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RESEARCH ARTICLE

A study on AI literacy of teachers in Chinese higher vocational colleges based on the AI-TPACK model

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ABSTRACT

Based on the AI-TPACK (Artificial Intelligence-Technological Pedagogical Content Knowledge) model, this study explores the current status of Artificial Intelligence(AI) literacy among teachers in Chinese higher vocational colleges and its influencing factors. Through a questionnaire survey of 1,138 teachers from 16 higher vocational colleges in Zhejiang, Shandong, Jiangsu, and other provinces, the study found that the overall AI literacy of higher vocational teachers was relatively good, with the highest scores in the attitude and values dimension, but relatively weak performance in the knowledge and skills dimension. Gender, professional title, and region significantly influence teachers' AI literacy. Male teachers, senior-level teachers, and teachers from eastern regions generally exhibit higher AI literacy, while intermediate-level teachers and teachers from central regions show relatively weaker performance. The study also proposes targeted recommendations to enhance AI literacy among teachers at Chinese vocational colleges, including strengthening AI technology training for teachers, optimizing career development incentive measures, and promoting the equitable distribution of educational resources.

Keywords: AI-TPACK model; vocational college teachers; AI literacy; influencing factors; improvement strategies

1. Introduction

With the rapid development of AI technology, the education sector is undergoing unprecedented transformation (Guggemos & Seufert, 2021). Recent studies have highlighted the significant impact of AI on educational practices, emphasizing its potential to enhance both teaching and learning processes (Seufert et al., 2021). AI technology has become an essential tool for improving teachers' instructional capabilities and students' learning abilities (Seufert et al., 2021). In particular, the role of AI in higher education has garnered increasing attention, as it is seen as a key driver for innovation and efficiency in teaching (Lin et al, 2023).

The level of AI literacy among university teachers is crucial, as it not only affects their individual teaching literacy but also directly impacts the quality of future talent cultivation (Wang et al., 2023). Recent research has shown that teachers with higher AI literacy are better equipped to integrate AI tools into their teaching practices, leading to more effective and engaging learning experiences for students (Darayseh, 2023). Moreover, the integration of AI in education has been identified as a critical factor in preparing

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students for the digital workforce of the future (Roy et al., 2021).

The AI-TPACK theory, as an extension of the TPACK framework, provides a new perspective for understanding the integration of AI technology with subject-specific pedagogical content knowledge (Yan et al., 2020). This model emphasizes the importance of teachers' technological knowledge, pedagogical knowledge, and content knowledge in effectively incorporating AI into their teaching practices (Yan et al., 2020). Recent study have further explored the practical applications of the AI-TPACK model, highlighting its potential to guide teacher training and curriculum development (Mo & Yu., 2024).

Despite growing recognition of AI-TPACK's importance, research on vocational college teachers' AI literacy remains fragmented, particularly in the Chinese context. Existing studies predominantly focus on K-12 or university settings, overlooking the unique demands of vocational education, where AI applications must align with industry-specific skill development (Wang et al., 2023; Li, 2025). This study aims to analyze the current state and influencing factors of university teachers' AI literacy in China using the AI-TPACK model and to propose targeted improvement strategies. By doing so, this research seeks to provide valuable references for educational practice and policy-making in the context of AI integration in Chinese Higher Vocational Colleges.

2. Literature review

2.1. The definition and connotation of AI literacy

According to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2015), "Literacy" refers to the ability to apply knowledge (broadly defined to include information, comprehension skills, values, and attitudes) to meet specific contextual needs and solve problems. In the field of information technology applications, as information technology continues to evolve, new literacy terms have emerged, such as digital literacy and media literacy. The rapid development of AI technology has led to the emergence of AI literacy. Agre first coined the term "AI literacy" in 1972, but it did not gain widespread attention. It was not until 2018 that AI literacy re-entered the public eye and sparked a research boom (Xu et al., 2020). Currently, there is no unified definition of AI literacy within the academic community. By reviewing the concepts proposed by various scholars, AI literacy can be broadly categorized into two main categories.

