

Practical Pathways for Enhancing Artificial Intelligence Literacy among University Teachers in Ningbo under the Background of Digital-Intelligent Transformation

Kebiao Yuan*, Yun Ren

School of Economics and Management, Ningbo University of Technology, Ningbo, Zhejiang, 315211, China

*Corresponding author: *Kebiao Yuan, ykbjob@163.com*

Copyright: 2025 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY-NC 4.0), permitting distribution and reproduction in any medium, provided the original author and source are credited, and explicitly prohibiting its use for commercial purposes.

Abstract: Against the backdrop of digital-intelligent transformation, artificial intelligence has evolved from an auxiliary tool into a technological force that is increasingly embedded in university teaching design, research support, administrative services, and social engagement, and is reshaping the modes of knowledge production, talent cultivation, and organizational operation in higher education institutions. For university teachers, artificial intelligence literacy does not merely refer to the ability to use a particular tool; rather, it represents a professional capacity to understand technological logic, judge application boundaries, and transform artificial intelligence into an enabling force for curriculum reform, research innovation, student development, and professional growth. Ningbo has a solid manufacturing foundation, a well-developed port and shipping logistics system, and abundant application scenarios in digital trade, intelligent manufacturing, and industry-education integration, which provide a favorable practical foundation for enhancing artificial intelligence literacy among university teachers. Based on a review of studies on educational digital transformation, teacher digital literacy, and artificial intelligence literacy, and in light of the actual development of higher education institutions in Ningbo, this paper analyzes the major problems in the development of university teachers' artificial intelligence literacy, including uneven conceptual awareness, incomplete competency structures, fragmented training systems, insufficient disciplinary integration, weak ethical governance, and imperfect evaluation and incentive mechanisms. To address these problems, this paper proposes practical pathways such as standards-based guidance, tiered cultivation, scenario-driven application, curriculum reconstruction, integration of teaching and research, university-government-enterprise collaboration, ethics-first governance, and closed-loop evaluation. The study argues that the enhancement of artificial intelligence literacy among university teachers in Ningbo should not remain at the level of general tool training, but should be oriented toward real teaching, research, and local industrial contexts, enabling teachers to gradually move from simply using artificial intelligence to using it effectively, cautiously, and creatively.

Keywords: Digital-Intelligent Transformation; Ningbo Higher Education Institutions; University Teachers; Artificial Intelligence Literacy; Educational Digital Transformation; Practical Pathways

Published: Jun 18, 2026

DOI: <https://doi.org/10.62177/jaet.v3i2.1504>

1. Research Background and Problem Statement

1.1 Digital-Intelligent Transformation Is Reshaping the Higher Education Ecosystem

Digital-intelligent transformation can be understood as a process in which digitalization and intelligentization become integrated across technology, organization, and practice. It is based on data resources, supported by artificial intelligence algorithms, and carried by digital platforms. In operation, it is characterized by intelligent decision-making, human-machine collaboration, and dynamic optimization. Unlike earlier stages of educational informatization, which mainly focused on hardware configuration, network access, and online resource development, digital-intelligent transformation places greater emphasis on the deep impact of technology on educational structures, teaching relationships, operational mechanisms, and value logic. Zhu and Hu argue that educational digital transformation is not a simple upgrading of informatization. Rather, it involves systematic changes in new paradigms, new thinking, new capabilities, new environments, new resources, new applications, and new cultures ^[1]. Yu further points out that educational digital transformation includes changes in technology, business processes, and human-centered development, and it involves the entire process from localized informatization applications to school organizational transformation and then to the formation of a new ecosystem of smart education services ^[2]. Therefore, under the background of digital-intelligent transformation, the key issue in higher education reform is no longer whether technology is available, but whether technology can truly enter the processes of teaching, research, and governance, thereby promoting substantive changes in the operation of higher education institutions.

In university contexts, the influence of digital-intelligent transformation does not emerge in isolation. It penetrates various aspects of education, teaching, and organizational operation. In terms of teaching resources, digital textbooks, online courses, virtual simulation experiments, knowledge graphs, and intelligent resource libraries provide new conditions for teachers to reorganize teaching content and update course cases. In the teaching process, learning platforms, classroom interaction systems, intelligent teaching assistants, and learning analytics systems can track students' learning conditions and provide teachers with richer data support for process diagnosis and personalized guidance. From the perspective of teaching evaluation, artificial intelligence can support feedback on student assignments, learning profiles, formative assessment, and comprehensive competency analysis, thereby shifting evaluation from single-result judgment to process-oriented and comprehensive evaluation. In research activities, artificial intelligence has also begun to participate in literature retrieval, data processing, model construction, manuscript revision, and academic trend analysis, influencing the research process of university teachers. In university governance, the application of data middle platforms, smart campus platforms, and intelligent decision-making systems is also transforming university management from extensive administration toward refined and collaborative development.

University teachers play a connecting role between technological change and educational practice. Without the necessary artificial intelligence literacy, educational digitalization may remain limited to platform construction, tool use, and resource accumulation, and it cannot be truly transformed into a process that improves the quality of talent cultivation. Conversely, if teachers can understand the basic logic of artificial intelligence, master methods of human-machine collaborative teaching, develop data analysis awareness, and form ethical judgment capabilities, then artificial intelligence can become an important force for improving curriculum teaching, promoting student development, enhancing research capacity, and serving local industries. Based on the above analysis, enhancing university teachers' artificial intelligence literacy is not only an inevitable requirement for teachers to adapt to technological change, but also a key factor determining whether the digital-intelligent transformation of higher education institutions can be successfully realized.

1.2 Policy Requirements Have Made Teachers' Artificial Intelligence Literacy an Issue of the Times

In recent years, educational digitalization and the empowerment of education through artificial intelligence have received sustained attention at the national level. According to relevant documents issued by the Ministry of Education, by 2024, China should establish a national strategy for educational digitalization, promote smart campus construction, explore effective pathways for digitally empowered large-scale personalized teaching and innovative teaching, use artificial intelligence to promote educational transformation, improve standards for teachers' and students' digital literacy, deepen the application of artificial intelligence in teacher development, and strengthen data security, algorithm security, and ethical security ^[3]. This indicates that teacher digital literacy and artificial intelligence literacy are no longer merely local technical capacity issues. They have become part of the broader agenda of building China into an education power and modernizing the teaching

workforce.

The “Artificial Intelligence + Education” Action Plan further proposes that artificial intelligence should empower student learning, teacher teaching, educational governance, and scientific research, while promoting full-staff training, competency assessment, and evaluation reform^[4]. The Teacher Digital Literacy standard issued by the Ministry of Education defines teacher digital literacy as the awareness, ability, and responsibility of teachers to discover, analyze, and solve educational and teaching problems based on the acquisition, processing, use, management, and evaluation of digital information and resources, thereby optimizing, innovating, and transforming educational and teaching activities^[5]. The Framework for Artificial Intelligence Literacy of University Teachers in Zhejiang Province (Trial) further proposes that university teachers’ artificial intelligence literacy consists of three components: basic artificial intelligence literacy, ethical norms, and application literacy^[6]. From national policy to local frameworks, these documents provide institutional support for higher education institutions in Ningbo to establish teacher artificial intelligence literacy standards, enrich training systems, and improve evaluation mechanisms.

