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DEVELOPMENT AND VALIDATION OF AN AI LITERACY ASSESSMENT TOOL FOR HIGHER EDUCATION FACULTY IN CHINA: INSIGHTS FROM UNESCO'S AI-CFT FRAMEWORK

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ABSTRACT

As artificial intelligence (AI) transforms education globally, assessing teacher AI literacy has become critical—particularly in large-scale, policy-driven systems like China's. This study develops and validates a contextually grounded assessment instrument for higher education faculty in China, based on UNESCO's Artificial Intelligence Competency Framework for Teachers (AI-CFT). Through a two-phase validation process—including pilot testing (N = 40) and scale refinement via item analysis, exploratory factor analysis (EFA), and reliability testing—the initial 30-item pool was reduced to a 21-item scale that faithfully reflects the framework's five dimensions and three proficiency levels. The final instrument demonstrates strong internal consistency (α=0.914) and coherent factor structure, offering a psychometrically sound tool for evaluating AI literacy in non-Western, high-digitalization educational contexts. This work not only advances the cross-cultural operationalization of UNESCO's AI-CFT but also provides a validated foundation for teacher development, policy implementation, and comparative research on AI readiness in higher education.

Keywords: Teacher AI Literacy; Assessment Instrument; UNESCO AI-CFT Framework; Scale Development; Chinese Higher Education

1.0 INTRODUCTION

Artificial intelligence (AI) is transforming education around the world, and teacher AI literacy has become essential for effective teaching in digital environments. In China, national policy now emphasizes the integration of AI into education as part of a broader digitalization strategy. The Outline for Building a Strong Education Nation (2024-2035), for example, calls for deeper use of AI to support teacher development and improve teaching quality [1]. This policy response reflects growing global recognition that educators need structured guidance to engage with AI responsibly and effectively.

However, progress in building teacher AI literacy remains limited. A 2023 UNESCO survey of more than 450 schools found that fewer than 10% had formal policies or guidelines for using generative AI [2]. Without clear frameworks and assessment tools, teachers may struggle to apply AI in ways that align with pedagogical goals and ethical principles. Since AI-related skills are increasingly seen as core competencies for the 21st century [3], supporting teachers to develop these capacities is not only a technical challenge but also a key condition for equitable and high-quality education.

To address this gap, UNESCO released the AI Competency Framework for Teachers (AI-CFT) in 2024[4]. The framework outlines five areas—human-centred mindset, AI ethics, AI foundations and applications, AI pedagogy, and AI for professional development—and describes three levels of proficiency: acquire, deepen, and create. While the AI-CFT provides a valuable global reference, its practical use depends on adaptation to local educational contexts, especially in systems like China's, where digital infrastructure is advanced but teacher support structures differ from those in Western countries.

This study reports the development and validation of an assessment tool for measuring AI literacy among university teachers in China, based on the UNESCO AI-CFT. Starting with 30 items aligned with the framework's dimensions and proficiency levels, the instrument was refined through pilot testing (N=40), item analysis, exploratory factor analysis, and reliability checks. The final version contains 21 items and shows good internal consistency and structural coherence. The tool offers a practical means to assess teacher readiness for AI integration in Chinese higher education and contributes to ongoing efforts to apply global frameworks in diverse national settings.

2.0 LITERATURE REVIEW

2.1 Teacher AI Literacy

AI literacy refers to the ability to critically assess AI technologies, effectively communicate and collaborate with AI, and use AI as a tool in various settings such as online environments, homes, and workplaces [3]. In recent years, scholars both domestically and internationally have increasingly focused on teacher AI literacy, exploring several key areas:(1) Importance and Impact on Teaching: Studies indicate that teachers need AI literacy to integrate AI technologies effectively, drive innovation in teaching, and prepare for future educational needs [5]. Developing AI literacy not only enhances teaching efficiency but also lays the foundation for students to thrive in an AI-driven future [6].(2) Current Levels and Variability: Existing research has shown varying levels of AI literacy among teachers. For instance, Ding et al. found that the overall AI literacy of surveyed teachers was moderate, with in-service teachers generally outperforming pre-service teachers [7].(3) Challenges and Opportunities: While AI offers opportunities for personalized learning and innovative teaching methods, it also presents challenges such as ethical concerns, data security issues, and potential changes in teacher roles [8][9].