One perspective suggests that AI literacy is in a relationship of inclusion with other forms of literacy. Xu et al. (2020) argue that digital literacy encompasses AI literacy, and the abilities required for individuals to adapt to learning, working, and other activities in the AI era constitute AI literacy. Cetindamar et al. (2022) define AI literacy as "four core competencies," including technology-related competencies, work-related competencies, human-machine-related competencies, and learning-related competencies, all of which fall within the scope of tool and data literacy. Yi (2021) argues that AI literacy encompasses functional literacy (traditional reading and writing skills), social literacy (the ability to understand society through education), and technical literacy (foundational technical skills essential for the modern era, including digital literacy, media literacy, Information literacy, and AI utilization capabilities).

Another perspective views AI literacy as an extension of information literacy, digital literacy, and other related literacies, with some overlap but also distinct differences. Long et al. (2020) define AI literacy as a set of skills enabling individuals to critically evaluate AI technology, communicate and collaborate effectively with AI, and use AI tools in various settings: AI literacy is related to other information technology literacies, and digital literacy is a prerequisite for AI literacy, as individuals need to understand how to use computers to comprehend AI; computational literacy and scientific literacy are not essential prerequisites for AI literacy: Since data literacy is closely related to AI subfields (such as machine learning), certain aspects of data literacy overlap with AI literacy. Wang Huan (2021) agrees with this view, proposing that AI literacy is a comprehensive literacy that integrates AI knowledge, the ability to apply AI, and intelligent awareness of AI. Another area of overlap with other information technology literacies is the ethical and moral considerations mentioned in various literacy concepts. Ethics is a key factor in AI literacy (Wong et al., 2020; Xuan et al., 2025). Wang et al. (2023) propose that AI literacy is the ability to correctly identify, use, and evaluate AI-related products in accordance with ethical standards.

In summary, AI literacy is a key ability for individuals to adapt to technological change in the new era. Although there is no consensus on its definition and connotation, scholars emphasize the importance of AI literacy in individual learning, work, and social interaction. On the one hand, AI literacy is regarded as part of a broader literacy framework, such as digital literacy, tool literacy, and data literacy, emphasizing individuals' abilities in applying AI technology. On the other hand, AI literacy is also seen as an extension of information literacy, digital literacy, and others, though it overlaps with these literacies, it demonstrates uniqueness in critically evaluating AI technology, effectively communicating with and collaborating with AI, and other areas. Therefore, understanding the definition and connotation of AI literacy not only helps us grasp the development trends of AI technology in the field of education but also provides theoretical support and practical guidance for enhancing university teachers' AI teaching literacy.

2.2. AI-TPACK model

The AI-TPACK model has emerged as an important research direction in the field of educational technology in recent years, aiming to explore how AI can be integrated with the traditional TPACK framework to support teachers in effectively incorporating AI tools into their teaching practices. TPACK itself is a teacher knowledge framework that emphasizes the need for teachers to integrate knowledge in three areas—technology, pedagogy, and subject content—during the teaching process (Köehler et al., 2013). With the widespread adoption of GenAI tools, the AI-TPACK model has increasingly become a crucial theoretical tool for studying how teachers utilize AI in instructional design, assessment, and practice (Celik, 2022).

The introduction of the AI-TPACK model （See **Figure 1**）represents an extension of the traditional TPACK framework, aimed at addressing the issue of how teachers can effectively integrate AI tools into their teaching practices. Turguta (2025) noted in their research that AI-TPACK not only focuses on teachers' understanding and application of technology but also emphasizes how teachers can utilize AI tools to enhance students' cognitive abilities, learning motivation, and engagement during the teaching process. Additionally, Celik (2022) introduced the concept of “Intelligent-TPACK” in their research, stressing that teachers should possess ethical awareness and critical thinking when using AI tools to ensure the appropriate use of AI technology. These studies provide important theoretical support for the development of the AI-TPACK model.

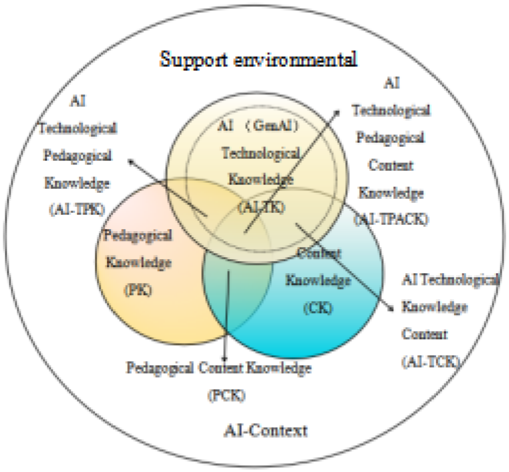

Figure 1. AI-TPACK theoretical model.