1.3 The Practical Urgency of Enhancing Artificial Intelligence Literacy among University Teachers in Ningbo

Ningbo is a major manufacturing city, a port city, and an open economy city, with a solid industrial foundation and abundant artificial intelligence application scenarios. The public consultation draft of the Ningbo Artificial Intelligence Innovation and Development Action Plan (2025–2030), issued by the Ningbo Municipal Bureau of Economy and Information Technology, represents the local government’s policy orientation toward accelerating artificial intelligence development and promoting industrial upgrading empowered by artificial intelligence^[7]. Ningbo’s “Hundred Scenarios and Thousand Products AI Empowerment” plan takes AI-enabled new industrialization as its starting point and promotes artificial intelligence empowerment for new industrialization from four aspects: AI-enabled scenarios, AI-enabled manufacturing, AI empowerment in digital economy parks, and artificial intelligence product supply^[8]. These local arrangements show that the development of artificial intelligence in Ningbo is not merely a matter of technological renewal in the industrial sector. It will also influence the direction of talent cultivation, teacher development, and industry-education integration in higher education institutions.

Higher education institutions in Ningbo are diverse in type, including comprehensive universities, application-oriented undergraduate institutions, vocational colleges, and Chinese-foreign cooperative universities. Although these institutions differ in their educational positioning, they all need to answer the same question: whether their teachers possess the professional capacity to support talent cultivation in the intelligent era. Comprehensive universities rely on artificial intelligence to promote interdisciplinary development and research innovation. Application-oriented undergraduate institutions need to integrate artificial intelligence into professional courses and engineering practice. Vocational colleges should focus on job-based scenarios such as intelligent manufacturing, smart logistics, and digital trade to strengthen digital teaching and intelligent practical training. Zhang’s study on the implementation path of digital teaching in vocational colleges shows that teacher digital literacy and digital teaching in vocational colleges are coupled and mutually reinforcing, and that digital teaching in vocational colleges needs to be promoted simultaneously in teaching content, teaching design, teaching modes, and teaching evaluation^[9]. At the same time, Ningbo has been selected into the relevant construction list of the second batch of national city-level industry-education consortiums, which has laid a platform foundation for universities, government, and enterprises to collaboratively enhance teachers’ artificial intelligence literacy^[10].

2. Theoretical Foundations and Analytical Framework

2.1 Research on Teacher Digital Literacy Provides a Foundational Support for Artificial Intelligence Literacy

Teacher artificial intelligence literacy is not a new concept detached from the existing system of teacher professional competence. Rather, it is a new type of professional literacy further developed on the basis of teacher digital literacy. Wu, Gui, Zhou, and others argue that teacher digital literacy is an important component of teacher development in the digital era, and its evaluation should be promoted through tiered classification, digital-intelligent drive, and continuous monitoring^[11]. Zhang and Yang analyze the internal mechanism through which teacher digital literacy promotes digital education

development. They argue that teacher digital literacy can advance the high-quality development of digital education through teaching method innovation, improved resource utilization, enhanced evaluation methods, and teacher professional growth^[12]. Mei points out that in the process of enhancing university teachers' digital literacy, there are still problems such as deviation from educational goals, insufficient support systems, lack of frontier technologies, and neglect of subject characteristics. Corresponding support systems should therefore be established from the dimensions of concepts, capabilities, institutions, and culture^[13]. Zhuang and others argue that cultivating university teachers' digital literacy should focus on stimulating internal motivation, building communication platforms, improving training mechanisms, establishing assessment and evaluation systems, and creating a favorable ecosystem^[14].

The above studies indicate that teachers' digital literacy does not simply refer to technical operational ability. It includes digital awareness, digital technology knowledge and skills, digital application, digital social responsibility, and professional development. Artificial intelligence literacy further deepens these dimensions by placing greater emphasis on teachers' understanding and application of data, algorithms, models, human-machine collaboration, intelligent evaluation, and ethical governance.

2.2 Research on Teacher Artificial Intelligence Literacy Emphasizes the Unity of Competency Development and Ethical Norms

Existing research on teacher artificial intelligence literacy has produced a number of valuable findings, most of which focus on competency structures and value norms. Li, Sun, Jiang, and others argue that university teachers' artificial intelligence literacy should respond to the new requirements imposed on university teachers in the intelligent era in areas such as teaching and educating students, research innovation, social service, and cultural inheritance and innovation. Teachers should not only master basic artificial intelligence knowledge and application skills, but also use intelligent technologies to promote teaching evaluation reform, research innovation, and industry-university-research collaboration^[15]. Wang argues that teachers' professional literacy in the intelligent era should reflect the unity of intelligence and humanity, and that a proper balance should be found among technology application, intelligent talent cultivation, and value guidance^[16]. Guo and Hao argue that teachers in the intelligent era should possess abilities related to technological cognition, innovative teaching, human-machine collaboration, resource integration, data application, and ethical security^[17].

Liu and Yin suggest that improving teachers' digital literacy through artificial intelligence should be demand-oriented, standards-led, scenario-based, and feedback-driven^[18]. Wei, Yang, and Xu argue that scenario-based teacher digital literacy training should not remain at the level of abstract competency training. Instead, it should shift toward task-driven and practice-generated training in real educational contexts^[19]. Therefore, teacher artificial intelligence literacy should not be simply regarded as the ability to use AI tools. It should be understood as a comprehensive professional capacity involving value cognition, technical understanding, teaching application, research innovation, and ethical governance.

2.3 Policy Standards and AI-TPACK Theory Provide Important References

From the perspective of policy and theory, the cultivation of teacher artificial intelligence literacy should be based on national and local standards, while also relying on theories of disciplinary teaching integration to construct practical frameworks. The Teacher Digital Literacy standard defines teacher digital literacy from the dimensions of digital awareness, digital technology knowledge and skills, digital application, digital social responsibility, and professional development. The Framework for Artificial Intelligence Literacy of University Teachers in Zhejiang Province (Trial) summarizes university teachers' artificial intelligence literacy into three basic elements: basic artificial intelligence literacy, ethical norms, and application literacy^{[5][6]}. Cen argues that the improvement of teacher competence should involve the linkage of policy standards, training systems, application scenarios, and evaluation mechanisms^[20].

AI-TPACK theory also provides an analytical tool for enhancing teachers' artificial intelligence literacy. Yan, Fu, Zhu, and others argue that teachers need to understand the relationship among artificial intelligence technology, disciplinary content, and teaching methods, and integrate the three organically in specific teaching contexts^[21]. This has strong implications for higher education institutions in Ningbo. The application of artificial intelligence differs across disciplines. Engineering, business, humanities and social sciences, and art and design programs have quite different needs for artificial intelligence

application. Therefore, enhancing artificial intelligence literacy among university teachers in Ningbo should not adopt a one-size-fits-all approach. Instead, it should be promoted according to disciplinary characteristics, professional positioning, and teaching scenarios.

