional tool and avoiding the cognitive pitfalls of "technological solutionism" or "technological rejection."

On a practical level, the emphasis should be on enhancing the capacity to integrate AI technology with professional instruction. Referencing AI empowerment frameworks across areas such as teaching, learning, management, assessment, and decision-making, teachers can embed intelligent lesson-planning tools into instructional design, utilize AI for group optimization and interaction control during classroom activities, and introduce data-driven formative assessments for student evaluation [19]. Furthermore, educators should actively conduct action research based on authentic problems. Through a cyclical process of design, practice, reflection, and improvement, they can continuously optimize the pedagogical suitability and effectiveness of artificial intelligence tools.

5.Conclusion and Future Research

The UNESCO Beijing Consensus on Artificial Intelligence and Education calls for the cultivation of teacher digital competency to advance the digitalization of education. Against the backdrop of rapidly advancing AI technology, the question of how to empower teacher professional development has become a key issue for education systems globally. This study presents a preliminary exploration of this theme, constructing a framework for teacher AI literacy and proposing an implementation pathway that coordinates macro, meso, and micro levels to foster its development.

However, the research is subject to limitations. The proposed literacy framework is detailed only to second-level indicators, and an operational third-level indicator system has not been developed. Future inquiry could proceed in two directions. One line of research could focus on conducting more targeted AI literacy studies for teachers within specific professional disciplines. Another could involve developing a third-level indicator system and undertaking empirical research to further refine the framework. Such efforts would contribute to the formulation of more directive and practical strategies for enhancing teacher AI literacy.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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