The application of the AI-TPACK model in actual teaching is primarily reflected in the following aspects: first, how teachers utilize AI tools for personalized instruction; second, how AI assists teachers in assessing students' learning outcomes; and third, ethical issues related to AI in teaching. For example, Kim et al. (2021) investigated teachers' capabilities in using AI tools in K-12 education and found that teachers exhibit certain gaps in technology integration, particularly in terms of ethics and privacy protection. Additionally, some studies have pointed out that the AI-TPACK model faces certain challenges during implementation, such as teachers' acceptance of AI technology, the accessibility of AI tools, and insufficient teacher training (Yan et al., 2020). This model provides a theoretical foundation for analyzing teachers' AI teaching literacy, particularly demonstrating strong applicability among pre-service teachers and vocational education teachers (Chen and Huang, 2025).

2.3. Research status of AI-TPACK for teachers

In recent years, with the deepening application of AI technology in the field of education, research on AI-TPACK for teachers has shown a trend toward diversification. Through a systematic review of relevant literature in recent years, current research has mainly focused on three areas: theoretical model construction, application practice exploration, and literacy improvement strategies.

In terms of theoretical model construction, scholars have expanded the TPACK framework in multiple dimensions. Chen and Huang (2025) developed a three-dimensional model encompassing knowledge and skills, attitudes and values, and continuous learning and development capabilities, and validated the model's effectiveness through empirical research involving 1,138 vocational college teachers. Wang et al. (2023) proposed a three-dimensional framework for pre-service teachers, focusing on AI knowledge, AI skills, and AI ethics, emphasizing the educational objectives of “learning to develop, learning to teach, and learning to nurture.” Zhang and Tian (2023) further refined the secondary dimensions of AI-TPACK, including seven core elements such as AI-TK and AI-TPK, providing a theoretical basis for evaluating teachers' AI teaching literacy.

In the field of applied practice, researchers focus on specific applications across different disciplines and educational levels. Jiao et al. (2025) validated the applicability of the AI-TPACK framework in junior high school information technology education and developed teaching cases based on this theory. Li (2025) explored the application of AI-TPACK in art design education and found that the integration of technology significantly enhanced students' creative expression. Luo (2025) focused on vocational education, investigating the interactive relationships among the various elements of AI-TPACK in teachers' application of big data technology.

In terms of literacy enhancement strategies, existing research has proposed multi-level development pathways. Ma et al. (2023) designed a school-based teacher development program based on AI-TPACK, promoting knowledge integration through lesson study. At the institutional level, Chen and Huang (2025) suggested establishing a tiered certification system ("basic level-professional level-expert level") to incorporate AI literacy into teacher evaluation standards. Notably, multiple studies have emphasized the importance of school-industry collaboration in teacher AI-TPACK development (Liu, 2024; Zhang and Hu, 2021).

In summary, AI literacy has been widely recognized as a key competency that teachers in the new era must possess. The AI-TPACK model, as an extension of the TPACK framework, provides an important theoretical framework for teachers on how to effectively integrate AI technology into teaching practice. However, despite significant progress in research on AI literacy and the AI-TPACK model, existing studies still have some shortcomings. First, most studies have focused on the construction and preliminary validation of theoretical models, with a lack of in-depth empirical research targeting vocational colleges. Second, research on the assessment and enhancement strategies for AI literacy is relatively scarce, particularly regarding how to effectively integrate AI ethics education into teacher professional development, which requires further exploration. Additionally, existing research lacks a systematic analysis of external factors influencing the development of teachers' AI literacy (such as school environment and policy support), making it difficult to fully explain the formation and development mechanisms of teachers' AI literacy. This study aims to address these gaps by constructing an AI-TPACK model tailored for teachers in Chinese vocational colleges, and conducting an in-depth analysis of their current AI literacy status and its influencing factors. This study will not only provide theoretical support based on the latest academic literature but also validate the model's effectiveness through large-scale empirical surveys and propose targeted improvement strategies. Through this research, the study aims to provide valuable references for educational practice, scientific basis for policymakers, and promote the effective application of AI technology in vocational education.