3. The Practical Foundation for Enhancing Artificial Intelligence Literacy among University Teachers in Ningbo

3.1 Policy Foundation

Enhancing artificial intelligence literacy among university teachers in Ningbo is supported not only by policy foundations, but also by a relatively solid higher education foundation, digital economy foundation, intelligent manufacturing foundation, port and shipping logistics foundation, and technological innovation foundation. To strengthen the objectivity of the analysis, this paper selects relevant Ningbo statistical data for 2025 to quantitatively present the practical foundation, as shown in Table 1.

Table 1. Practical Foundation Data for Enhancing Artificial Intelligence Literacy among University Teachers in Ningbo

Dimension	Representative Indicator	2025 Data	Significance for Enhancing University Teachers' Artificial Intelligence Literacy
Higher education foundation	Number of higher education institutions in Ningbo	16	Indicates that Ningbo has the institutional foundation for enhancing artificial intelligence literacy among university teachers.
Higher education foundation	Number of students enrolled in higher education institutions in Ningbo	257,000	Indicates that the enhancement of teachers' artificial intelligence literacy will affect the quality of talent cultivation for a large student population.
Digital economy foundation	Added value of core digital economy industries	RMB 159.9 billion	Provides practical support for teachers to reform courses related to the digital economy, artificial intelligence, and data analysis.
Digital economy foundation	Growth rate of the added value of core digital economy industries	12.1%	Indicates rapid development of Ningbo's digital economy and higher requirements for teachers' digital-intelligent teaching capacity.
Intelligent manufacturing foundation	Growth rate of added value of high-tech manufacturing	11.9%	Provides industrial scenarios for course construction in intelligent manufacturing, industrial internet, machine vision, and digital twins.
Intelligent manufacturing foundation	Growth rate of industrial robot output	46.4%	Indicates that Ningbo's manufacturing industry is undergoing significant intelligent transformation, which can be converted into practical teaching and industry-education integration projects.
Port and shipping logistics foundation	Cargo throughput of Ningbo-Zhoushan Port	1.43 billion tons	Provides local cases for professional courses on smart ports, smart logistics, and intelligent supply chain decision-making.
Port and shipping logistics foundation	Container throughput of Ningbo-Zhoushan Port	43.872 million TEUs	Indicates abundant port and shipping logistics scenarios, which are conducive to scenario-based AI teaching and research.
Technological innovation foundation	Number of valid high-tech enterprises	10,050	Provides an enterprise foundation for university teachers to conduct university-enterprise cooperation, horizontal research projects, and industrial case development.
Technological innovation foundation	Number of registered technology contracts	6,393	Indicates active industry-university-research cooperation in Ningbo and supports teachers in integrating AI applications into research and social service.

Source: Ningbo Municipal Bureau of Statistics, 2025 Statistical Communiqué on Ningbo's National Economic and Social Development.

Table 1 shows that enhancing artificial intelligence literacy among university teachers in Ningbo has strong regional practical

support. On the one hand, Ningbo has 16 higher education institutions and 257,000 enrolled university students, indicating that the enhancement of teachers' artificial intelligence literacy has a broad educational coverage. On the other hand, the added value of Ningbo's core digital economy industries reached RMB 159.9 billion, while indicators related to high-tech manufacturing, industrial robots, port and shipping logistics, and high-tech enterprises also performed strongly. This shows that the enhancement of artificial intelligence literacy among university teachers in Ningbo should not remain at the level of general tool use. Instead, it should be integrated with local scenarios such as intelligent manufacturing, smart ports, digital trade, industrial innovation, and industry-education integration.

The enhancement of artificial intelligence literacy among university teachers in Ningbo has relatively clear policy support. At the national level, the Outline of the Plan for Building China into an Education Power (2024–2035) and the Artificial Intelligence + Education Action Plan provide direction for the development of university teachers' artificial intelligence literacy, while the Teacher Digital Literacy standard provides a basic reference for the development of teachers' digital competence ^{[3][4][5]}. At the provincial level, the Framework for Artificial Intelligence Literacy of University Teachers in Zhejiang Province (Trial) further clarifies the basic components of university teachers' artificial intelligence literacy ^[6]. At the local level, Ningbo's artificial intelligence innovation and development actions, the "Hundred Scenarios and Thousand Products AI Empowerment" plan, and the construction of city-level industry-education consortiums provide industrial scenarios and collaborative mechanisms for enhancing teachers' literacy ^{[7][8][10]}. Overall, national policy provides direction, the provincial framework provides competency structure, and local arrangements provide scenario support and regional coordination.

3.2 Industrial Foundation

Ningbo has a relatively complete industrial system. Intelligent manufacturing, green petrochemicals, new energy vehicles, port and shipping logistics, foreign trade services, cross-border e-commerce, smart healthcare, cultural tourism, and urban governance all generate rich demand for artificial intelligence applications. Ningbo's "Hundred Scenarios and Thousand Products AI Empowerment" plan emphasizes the leading role of application scenarios in the large-scale application of new artificial intelligence technologies and products, providing practical resources for university teachers to conduct curriculum development, case construction, practical teaching, and research cooperation ^[8].

To further illustrate the practical foundation of Ningbo's industrial digital-intelligent development, this paper selects the growth rates of relevant indicators such as the digital economy, high-tech manufacturing, and equipment manufacturing in Ningbo in 2025 for comparison, as shown in Figure 1.

Source: Ningbo Municipal Bureau of Statistics, 2025 Statistical Communiqué on Ningbo's National Economic and Social Development.