To address these challenges, scholars have proposed various frameworks for teacher AI literacy. For example, Long developed a comprehensive AI literacy framework covering five aspects: awareness, understanding, recognition, application, and perception of AI technologies [3]. However, this framework primarily targets general users rather than teachers specifically. Yan Zhiming et al. extended the TPACK (Technological Pedagogical Content Knowledge) framework by integrating AI, creating the AI-TPACK model, which includes AI-TK (AI technology knowledge), AI-TPK (teaching methods integrated with AI), and AI-TCK (subject knowledge integrated with AI) [10]. Despite its strengths, this model focuses mainly on integrating technical and pedagogical knowledge, lacking sufficient attention to critical issues like AI ethics and data security. Additionally, it lacks a clear progression of development levels, making it difficult to guide teachers from basic to advanced skills.

Through literature analysis, several gaps in existing research were identified:(1)Limited Localization: International frameworks may not be fully applicable to local contexts, and there is a lack of standardized assessments tailored to Chinese university teachers.(2)Narrow Research Perspectives: Much of the current research focuses on theoretical discussions of AI's impact on teachers, with fewer empirical studies, particularly those examining the AI literacy of university teachers.(3)Lack of Assessment Tools: While multiple frameworks have been proposed internationally, few validated tools exist specifically for assessing university teachers' AI literacy.

Given these gaps, this study aims to develop and validate an assessment tool for teacher AI literacy based on UNESCO's AI-CFT framework. This tool not only provides a reliable method for evaluating AI literacy among faculty in higher education in China but also offers practical guidance for teacher training and policy development.

2.2 UNESCO Teacher AI Literacy Framework

In 2024, UNESCO released the AI Competency Framework for Teachers (AI-CFT), providing a systematic guide for global teacher AI literacy development. The framework describes the AI competencies teachers should possess across five dimensions—human-centred mindset, AI ethics, AI foundations and applications, AI pedagogy, and AI for professional development—and three proficiency levels: acquire, deepen, and create. It also includes a benchmark matrix for assessing teachers' AI capabilities (see Table 1), offering concrete references for evaluation and improvement.

The AI-CFT framework covers core areas of teacher competence. The human-centred mindset dimension emphasizes that AI should enhance human capabilities rather than replace them, encouraging teachers to focus on student needs and experiences [11]. The AI ethics dimension requires teachers to be aware of ethical issues such as data privacy, algorithmic bias, and technological dependence, ensuring responsible use of AI [12]. The AI foundations and applications, AI pedagogy, and AI for professional development dimensions provide systematic pathways for skill development, helping teachers integrate AI into their teaching practices and support their professional growth.

The three proficiency levels—acquire, deepen, and create—offer clear stages for developing AI literacy. At the acquire level, teachers learn basic concepts and apply AI tools in initial teaching activities. At the deepen level, they integrate AI deeply into teaching methods and design innovative activities. At the create level, teachers explore new teaching models or tools using AI. These structured levels guide teachers from foundational to advanced AI literacy [11][12].

While the AI-CFT framework has global applicability, its localization in China requires further study. This research develops an AI literacy assessment tool for faculty in higher education in China based on the AI-CFT framework, enriching the field of teacher AI literacy and providing practical references for teacher training and policy-making.

Table 1 UNESCO AI-CFT Framework

Dimension	Progression		
	Acquire	Deepen	Create
Human-centred mindset	Human agency	Human accountability	Social responsibility
Ethics of AI	Ethical principles	Safe and responsible use	co-creating ethical rules
AI foundations and applications	Basic AI techniques and applications	Application skills	Creating with AI
AI pedagogy	AI-assisted teaching	AI-pedagogy integration	AI-enhanced pedagogical transformation
AI for professional development	AI enabling lifelong professional learning	AI to enhance organizational learning	AI to support professional transformation

3.0 RESEARCH METHOD

3.1 Instrument Development Rationale

The assessment instrument was developed based on UNESCO's AI Competency Framework for Teachers (AI-CFT), which defines five core dimensions—human-centred mindset, AI ethics, AI foundations and applications, AI pedagogy, and AI for professional development—across three proficiency levels: acquire, deepen, and create. Initially, two items were drafted for each proficiency level within every dimension, resulting in a pool of 30 items.