3. Research methods

Based on the AI-TPACK theoretical framework, this study constructed an evaluation model comprising three dimensions: knowledge and skills (AI-TK, AI-TPK, AI-TCK), attitudes and values (AI ethical awareness, technology acceptance), and continuous learning and development capabilities (self-directed learning, industry collaboration). The model comprises three primary indicators and 12 secondary indicators, and its validity was validated using the expert consultation method ($\chi^2/df = 2.1$, $CFI = 0.93$, $RMSEA = 0.04$).

The questionnaire is divided into three sections with a total of 30 questions. The first section (questions1–8) primarily includes basic information about the survey respondents, such as gender, age, education level, and professional title, which is used for subsequent cross-analysis. The second section (questions9–28) is the main part, which references the AI education literacy model to investigate the AI education literacy level of vocational college teachers, with a total of 20 questions compiled. Each question features four-tiered options, using a 4-point positive scoring system, where higher scores indicate better performance, as shown in **Table 2**. The third section (questions29–30) includes two open-ended questions based on the aforementioned 20 items, aiming to investigate vocational college teachers' expectations, attitudes toward the future development of AI in education, and their training needs for enhancing AI-related teaching capabilities.

The questionnaire's reliability and validity were tested using SPSS 25.0 software. The Cronbach's α values for the overall dimension and three sub-dimensions of the AI Education Literacy Survey Questionnaire were all greater than 0.8, indicating high reliability (**Table 1**). Additionally, the KMO test was used to assess the validity of the questionnaire, with a KMO value of 0.864, indicating that the questionnaire's validity is suitable for factor analysis. In summary, the questionnaire's reliability and validity are satisfactory and can be used for survey analysis.

Table 1. Internal consistency coefficients of the questionnaire.

Survey dimensions	Knowledge and skills	Attitudes and values	Continuous learning and development capabilities	Overall reliability of the questionnaire
Cronbach's α value for "AI technology competency performance"	0.907	0.828	0.864	0.872

This study employed a stratified random sampling method to select 16 higher vocational colleges from nine provinces across eastern, central, and western China (Zhejiang, Shandong, Jiangsu, Shaanxi, Yunnan, Guizhou, Chongqing, Hunan, and Jiangxi) as research subjects, ensuring the regional representativeness and institutional diversity of the sample. The sample institutions included four national model colleges, eight provincial key colleges, and four general colleges, covering higher vocational colleges at different levels of education. The questionnaire was distributed via the "QuestionStar" platform, covering three categories of respondents: school leaders, middle-level managers, and frontline teachers, ensuring the comprehensiveness of the sample. After data collection, the study excluded invalid questionnaires where response time was less than 120 seconds or where responses exhibited regular patterns (exclusion rate: 4.3%), resulting in a final sample of 1,138 valid responses for analysis. According to Krejcie and Morgan's (1970) sample size calculation formula, at a 95% confidence level and a 5% error margin, the minimum sample size required for China's approximately 500,000 vocational college teachers was calculated to be 384. However, the actual sample size in this study reached 1,138, which is 2.96 times the theoretical minimum value, significantly enhancing statistical power. The latent variables in this study are the three dimensions of AI literacy: "knowledge and skills," "attitudes and values," and "continuous learning and development." Seven independent variables were set to measure the individual characteristics of the survey participants, including gender, age, years of teaching experience, educational background, and professional title. The statistical analysis of the basic information of the survey participants is presented in **Table 2**.

Table 2. Statistics on basic information of survey respondents.

Variable	Type	Number of people	Percentage (%)
Gendar	Male	482	42.4
	Female	656	57.6
Age	Under 35 years old	390	34.3
	36–45 years old	503	44.2
	46–50 years old	121	10.6
	51–59 years old	124	10.9
Years of teaching experience	Less than 5 years	353	31.0
	6–10 years	229	20.1
	11–15 years	185	16.3
	16 years or more	371	32.6
Educational background	Bachelor's degree	230	20.2
	Master's degree	816	71.7
	Doctorate	92	8.1
	Other (please specify)	0	0

Variable	Type	Number of people	Percentage (%)
Professional title	Junior	260	22.8
	Intermediate	410	36.0
	Associate Senior	353	31.0
	Senior	115	10.1
Subject background	Science-related	155	13.6
	Engineering-related	472	41.5
	Social sciences-related	420	36.9
	Sports/arts-related	71	6.2
	Other (please specify)	20	1.8
Regional	Western region	181	15.9
	Central region	258	22.7
	Eastern region	699	61.4