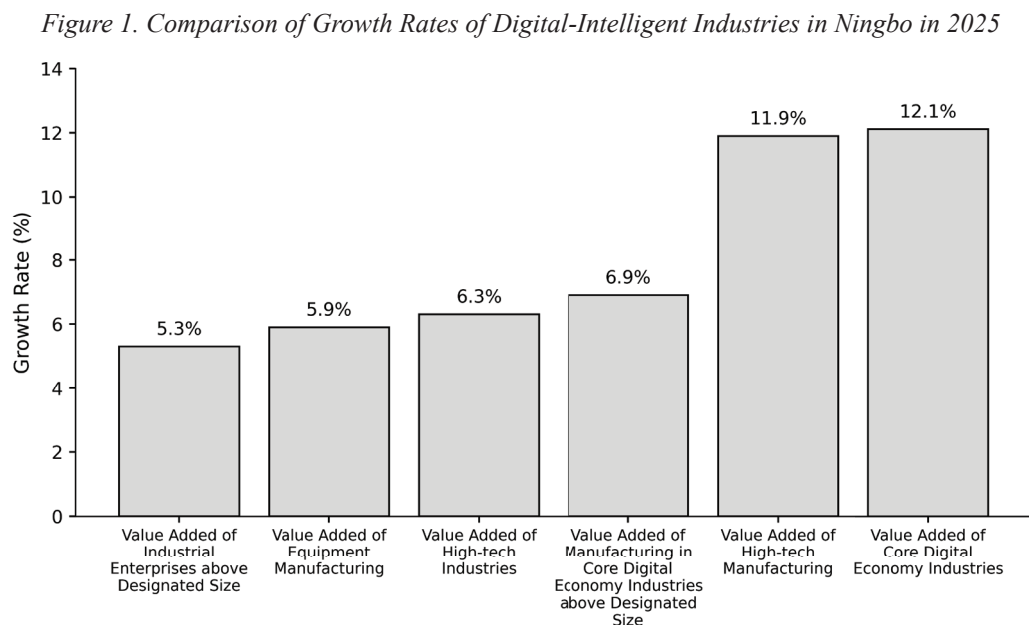


Figure 1 shows that in 2025, the added value of Ningbo's core digital economy industries increased by 12.1%, and the added value of high-tech manufacturing increased by 11.9%, both significantly higher than the average growth rate of 5.3% for industrial enterprises above designated size. This indicates that Ningbo's industrial structure is accelerating its transformation toward the digital economy, high-tech manufacturing, and intelligent manufacturing. For university teachers, this industrial transformation means that the enhancement of artificial intelligence literacy should not be limited to the use of general tools. It should be further oriented toward the digital economy, intelligent manufacturing, equipment manufacturing, industrial data analysis, and scenario-based industrial teaching, so as to better serve Ningbo's local industrial development and the cultivation of application-oriented and interdisciplinary talent.

The above analysis shows that the integration of artificial intelligence and manufacturing can support teaching cases such as industrial visual inspection, intelligent scheduling, predictive equipment maintenance, and digital twin factories. The integration of artificial intelligence and port and shipping logistics can be transformed into course projects on port scheduling, intelligent warehousing, and supply chain forecasting. The integration of artificial intelligence and digital trade can serve practical teaching in intelligent customer service, cross-border e-commerce data analysis, user profiling, and intelligent marketing. Therefore, industrial scenarios transform abstract artificial intelligence learning into practical problem-solving processes, which is consistent with the concepts of "scenario implementation" and "scenario-based training"^{[18][19]}.

3.3 Institutional and Organizational Foundation

The diversity of higher education institutions in Ningbo provides practical space for classified promotion of teacher artificial intelligence literacy. Comprehensive universities can engage in basic artificial intelligence research, interdisciplinary development, and intelligent research methods. Application-oriented undergraduate institutions can focus on intelligent transformation of professional courses, industry-education integration projects, and engineering practice capacity development. Vocational colleges can focus on job competencies, practical training scenarios, and the application of intelligent equipment. Chinese-foreign cooperative universities can learn from international digital education resources and cross-cultural intelligent education experience.

At the same time, higher education institutions in Ningbo generally have teacher development centers, teaching promotion centers, academic affairs training systems, teaching competition systems, and curriculum construction mechanisms. These platforms provide organizational foundations for enhancing teachers' artificial intelligence literacy. Universities can integrate artificial intelligence literacy training into new teacher induction training, young teacher teaching capacity improvement, backbone teacher training, online excellent course construction, and teaching innovation competition cultivation, instead of creating an entirely separate system. Zhu, Zhang, and others argue that teacher digital literacy assessment scenarios should be constructed according to the concept of "technology empowerment, scenario integration, and process accompaniment"^[22]. The same idea can also be applied to enhancing artificial intelligence literacy among university teachers in Ningbo.

4. Major Problems in Enhancing Artificial Intelligence Literacy among University Teachers in Ningbo

4.1 Uneven Conceptual Awareness

At present, university teachers in Ningbo differ in their understanding and acceptance of artificial intelligence. Some teachers have already applied generative artificial intelligence to lesson preparation, information collection, case creation, manuscript revision, data analysis, teaching feedback, and other areas. Some teachers remain cautious and regard artificial intelligence as a temporary technological trend. Others worry that artificial intelligence will increase their workload, weaken their professional authority, and lead to academic misconduct, and therefore oppose its use.

The deeper reason is that some teachers regard artificial intelligence merely as a tool for improving efficiency, such as assisting in writing materials, making slides, and generating test questions. They do not fully recognize that artificial intelligence may change course content, learning methods, evaluation methods, and teachers' roles. In the intelligent era, teachers need to achieve role transformation in human-machine collaboration, resource integration, data application, and ethical security^[17]. Without corresponding conceptual renewal, it is difficult for teachers to develop a high level of artificial intelligence literacy.

4.2 Incomplete Competency Structure

Although some teachers have begun to use artificial intelligence tools, their competency structures remain incomplete. This is mainly reflected in several aspects: they can use tools but do not understand the basic principles; they can generate content but lack the ability to judge its quality; they can use AI to improve efficiency but cannot design human-machine collaborative learning activities; they can use intelligent scoring but lack awareness of academic norms and authorship boundaries; and they can use AI to assist research but do not fully understand academic standards and authorship boundaries. University teachers' artificial intelligence literacy includes tool use ability, but it also includes educational concepts, artificial intelligence knowledge and skills, teaching innovation capacity, research innovation capacity, and ethical awareness^[15]. Therefore, higher education institutions in Ningbo should not focus only on tool lists and operational techniques. They should pay more attention to the systematic and complete structure of teachers' artificial intelligence literacy.

4.3 Fragmented Training Systems

In recent years, artificial intelligence-related training in universities has increased. However, most training still takes the form of lectures, tool demonstrations, and short-term workshops. The content mainly focuses on introductions to generative artificial intelligence tools and prompt techniques, without forming systematic course design, disciplinary case development, teaching practice tracking, and outcome evaluation. Teachers may feel inspired during training sessions, but when they return to specific courses, they still encounter problems such as not knowing how to design AI-supported assignments, how to adjust course evaluation, and how to handle students' use of AI.

Teacher digital literacy training should move toward scenario-based development and should not be separated from teachers' real tasks and educational contexts^[19]. Therefore, if higher education institutions in Ningbo rely only on scattered lectures and short-term training to improve teachers' artificial intelligence application capacity, it will be difficult to form stable and transferable competence.

4.4 Insufficient Disciplinary Integration

The enhancement of artificial intelligence literacy must ultimately be implemented in professional curriculum reform. In reality, however, some teachers regard artificial intelligence as a public basic course or as content belonging to computer science majors, believing that it has little connection with their own disciplines. Even when some teachers are willing to try, they often use AI only as an auxiliary tool and do not seriously consider the internal relationship among professional knowledge systems, job competency requirements, and artificial intelligence applications. To generate educational value, artificial intelligence technology must be integrated with disciplinary content and teaching methods^[21]. Without disciplinary integration, teachers' artificial intelligence literacy can easily remain at a shallow application level.