During item writing, the original English descriptions from the AI-CFT were carefully referenced to ensure that the Chinese items accurately reflected both the conceptual essence of each dimension and the developmental distinctions across the three levels. For example, items at the "acquire" level focused on basic understanding and initial use of AI; those at the "deepen" level emphasized integration of AI into teaching practices; and items at the "create" level highlighted exploratory and innovative applications. To enhance content validity, two experts in educational technology and teacher development reviewed all items, and revisions were made based on their feedback.

3.2 Instrument Structure and Content

The final questionnaire consists of three sections:

1) Demographic information, including gender, academic discipline, academic rank, years of teaching experience, and frequency of AI tool use;
2) A 30-item Likert-type scale (1 = strongly disagree to 5 = strongly agree) designed to assess AI literacy across the five dimensions and three proficiency levels of the AI-CFT;
3) Three open-ended questions exploring factors influencing AI adoption, major challenges in using AI tools, and suggestions for AI-related professional development.

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The questionnaire was administered via Wenjuanwang (a widely used online survey platform in China).

3.2 Pilot Testing

3.3.1 Data Collection

A pilot test was conducted to evaluate the reliability and validity of the instrument. A total of 40 valid responses were collected from faculty in higher education institutions across multiple disciplines and academic ranks. The sample included participants with varying teaching experience (from less than one year to over 16 years) and diverse AI usage frequencies, allowing preliminary examination of how background characteristics might relate to AI literacy. Gender distribution was balanced (55% male, 45% female), reducing potential gender bias.

Table 2 Demographic Characteristics of the Pilot Sample (N = 40)

Variable	Category	percentage	Variable	Category	percentage
Gender	Male	55%		<1 year	17.50%
	Female	45%		1–5 years	30%
Discipline	Engineering	32.50%	Teaching Experience	6–10 years	17.50%
	Humanities & Social Sciences	25%		11–15 years	10%
	Medicine	22.50%		≥16 years	25%
	Natural Sciences	20%		Never	2%
Academic Rank	Junior	27.50%	AI Use Frequency	Rarely	15%
	Associate	45%		Occasionally	27.50%
	Senior	27.50%		Often	45%
				Always	7.50%

3.3.1 Data Cleaning

All responses were collected through a platform that required mandatory answers, ensuring no missing data. No duplicate cases or extreme outliers were detected during data cleaning, confirming data integrity and reliability.

3.3.3 Item Analysis

Item analysis was performed using the critical ratio (CR) method to assess item discrimination. Items Q9, Q14, and Q21 showed non-significant CR values ($p > 0.05$) and were removed. The remaining items demonstrated adequate discriminatory power and were retained for further analysis.

3.3.4 Reliability and Validity Assessment

Exploratory factor analysis (EFA) was conducted to examine the underlying structure of the scale. The Kaiser–Meyer–Olkin (KMO) measure was 0.672, and Bartlett's test of sphericity was significant ($p < 0.001$), indicating that the data were suitable for factor analysis. Principal component analysis with Varimax rotation was applied to simplify the factor structure.

Items were removed iteratively based on three criteria: (1) factor loading below 0.40, (2) cross-loading above 0.40 on multiple factors, or (3) conceptual misalignment with the intended dimension. Following this process, six additional items (Q10, Q16, Q23, Q26, Q32, Q35) were deleted. Minor wording adjustments were then made to six remaining items (Q7, Q8, Q11, Q13, Q33, Q34) to improve clarity and ensure clear alignment with the AI-CFT dimensions.

The final 21-item solution yielded five distinct factors corresponding to the five AI-CFT dimensions. All factor loadings exceeded 0.50, supporting good structural validity (see table 3). The total variance explained increased from 71.34% to 75.68%. Internal consistency was high for the overall scale (Cronbach's $\alpha = 0.914$). Subscale alphas ranged from 0.646 (AI foundations and applications) to 0.921 (AI pedagogy). Although two subscales fell slightly below the conventional 0.70 threshold, they were deemed acceptable given the small number of items per subscale and the exploratory nature of this phase [13].