4. Research finding

4.1. Descriptive statistical analysis of AI literacy among vocational college teachers

To understand the overall status of AI literacy among Chinese vocational college teachers, this study conducted descriptive statistical analyses of the three dimensions—knowledge and skills, attitudes and values, and continuous learning and development capabilities—based on a descriptive statistical analysis of the overall results. According to **Table 3**, the average score for AI literacy among vocational college teachers was 2.915, with a standard deviation of 0.46. This result was compared with the theoretical mean of 2.8 points using an independent samples t-test, which revealed that teachers' AI literacy performance exceeded the expected value (t-value of 37.464, p-value less than 0.001). Among all respondents, 143 teachers scored below the theoretical mean of 2.8, accounting for 12.57% of the total, while 605 teachers scored above the mean, accounting for 53.16%. This indicates that the overall AI education literacy performance of the surveyed teachers is relatively good.

Table 3. Descriptive statistics for AI literacy (N=1138).

	Minimum value	Maximum value	Mean value	Standard deviation
Average score for knowledge and skills	.750	4.000	2.796	.482
Average score for attitudes and values	1.000	4.000	3.028	.535
Average score for continuous learning and development capabilities	1.000	4.000	2.920	.495
Overall average score	.916	4.000	2.915	.4635

From the perspective of three-dimensional indicators, the average score for attitude and values literacy was the highest at 3.028; followed by continuous learning and development capabilities, with an average score of 2.920; while the average score for knowledge and skills literacy was relatively low at 2.796. This indicates that vocational college teachers perform relatively well in the dimensions of attitude and values, and continuous learning and development, but their performance in the dimension of knowledge and skills is relatively low, failing to reach the theoretical mean. This suggests that vocational college teachers generally recognize the importance of AI technology and hold a positive attitude toward improving AI education literacy, but their mastery of AI technology knowledge and practical application outcomes are suboptimal. Pearson correlation analysis was conducted to explore the interrelationship among the three dimensions of AI education literacy. The results showed significant positive correlations among these dimensions. The correlations between attitude and values, knowledge and skills, and continuous learning and development were relatively high (correlation coefficients of 0.750 and 0.807, respectively), indicating that teachers with good attitudes and values are positively correlated with their ability to better learn and apply AI technology, as shown in **Table 4**.

Table 4. Correlation analysis between sub-dimensions

Basic Elements	M（SD）	Knowledge and skills	Attitudes and values	Continuous learning and development capabilities
Knowledge and skills	2.796（0.482）	1		
Attitudes and values	3.028（0.535）	.750**	1	
Continuous learning and development capabilities	2.920（0.495）	.807**	.753**	1

4.2. Analysis of differences in AI literacy among teachers with different individual characteristics

(1) Gender differences

Using AI literacy performance of vocational college teachers as the latent variable and gender as the independent variable, an independent samples t-test was conducted. The results showed that gender significantly influenced AI literacy performance ($t=4.879$, $p=0.000<0.01$). Gender differences were significant in terms of both the overall mean of AI literacy and the specific performance in the three sub-dimensions of knowledge and skills, attitudes and values, and continuous learning and development. Overall, male teachers had higher AI literacy levels than female teachers (**Table 5**).

Table 5. Comparison of differences in teacher AI literacy performance by gender differences.

	M（SD）		t-value
	Male teacher	Female teacher	
Knowledge and skills	2.873（0.514）	2.740（0.499）	4.651**
Attitudes and values	3.084（0.562）	2.988（0.511）	2.997**
Continuous learning and development capabilities	3.020（0.519）	2.846（0.463）	5.945**
Overall competency level	2.992（0.497）	2.859（0.429）	4.879**

(2) Differences in educational and subject areas

Using one-way analysis of variance (ANOVA), this study compared the AI literacy performance of vocational college teachers with different educational backgrounds and disciplinary specializations to identify potential differences among these groups. The results showed that there were no significant differences in the overall level of AI literacy, as well as in the specific performance across the three sub-dimensions of knowledge and skills, attitudes and values, and continuous learning and development, among teachers with different educational backgrounds (**Table 6**). Teachers with different subject backgrounds exhibited significant differences in the sub-dimensions of knowledge and skills, and continuous learning and development, with P-values less than 0.05, while no significant differences were observed in overall levels or attitudes and values. Through multiple comparisons (**Table 7**), it can be seen that engineering and science disciplines demonstrated higher levels across all dimensions, indicating a disciplinary advantage in AI literacy.