4.5 Insufficient Awareness of Ethical Governance

After artificial intelligence enters university teaching and research, it also produces new risks and challenges. The first is data security risk. Teachers and students may upload materials containing personal information, course data, experimental data, or enterprise cooperation data to external platforms. The second is academic integrity risk. Students may use AI to write assignments, papers, and laboratory reports, while teachers may also improperly use AI-generated content in research. The third is intellectual property risk. The copyright ownership, citation methods, and scope of use of AI-generated texts, images, codes, and cases need to be further standardized. The fourth is evaluation fairness risk. Intelligent scoring and learning profiling may be affected by data quality, algorithmic bias, and model limitations. The Teacher Digital Literacy standard emphasizes teachers' digital social responsibility^[5], and the Framework for Artificial Intelligence Literacy of University Teachers in Zhejiang Province regards ethical norms as an important component of university teachers' artificial intelligence literacy^[6]. Therefore, ethical governance awareness should become an important part of enhancing artificial intelligence literacy among university teachers in Ningbo.

4.6 Imperfect Evaluation and Incentive Mechanisms

Whether teachers are willing to continuously strengthen their artificial intelligence literacy is closely related to university evaluation and incentive mechanisms. If teachers invest considerable time in intelligent curriculum transformation, AI teaching case construction, and intelligent teaching assistant maintenance, but these efforts are not reflected in teaching

workload, performance assessment, professional title evaluation, awards, and honors, then their enthusiasm will be affected. The evaluation of teacher digital literacy should reflect tiered classification, digital-intelligent drive, and continuous monitoring, and should also use scenario-based assessment and process evaluation to reflect teachers' real abilities ^{[11][22]}. Therefore, higher education institutions in Ningbo should establish an evaluation system that reflects teachers' practical contributions, rather than using participation in training and submission of materials as the main evaluation criteria.

5. A Target Framework for Enhancing Artificial Intelligence Literacy among University Teachers in Ningbo

The enhancement of artificial intelligence literacy among university teachers in Ningbo should not remain at the level of mastering a few AI tools. Instead, it should point toward a more complete form of digital-intelligent educational competence. Digital-intelligent educational competence refers to teachers' comprehensive ability to correctly understand, select, apply, and evaluate artificial intelligence technologies in digital-intelligent educational environments according to educational laws and disciplinary characteristics, and to apply them in student learning, curriculum reform, research innovation, and educational governance.

Based on the practical needs of higher education institutions in Ningbo, teachers' artificial intelligence literacy should consist of three basic levels. The first is the ability to "understand AI." Teachers should have a comprehensive understanding of the basic concepts, technical principles, application fields, and limitations of artificial intelligence, rather than regarding artificial intelligence merely as a tool for automatically generating texts or courseware. The second is the ability to "use AI." Teachers should be able to apply artificial intelligence to teaching design, course resource development, classroom interaction, personalized tutoring, learning assessment, and research, so that technology can genuinely serve teaching and research. The third is the ability to "govern AI." Teachers should be able to identify risks related to data security, algorithmic bias, academic integrity, intellectual property, and educational ethics. Only by integrating understanding, application, and governance can teachers' artificial intelligence literacy avoid remaining at the level of simple operation.

In terms of competency structure, artificial intelligence literacy among university teachers in Ningbo can be understood from five dimensions. Value cognition literacy requires teachers to understand the relationship between artificial intelligence and the development of higher education, and to recognize that technology application cannot be separated from talent cultivation, educational equity, and high-quality development. Basic knowledge literacy requires teachers to understand basic concepts such as machine learning, deep learning, generative artificial intelligence, large models, knowledge graphs, natural language processing, and learning analytics. Teaching application literacy refers to whether teachers can use artificial intelligence in intelligent lesson preparation, resource generation, learning analysis, human-machine collaborative classrooms, intelligent Q&A, and formative assessment. Research innovation literacy refers to teachers' ability to use artificial intelligence properly for literature retrieval, data processing, research review, model construction, and manuscript revision. Ethical governance literacy refers to teachers' adherence to data security, privacy protection, intellectual property, academic integrity, algorithmic fairness, and educational ethics when using artificial intelligence.

From the perspective of developmental levels, different teachers do not need to advance according to the same standard at the same pace. Most teachers should reach the basic application level, meaning that they can master basic concepts and common tools of artificial intelligence and complete basic work such as intelligent lesson preparation, information organization, classroom support, and assignment feedback. Teachers who already have a foundation in curriculum reform can further develop into integration-innovation teachers, meaning that they can carry out intelligent curriculum transformation according to disciplinary characteristics, design human-machine collaborative learning activities, and use data for learning diagnosis and formative assessment. Teaching backbone teachers and program leaders can develop toward a leading-demonstration level by promoting AI-empowered course groups, professional case libraries, and teaching reform projects through team building, while also participating in university-enterprise cooperation, regional promotion, and demonstration applications.

6. Practical Pathways for Enhancing Artificial Intelligence Literacy among University Teachers in Ningbo

6.1 Standards-Based Guidance: Establishing School-Based Artificial Intelligence Literacy Standards

Higher education institutions in Ningbo can refer to the national Teacher Digital Literacy standard^[5] and the Framework for Artificial Intelligence Literacy of University Teachers in Zhejiang Province. On this basis, they can combine the implications of AI-TPACK theory regarding the integration of artificial intelligence technology, disciplinary content, and teaching methods to formulate teacher artificial intelligence literacy standards that better fit their own institutional realities^{[4][6][21]}. School-based standards should not simply copy higher-level documents. They should be transformed into specific requirements that teachers can understand, implement, and evaluate.

Universities can first identify basic requirements that all teachers should meet, including basic understanding of artificial intelligence, use of common tools, basic teaching applications, data security awareness, and academic integrity norms. On this basis, classified requirements can be proposed according to disciplinary differences. Engineering teachers can pay more attention to engineering data analysis, intelligent manufacturing cases, and simulation practice. Business teachers can focus more on business intelligence, intelligent decision-making, and digital trade cases. Humanities and social science teachers can emphasize text analysis, digital humanities, and intelligent communication ethics. Art and design teachers can focus on generative creative tools, visual expression, and copyright norms. Vocational college teachers can develop around job scenarios, intelligent equipment, and practical training teaching. Through such treatment, artificial intelligence literacy standards will no longer be abstract statements. Instead, they will enter the professional development process of teachers in different disciplines.

6.2 Tiered Cultivation: Building a Training System with Full Coverage and Classified Promotion

Higher education institutions in Ningbo can establish a tiered training system consisting of “general popularization—disciplinary integration—project practice—demonstration leadership.” General popularization training should be oriented toward all teachers and mainly solve the problems of “not knowing, not daring to use, and not knowing how to use AI properly.” The content should include artificial intelligence development trends, basic principles of generative AI, use of common tools, prompt design, educational application scenarios, data security, intellectual property, and academic integrity. Such training should not be overly technical. It should enable teachers from different disciplinary backgrounds to form basic understandings of when AI can be used and when it should be used cautiously.

Disciplinary integration training can be organized by colleges, programs, or course groups and should be directly linked to teachers’ own courses. Intelligent manufacturing programs can conduct training on industrial AI case development. Digital trade programs can conduct training on AI-enabled cross-border e-commerce. Journalism and communication programs can conduct training on AIGC and communication ethics. Project-based practical training should not remain at the listening stage. It should require teachers to produce specific outcomes, such as designing an AI-empowered teaching unit, transforming a course assignment, creating an intelligent course knowledge base, developing a local industrial case, or writing a teaching reform paper. For backbone teachers, workshops, enterprise practice, inter-university exchanges, and action research can be used to improve their capacity in course group construction, intelligent evaluation design, teaching achievement cultivation, and team leadership.

6.3 Scenario-Driven Application: Promoting the Integration of Artificial Intelligence into the Whole Teaching Process

Artificial intelligence literacy can become a stable teaching capacity only when it enters real teaching contexts. For higher education institutions in Ningbo, instead of treating AI training as an additional task, it is more effective to integrate artificial intelligence into pre-class, in-class, after-class, and evaluation processes, so that teachers can experience the value and boundaries of technology in specific tasks.

Before class, teachers can use artificial intelligence to decompose teaching objectives, organize knowledge points, collect cases, design teaching activities, and generate learning resources. They can also create course knowledge graphs to help students develop an overall understanding of the knowledge structure. During class, teachers can design learning activities in which students dialogue with, compare, question, and revise AI-generated content, enabling students to analyze the rationality, limitations, and possible improvements of AI-generated outputs. After class, teachers can use AI to analyze

students' assignments, tests, and discussion data, identify common errors and individual learning difficulties, and provide personalized learning suggestions. Artificial intelligence can support formative assessment by recording learning trajectories, providing personalized feedback, and identifying learning risks, but it cannot completely replace teachers' judgment. Especially in the evaluation of innovation capacity, value judgment, and practical performance, teachers should still play a leading role.

6.4 Curriculum Reconstruction: Building AI-Empowered Professional Curriculum Systems

The enhancement of teachers' artificial intelligence literacy should ultimately return to curriculum reform. The Artificial Intelligence Action Plan proposes promoting artificial intelligence as a public basic course in higher education so that all students can master artificial intelligence knowledge^[4]. Higher education institutions in Ningbo can offer artificial intelligence general education courses for all students, covering artificial intelligence basics, data literacy, algorithmic thinking, generative AI applications, artificial intelligence ethics, and industry cases. Such courses can improve students' cognitive level and also lay a common foundation for the intelligent transformation of professional courses.

At the same time, each program should promote intelligent curriculum transformation according to its talent cultivation objectives. Programs related to intelligent manufacturing can add content on industrial AI, machine vision, industrial internet, and digital twins. International trade and e-commerce programs can add content on intelligent marketing, intelligent customer service, cross-border data analysis, and supply chain forecasting. Journalism and communication programs can add content on intelligent communication, algorithmic recommendation, AIGC content governance, and media ethics. Art and design programs can add content on AIGC design, interactive experience, and copyright norms. Higher education institutions in Ningbo can jointly build local industrial AI case libraries with enterprises, developing real cases in intelligent factories, smart ports, cross-border e-commerce, urban governance, smart healthcare, cultural tourism, and other areas. This can prevent artificial intelligence courses from being separated from professional teaching and can also promote the transformation of single-course reform toward the overall development of professional course groups.

6.5 Integration of Teaching and Research: Promoting the Coordination of Teaching, Research, and Social Service

University teachers undertake teaching, research, and social service. The enhancement of artificial intelligence literacy should serve all three dimensions. Teachers can use artificial intelligence for literature retrieval, research hotspot analysis, text mining, data processing, model construction, and manuscript revision. Li and others argue that artificial intelligence can improve university teachers' ability to collect, organize, analyze, and present research data, thereby improving research efficiency and research quality^[15]. However, artificial intelligence should only serve as an auxiliary tool in research. Teachers should not treat AI-generated content as original research outcomes, nor should they fabricate literature or data.

Teachers can also treat AI-supported teaching practice as a teaching research issue. They can explore the influence of AI-assisted feedback on student engagement, the effect of human-machine collaborative learning on critical thinking, the limits of generative AI in professional writing, and the ways in which intelligent evaluation supports learning outcomes. The result of such teaching research is that teachers shift from being users of experience to research-oriented practitioners. Teachers can also connect with Ningbo's industrial scenarios to carry out horizontal research projects, enterprise training, technical services, and case development. The construction of city-level industry-education consortiums provides an institutional platform for university teachers to participate in industrial practice, and real problems generated when teachers serve enterprises can also feed back into curriculum teaching and research innovation^[10].

From the perspective of the regional innovation environment, university teachers in Ningbo have a relatively strong practical foundation for AI-empowered teaching research, research transformation, and social service. To further illustrate this point, this paper compares the growth rates of indicators such as high-value invention patents, valid invention patents, high-tech enterprises, and registered technology contracts in Ningbo in 2025, as shown in Figure 2.

Source: Ningbo Municipal Bureau of Statistics, 2025 Statistical Communiqué on Ningbo's National Economic and Social Development.

Figure 2. Comparison of Growth Rates of Science and Technology Innovation Indicators in Ningbo in 2025

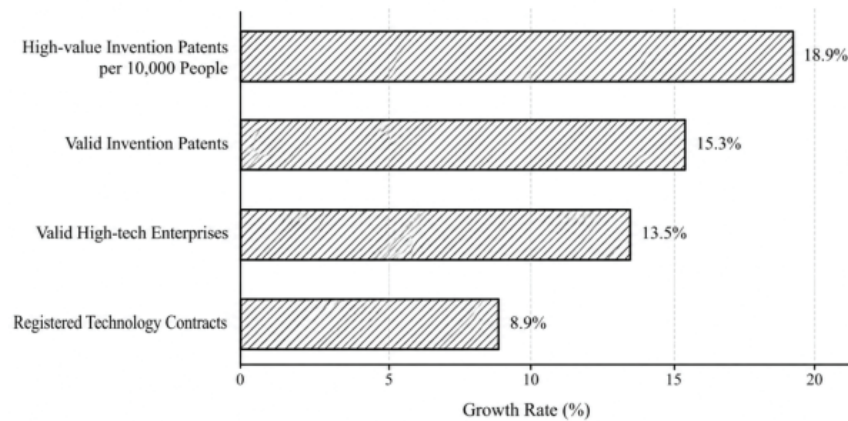


Figure 2 shows that in 2025, the number of high-value invention patents per 10,000 people in Ningbo increased by 18.9%, valid invention patents increased by 15.3%, valid high-tech enterprises increased by 13.5%, and registered technology contracts increased by 8.9%. These data indicate that Ningbo has active technological innovation actors and a strong foundation for technology achievement transformation. For university teachers, this regional innovation environment provides practical support for AI-empowered teaching research, horizontal project cooperation, enterprise case development, and social service. The enhancement of teachers' artificial intelligence literacy should not only serve classroom teaching, but also extend to research innovation, industry-education integration, and local industrial services.