Table 6. Comparison of differences in AI education literacy performance under educational attainment variables.

	M（SD）			**F**	**Retrospective inspection**
	Bachelor's degree ①	**Master's degree** ②	**Doctorate** ③		
Knowledge and skills	2.749（0.522）	2.811（0.458）	2.784（0.570）	1.515	①<②, ①<③, ②>③
Attitudes and values	2.983（0.572）	3.047（0.512）	2.982（0.630）	1.662	①<②, ①>③, ②>③
Continuous learning and development capabilities	2.879（0.572）	2.933（0.463）	2.907（0.559）	1.083	①<②, ①<③, ②>③
Overall competency level	2.870（0.516）	2.930（0.437）	2.891（0.542）	1.628	①<②, ①<③, ②>③

Table 7. Comparison of differences in AI education literacy performance under subject background variables**.**

	M（SD）					**F**	**Retrospective inspection**
	Science ①	**Engineering** ②	**Humanities and Social Sciences** ③	**Sports and Arts** ④	**Other** ⑤		
Knowledge and skills	2.781（0.534）	2.862（0.468）	2.739（0.466）	2.770（0.481）	2.663（0.556）	4.205*	①<②, ①>③, ①<④,①>⑤, ②>③, ②<④,②>⑤, ③<④, ③>⑤, ④>⑤
Attitudes and values	3.013（0.580）	3.066（0.531）	3.007（0.507）	2.967（0.575）	3.028（0.535）	1.162	①<②, ①>③, ①<④,①>⑤, ②>③, ②<④,②>⑤, ③>④, ③>⑤, ④>⑤
Continuous learning and development capabilities	2.925（0.570）	2.986（0.470）	2.583（0.471）	2.899（0.521）	2.790（0.641）	4.414*	①<②, ①>③, ①<④,①>⑤, ②>③, ②<④,②>⑤, ③<④, ③>⑤, ④>⑤
Overall competency level	2.907（0.529）	2.971（0.451）	2.867（0.436）	2.878（0.478）	2.586（0.419）	3.363	①<②, ①>③, ①<④,①>⑤, ②>③, ②<④,②>⑤, ③<④, ③>⑤, ④>⑤

(3) Cross-analysis of age, years of teaching experience, and professional title

ANOVA was conducted to analyze the differences in AI literacy performance levels among vocational college teachers across four age groups, four years of teaching experience, and four professional titles. The results showed that there were no significant differences in AI literacy performance levels or the three sub-dimensions among teachers of different age groups (**Table 8**). Teachers with different years of teaching experience showed significant differences in the attitude and values dimension ($P = 0.006 < 0.01$), while there were no significant differences in overall AIliteracy performance levels, knowledge and skills, and continuous learning and development subdimensions (**Table 9**). Teachers with different professional titles showed significant differences in overall AI literacy performance levels, as well as in the knowledge and skills, and continuous learning and development sub-dimensions (**Table 10**). Teachers with senior professional titles demonstrated the highest performance levels across all dimensions, followed by teachers with junior professional titles, while teachers with associate senior professional titles had the lowest AI literacy levels.

Table 8. Comparison of differences in AI literacy performance under age variables.

	M（SD）				F	Retrospective inspection
	Under 35 years old ①	**Between 36 and 45 years old ②**	**Between 46 and 50 years old ③**	**Between 51 and 59 years old ④**		
Knowledge and skills	2.829（0.449）	2.794（0.504）	2.744（0.453）	2.752（0.511）	1.414	①＞②, ①＞③, ①＞④, ②＞③, ②>④, ③< ④
Attitudes and values	3.082（0.478）	3.021（0.553）	2.942（0.572）	2.976（0.583）	2.803	①＞②, ①＞③, ①＞④, ②＞③, ②＞④, ③＜④
Continuous learning and development capabilities	2.947（0.473）	2.918（0.497）	2.886（0.488）	2.876（0.554）	0.902	①＞②, ①＞③, ①＞④, ②＞③, ②＞④, ③＞④
Overall competency level	2.952（0.426）	2.911（0.478）	2.857（0.460）	2.868（0.514）	1.917	①＞②, ①＞③, ①＞④, ②＞③, ②>④, ③＜④

Table 9. Comparison of differences in AI education literacy performance under the variable of teaching experience.