6.6 University-Government-Enterprise Collaboration: Building a Regional Ecosystem for Enhancing Teachers' Artificial Intelligence Literacy

The enhancement of artificial intelligence literacy among university teachers in Ningbo cannot rely solely on internal university efforts. It also requires the participation of government, universities, enterprises, industry associations, and other actors. The government can incorporate the enhancement of university teachers' artificial intelligence literacy into policy systems related to artificial intelligence industrial development, educational digitalization, talent development, and industry-education integration, and support teacher development through special projects, training platforms, practice bases, and case promotion. Universities should play the leading role by establishing school-level coordination bodies led by teacher development centers and jointly participated in by academic affairs offices, human resources offices, research offices, informatization departments, and secondary colleges.

Enterprises should not only provide internship positions, but also introduce real business scenarios, data samples, tool platforms, and practical instructors into teacher training and curriculum construction. Higher education institutions in Ningbo can also establish an alliance for enhancing teacher artificial intelligence literacy, sharing training courses, expert resources, case libraries, tool platforms, and evaluation standards. In this way, the enhancement of teachers' artificial intelligence literacy will no longer be merely an internal matter of individual universities, but can gradually form a regional development community with Ningbo characteristics.

6.7 Ethics-First Governance: Improving Governance Mechanisms for Educational Applications of Artificial Intelligence

The enhancement of artificial intelligence literacy should begin with ethics. Universities should formulate guidance manuals for teachers' use of artificial intelligence, specifying permitted, cautious, and prohibited application scenarios. Teachers may use AI to assist lesson preparation, case generation, and public information organization, but they must not casually upload student privacy data, examination materials, enterprise confidential data, or unpublished research data. Course syllabi should also specify which artificial intelligence technologies students may use, to what extent they may use them, whether they need to disclose the usage process, and whether they need to submit dialogue records or reflective explanations.

Universities should establish classified and graded management mechanisms for educational data. When using students' personal information, classroom records, examination results, research data, and enterprise cooperation data, use should be

restricted to internal platforms. Universities can build trusted on-campus AI platforms and private course knowledge bases to create secure and controllable intelligent tool environments for teachers. At the same time, artificial intelligence ethics should be integrated into teacher training and student courses, helping teachers and students understand issues such as algorithmic bias, privacy protection, intellectual property, deepfakes, academic integrity, and responsibility attribution. Only when ethical requirements are placed first can the educational application of artificial intelligence develop steadily.

6.8 Closed-Loop Evaluation: Establishing a Support Mechanism for Teachers' Artificial Intelligence Literacy Development

Evaluation mechanisms should serve teacher growth rather than add new formalistic burdens. Universities can form teachers' artificial intelligence literacy profiles through self-assessment, training records, curriculum practice, student feedback, peer evaluation, and outcome recognition. Such profiles can identify teachers' strengths and weaknesses and provide a basis for personalized training. Teachers' participation in AI training, completion of curriculum transformation, creation of intelligent resources, publication of teaching research outcomes, participation in enterprise projects, and acquisition of relevant certifications can be included in teacher development records and used as references for professional title evaluation, post appointment, performance rewards, and awards.

At the same time, universities should improve incentive policies and incorporate AI-empowered teaching reform achievements into teaching workload recognition, teaching project approval, curriculum construction funding, teaching achievement awards, and professional title evaluation. Good courses, outstanding cases, and demonstration teams should receive funding, honors, and platform support. Universities should also regularly evaluate the effects of teachers' artificial intelligence literacy enhancement, focusing on teacher participation, the number of transformed courses, changes in teaching quality, students' learning experience, ethical risk incidents, and outcome production. Evaluation results should be used to improve subsequent work. Only by forming a closed loop of training, practice, evaluation, and improvement can the enhancement of teachers' artificial intelligence literacy become sustainable.

7. Implementation Steps and Support Mechanisms

The enhancement of artificial intelligence literacy among university teachers in Ningbo should be promoted in stages. In the short term, the priority is to solve the problems of teachers "not knowing, not daring to use, and not knowing how to use AI properly." Universities can use full-staff general training to help teachers understand basic concepts, typical application scenarios, and major ethical risks of artificial intelligence. They can also quickly formulate guidelines for educational applications of artificial intelligence, stipulate basic behavioral norms for teachers and students using artificial intelligence, and select some courses with a good foundation for early pilot projects to generate replicable and promotable cases. It is not appropriate to require all teachers to carry out comprehensive reforms from the very beginning.

In the medium term, the focus should shift from popularization training to deeper application-oriented exploration, solving problems such as being able to use AI but not using it deeply, using it in scattered ways, and having difficulty transforming its use into concrete outcomes. Universities should establish a tiered certification system for teachers' artificial intelligence literacy, encouraging teachers at different levels to complete corresponding practical tasks. Secondary colleges should carry out intelligent curriculum transformation according to professional characteristics and create AI-driven course groups and Ningbo local industrial case libraries. At the same time, universities should support teachers in conducting teaching research based on AI-empowered teaching, incorporating curriculum reform, teaching cases, and teaching reform papers into the process of teacher professional development.

In the long term, higher education institutions in Ningbo should gradually form a regional ecosystem for enhancing teachers' artificial intelligence literacy. The government, universities, enterprises, and industry organizations should jointly build open and shared training platforms, case resource libraries, practice bases, and research communities, realizing resource sharing, experience sharing, and outcome sharing. Through such regional collaboration, Ningbo can form a local model for enhancing university teachers' artificial intelligence literacy and provide useful experience for other cities in the Yangtze River Delta.

Universities should establish school-level leadership groups for AI-empowered education, clarify leading and participating units, and treat the enhancement of teachers' artificial intelligence literacy as an important part of institutional development

planning. Universities should also increase financial investment to support teacher training, platform construction, course resource development, case library construction, and teaching reform projects. Institutions with sufficient conditions can create secure and controllable artificial intelligence education platforms to provide teachers with support for intelligent lesson preparation, resource management, intelligent teaching assistants, learning analytics, intelligent evaluation, and teaching research. At a deeper level, universities should form a digital-intelligent educational culture that encourages exploration, allows trial and error, values sharing, and upholds ethics, so that teachers are willing to learn actively, practice continuously, and innovate collaboratively.

8. Conclusion and Future Prospects

Under the background of digital-intelligent transformation, enhancing university teachers' artificial intelligence literacy has become a key component of educational digital transformation. It is also a practical support for improving the quality of talent cultivation, promoting research innovation, and serving local development. Higher education institutions in Ningbo are located at the intersection of the national educational digitalization strategy, Zhejiang Province's artificial intelligence education deployment, and Ningbo's industrial digital-intelligent transformation. They have policy foundations, industrial foundations, institutional foundations, and organizational foundations for promoting the enhancement of teachers' artificial intelligence literacy.

At present, the enhancement of artificial intelligence literacy among university teachers in Ningbo still faces problems such as uneven conceptual awareness, incomplete competency structures, fragmented training systems, insufficient disciplinary integration, weak ethical governance awareness, and imperfect evaluation and incentive mechanisms. Solving these problems cannot be achieved through several tool training sessions or short-term lectures. It requires joint promotion from multiple aspects, including systematic capacity building, institutional support, professional curriculum integration, and continuous training. Especially in a city like Ningbo, which has a strong foundation in manufacturing and port and shipping logistics, the enhancement of university teachers' artificial intelligence literacy should be integrated with local industrial scenarios, professional curriculum reform, and industry-education integration practice.

In the future, higher education institutions in Ningbo can establish practical pathways for enhancing teachers' artificial intelligence literacy through standards-based guidance, tiered cultivation, scenario-driven application, curriculum reconstruction, integration of teaching and research, university-government-enterprise collaboration, ethics-first governance, and closed-loop evaluation. The purpose of enhancing artificial intelligence literacy is not to allow technology to replace teachers, but to enable teachers to better understand, master, reflect on, and creatively use technology. In the digital-intelligent era, university teachers should understand educational laws and master the basic principles of intelligent technologies. They should not merely rely on artificial intelligence to improve the efficiency of teaching and research, but should also uphold the fundamental goal of education and comply with academic norms. They should not only use artificial intelligence to improve courses and research, but also guide students to develop correct views of technology, learning, and values. Only by continuously promoting the cultivation of teachers' artificial intelligence literacy can higher education institutions in Ningbo form new advantages for high-quality development in the wave of educational digitalization and provide talent and intellectual support for Ningbo to build itself into a modern coastal metropolis and a highland for artificial intelligence innovation and application.

Funding

This research was supported by China Higher Education Society 2025 Annual Higher Education Scientific Research Planning Project (grant no. 25ZJ0306): Research on the Innovation Evaluation Mechanism and Path of Vocational Education System Empowered by Artificial Intelligence, and Ningbo Educational Science Planning Project (grant no. 2025YGHGJ05): Research on the Practical Pathways for Enhancing Artificial Intelligence Literacy among University Teachers in Ningbo under the Background of Digital-Intelligent Transformation.

Conflict of Interests

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

Reference

- [1] Zhu, Z.-T., & Hu, J. (2022). An exploration of the essence of educational digital transformation and research prospects. *China Educational Technology*, (4), 1–8, 25.
- [2] Yu, S.-Q. (2023). Key pathways of educational digital transformation. *Journal of East China Normal University (Educational Sciences)*, 41(3), 62–71.
- [3] Central Committee of the Communist Party of China & State Council. (2025). Outline of the Plan for Building China into an Education Power (2024–2035) [Z/OL]. (2025-01-19). https://www.gov.cn/zhengce/202501/content_6999913.htm.
- [4] Ministry of Education, National Development and Reform Commission, Ministry of Industry and Information Technology, et al. (2026). Notice of the Ministry of Education and Other Four Departments on Issuing the “Artificial Intelligence + Education” Action Plan: Jiaokexin [2026]No. 1 [Z/OL]. (2026-04-02). https://www.gov.cn/zhengce/zhengceku/202604/content_7065138.htm.
- [5] Ministry of Education. (2022). Teacher Digital Literacy: JY/T 0646—2022 [S/OL]. (2022-11-30). http://www.moe.gov.cn/srcsite/A16/s3342/202302/t20230214_1044634.html.
- [6] Office of the Education Department of Zhejiang Province. (2025). Framework for Artificial Intelligence Literacy of University Teachers in Zhejiang Province (Trial) [Z/OL]. (2025-08-28). <https://tc.zwu.edu.cn/41/94/c2273a213396/page.htm>.
- [7] Ningbo Municipal Bureau of Economy and Information Technology. (2025). Announcement on Publicly Soliciting Opinions on the Ningbo Artificial Intelligence Innovation and Development Action Plan (2025–2030) (Draft for Comments) [EB/OL]. (2025-07-25). <https://app.ningbo.gov.cn/jact/front/mailpubdetail.do?sysid=63&transactId=51183>.
- [8] Ningbo Enterprise Comprehensive Service Platform. (2026). Developing the intelligent economy: Ningbo advances toward the “new” [EB/OL]. (2026-04-09). https://qf.ningbo.gov.cn/qfpt/fwbk/zcfw/rmzx/art/2026/art_bcbeb860fad2421a8cf9643636bd90a7.html.
- [9] Zhang, S.-B. (2023). Implementation pathways of digital teaching in vocational colleges from the perspective of teacher digital literacy. *Journal of Ningbo Institute of Education*, 25(6), 71–75.
- [10] Ministry of Education. (2024). The Ministry of Education deploys work to strengthen the construction of city-level industry-education consortiums [EB/OL]. (2024-11-14). <https://qspfw.moe.gov.cn/html/hotnews/20241114/22433.html>.
- [11] Wu, D., Gui, X.-J., Zhou, C., et al. (2023). Teacher digital literacy: Connotation, standards, and evaluation. *E-Education Research*, 44(8), 108–114, 128.
- [12] Zhang, G.-Y., & Yang, J.-S. (2024). Research on the mechanism of teacher digital literacy driving the development of digital education. *China Educational Technology*, (11), 37–44.
- [13] Mei, B. (2024). Enhancing university teachers’ digital literacy: Practical problems and system construction. *China Higher Education*, (12), 50–54.
- [14] Zhuang, R.-L., Yu, X.-J., & Mi, K.-N. (2025). Cultivating university teachers’ digital literacy under the background of digital transformation: Value connotation, practical challenges, and breakthrough pathways. *Higher Education Forum*, (1), 39–42.
- [15] Li, Y., Sun, L.-Y., Jiang, Q.-Y., et al. (2025). Artificial intelligence literacy of university teachers and improvement strategies. *Open Education Research*, 31(1), 23–33.
- [16] Wang, D. (2022). Research on teachers’ intelligent education literacy from the perspective of artificial intelligence: Connotation, challenges, and cultivation strategies. *Journal of the Chinese Society of Education*, (3), 91–96.
- [17] Guo, J., & Hao, J.-J. (2021). Role positioning and literacy framework of teachers in the intelligent era. *China Educational Technology*, (6), 121–127.
- [18] Liu, B.-Q., & Yin, H.-H. (2024). Artificial intelligence empowering the enhancement of teachers’ digital literacy: Strategies, scenarios, and evaluation feedback mechanisms. *Modern Educational Technology*, 34(7), 23–31.
- [19] Wei, F., Yang, K.-X., & Xu, R.-Y. (2026). Scenario-based teacher digital literacy training: Connotation framework, practical model, and generative AI empowerment mechanism. *China Educational Technology*, (1), 127–135.

- [20] Cen, Y. (2024). Practical dilemmas and global actions in cultivating teacher digital literacy. *Journal of Teacher Education*, 11(4), 38–46.
- [21] Yan, Z.-M., Fu, J.-L., Zhu, Y.-L., et al. (2020). Artificial intelligence technological pedagogical content knowledge (AI-TPACK): Connotation, teaching practice, and future issues. *Journal of Distance Education*, 38(5), 23–34.
- [22] Zhu, L., Zhang, J., Wu, X.-X., et al. (2024). Assessment of teacher digital literacy from the perspective of digital transformation: Development trends, scenario construction, and practical suggestions. *E-Education Research*, 45(2), 113–120.