	M（SD）				F	Retrospective inspection
	Less than 5 years ①	**6~10 years ②**	**11~15 years ③**	**16 years or more ④**		
Knowledge and skills	2.827（0.466）	2.817（0.418）	2.736（0.544）	2.784（0.499）	1.658	①＞②, ①＞③, ①＞④, ②＞③, ②＞④, ③＜④
Attitudes and values	3.095（0.490）	3.023（0.475）	2.924（0.601）	3.020（0.568）	4.250**	①＞②, ①＞③, ①＞④, ②＞③, ②＞④, ③＜④
Continuous learning and development capabilities	2.934（0.485）	2.947（0.460）	2.881（0.513）	2.904（0.515）	0.902	①＜②, ①＞③, ①＞④, ②＞③, ②＞④, ③＜④
Overall competency level	2.954（0.440）	2.929（0.407）	2.847（0.516）	2.903（0.488）	2.306	①＞②, ①＞③, ①＞④, ②＞③, ②＞④, ③＜④

Table 10. Comparison of differences in AI education literacy performance under different professional title variables.

	M（SD）				F	Retrospective inspection
	Junior ①	**Intermediate ②**	**Associate Senior ③**	**Senior ④**		
Knowledge and skills	2.805（0.458）	2.786（0.488）	2.762（0.501）	2.917（0.437）	3.124*	①＞②, ①＞③, ①＞④, ②＞③, ②＜④, ③＜④
Attitudes and values	3.073（0.496）	3.014（0.534）	2.984（0.572）	3.116（0.492）	2.553	①＞②, ①＞③, ①＜④, ②＞③, ②＜④, ③＜④

	M（SD）				F	Retrospective inspection
	Junior ①	Intermediate ②	Associate Senior ③	Senior ④		
Continuous learning and development capabilities	2.934（0.497）	2.908（0.491）	2.888（0.505）	3.050（0.453）	3.269*	①＞②, ①＞③, ①＜④, ②＞③, ②＜④, ③＜④
Overall level	2.934（0.440）	2.902（0.466）	2.878（0.487）	3.028（0.419）	3.291*	①＞②, ①＞③, ①＜④, ②＞③, ②＜④, ③＜④

Table 10. (*Continued*)

A multiple comparison analysis of age, years of teaching experience, and professional title variables indicates that teachers who are older, have more years of teaching experience, and hold lower professional titles generally have lower AI literacy: in the professional title structure for teachers with 11–15 years of teaching experience, lecturers and below account for 49.16%, and associate professors account for 40.11%. The overall literacy M(SD) value for this group of teachers is the lowest, primarily because their professional growth has entered a bottleneck and burnout phase, manifested by insufficient motivation for continuous learning and development. In contrast, senior-level teachers exhibit high AI literacy. Among teachers with 16 or more years of teaching experience, 83.56% hold senior-level titles. This group has the highest overall literacy score, indicating that senior-level teachers remain the main force in demonstrating and leading the way in professional development and skill enhancement.

(4) Regional differences

ANOVA was employed to investigate whether there were performance differences among teachers from different regions in terms of AI literacy. During the homogeneity of variance test, all p-values exceeded 0.05, indicating that the variances among the groups were homogeneous. Based on this finding, the LSD method was used for further multiple comparisons of the mean values across groups. According to the results in **Table 11**, there were no significant differences in the overall level of AI literacy among teachers from different regions, nor in their specific performance in the three sub-dimensions of knowledge and skills, attitudes and values, and continuous learning and development capabilities. However, when conducting multiple comparisons, it was found that the AI literacy level of vocational college teachers in the central region was significantly lower than that of teachers in the western and eastern regions.

Table 11. Comparison of differences in AI education literacy performance under regional variables.

	M（SD）			F	Retrospective inspection
	Western region ①	Central region ②	Eastern region ③		
Knowledge and skills	2.812（0.501）	2.747（0.464）	2.810（0.483）	1.271	①＞②, ①＞③, ②＜③
Attitudes and values	3.020（0.537）	2.963（0.529）	3.054（0.536）	1.929	①＞②, ①＜③, ②＜③
Continuous learning and development capabilities	2.956（0.502）	2.848（0.470）	2.936（0.500）	2.605	①＞②, ①＞③, ②＜③
Overall competency level	2.929（0.481）	2.853（0.439）	2.933（0.467）	2.008	①＞②, ①＜③, ②＜③

5. Discussion and conclusions

This study found that vocational college teachers generally hold a positive attitude toward AI technology, with an average score of 3.028 for attitude and value competence. This indicates that teachers fully recognize the importance of AI technology in education and hope to promote teaching innovation through learning and applying AI technology. This result aligns with the emphasis on teachers' technology acceptance and application willingness in the AI-TPACK theory (Yan et al., 2020). However, despite teachers' clear understanding of the importance of AI technology, there are significant shortcomings in their actual application capabilities. The average score for knowledge and skill competence was only 2.796, below the theoretical mean, indicating a significant gap in teachers' knowledge reserves and practical application of AI technology. This gap may stem from teachers underestimating the complexity and technical barriers of AI technology, as well as a lack of systematic training and practical opportunities (Wang et al., 2023). Additionally, the rapid updates in AI technology also place higher demands on teachers' ability to update their knowledge (Seufert et al., 2021).

The research results show that professional title has a significant impact on teachers' AI literacy, exhibiting a “middle-level slack” phenomenon. Teachers with senior professional titles score significantly higher than those with intermediate professional titles in terms of knowledge and skills, attitudes and values, and continuous learning and development capabilities. In contrast, teachers with junior professional titles, who have a stronger sense of professional crisis, are more open and accepting of new technologies and are more willing to actively learn AI technology to enhance their teaching capabilities. This phenomenon may be related to the stage of teachers' professional development. Senior-level teachers typically have higher achievements and richer experience in their professional fields, enabling them to better understand and apply AI technology (Chen and Huang, 2025). In contrast, intermediate-level teachers may be in a relatively stable stage of their professional development, lacking motivation for further improvement, which leads to poor performance in AI literacy. This result aligns with the findings of Ma Rui et al. (2023), who noted that teachers' professional development needs and sense of professional crisis significantly influence their learning and application of AI technology.

This study also found that vocational college teachers in eastern and western regions generally outperform those in central regions in terms of AI technology application and learning attitudes. Teachers in eastern regions scored the highest in AI technology application skills (3.054), while those in central regions scored the lowest (2.963). This regional disparity may be related to regional economic development levels, educational resource investments, and technological infrastructure. Eastern regions are generally more advanced in economic and technological development, providing teachers with more training opportunities and resource support (Wang et al., 2023). In contrast, central regions may lag behind in these areas, leading to poorer performance in AI technology application and learning attitudes among teachers. This finding aligns with the research of Xu et al. (2020), who noted that the unequal distribution of educational resources significantly impacts the improvement of teachers' AI literacy.

In summary, this study conducted a comprehensive survey and analysis of vocational college teachers' AI educational literacy based on the AI-TPACK model. The study found that vocational college teachers generally hold a positive attitude toward AI technology, but there are significant shortcomings in terms of knowledge reserves and practical application. Professional title and region have a significant impact on teachers' AI educational literacy, exhibiting a “middle-ground slack” phenomenon and regional differences. These findings provide important references for educational administrators and policymakers. First, there should be a focus on enhancing teachers' AI technology training, particularly in terms of knowledge and skills, to improve their practical application capabilities. Second, attention should be paid to teachers' career development stages, providing personalized training and development opportunities for teachers of different professional titles. For example, for teachers with intermediate professional titles, more incentive-based training programs can be designed to stimulate their learning motivation. Additionally, investments in educational resources should be increased, especially in regions like central China where educational resources are relatively scarce, to narrow the gap between regions. Finally, it is recommended to establish school-enterprise cooperation mechanisms to promote exchange and collaboration between teachers and businesses, providing teachers with more practical opportunities and resource support. Future research could further explore the characteristics of AI literacy among teachers at different educational stages and pathways for its improvement, offering more comprehensive support for educational reform.

The findings of this study offer practical value for policymakers by informing AI education policies, assist institutions in resource allocation and teacher training, and provide vocational educators with actionable strategies for AI integration. By bridging the gap between theoretical frameworks and vocational education needs, this research addresses a critical gap in both academic discourse and educational practice, ultimately supporting China's strategic goals for AI-driven vocational education reform.

Conflict of interest

The authors declare no conflict of interest.

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