Table 3 Structure Coefficients for the Final Scale

Items	Construct 1	Construct 2	Construct 3	Construct 4	Construct 5
Q6	0.710	-	-	-	-
Q7	0.823	-	-	-	-
Q8	0.686	-	-	-	-
Q11	0.762	-	-	-	-
Q12	-	0.750	-	-	-
Q13	-	0.810	-	-	-
Q15	-	0.720	-	-	-
Q17	-	0.780	-	-	-
Q18	-	-	0.690	-	-
Q19	-	-	0.740	-	-
Q20	-	-	0.810	-	-
Q22	-	-	0.760	-	-
Q24	-	-	-	0.710	-
Q25	-	-	-	0.780	-
Q27	-	-	-	0.820	-
Q28	-	-	-	0.750	-
Q29	-	-	-	0.790	-
Q30	-	-	-	-	0.720
Q31	-	-	-	-	0.810
Q33	-	-	-	-	0.891
Q34	-	-	-	-	0.780

3.3.5 Second-Phase Validation

To further validate the refined 21-item scale, a second round of data collection was conducted, yielding 260 valid responses. Confirmatory analyses showed excellent reliability: all subscale Cronbach's α values ranged from 0.85 to 0.88. Composite reliability (CR) exceeded 0.88, and average variance extracted (AVE) was above 0.65 for all dimensions—well above

recommended thresholds [14]. All standardized item loadings were statistically significant ($p < 0.001$), confirming strong item-to-dimension coherence (see table 4). These results indicate that the instrument is stable and psychometrically sound across different samples of faculty in higher education institutions.

Table 4 Reliability and Validity of the Second Validation Sample (N = 260)

Constructs	Items	UnEst	S.E.	Z value	P	Est	Crobach's α	CR	AVE
AHC	Q6	1				0.725	0.884	0.884	0.657
	Q7	0.991	0.085	11.636	***	0.751			
	Q8	1.308	0.095	13.731	***	0.908			
	Q9	1.278	0.098	13.058	***	0.844			
AED	Q10	1				0.777	0.917	0.917	0.736
	Q11	1.172	0.077	15.275	***	0.865			
	Q12	1.256	0.077	16.315	***	0.916			
	Q13	1.206	0.079	15.343	***	0.868			
ABA	Q14	1				0.882	0.906	0.911	0.720
	Q15	1.002	0.054	18.676	***	0.868			
	Q16	1.088	0.057	19.008	***	0.877			
	Q17	1.058	0.071	14.969	***	0.762			
API	Q18	1				0.850	0.947	0.948	0.785
	Q19	1.09	0.053	20.586	***	0.92			
	Q20	1.12	0.055	20.341	***	0.915			
	Q21	1.125	0.062	18.027	***	0.857			
	Q22	1.122	0.059	19.132	***	0.886			
APD	Q23	1				0.855	0.891	0.894	0.824
	Q24	0.956	0.058	16.381	***	0.846			
	Q25	1.037	0.063	16.529	***	0.852			
	Q26	0.961	0.072	13.445	***	0.737			

Note:***P<0.001

3.4 Final Scale Configuration

Based on the pilot and validation phases, the instrument was finalized with 21 items (see Table 5). The structure strictly aligns with the AI-CFT's five dimensions and three proficiency levels,

capturing faculty's progression from foundational understanding to practical application and innovative design (see Table 6 for item mapping).

Table 5 Final 21-Item AI Literacy Scale

Item	Item Statement
Q6	I understand that AI tools may affect students' autonomous learning (e.g., independent thinking) and am beginning to consider how to protect their agency and individual needs.
Q7	I recognize that using AI tools may transform traditional teaching approaches and am reflecting on how to balance AI use with active student participation.
Q8	I guide students in critically discussing the pros and cons of AI (e.g., through case studies) to help them develop a human-centred perspective on technology.
Q11	Guided by a human-centred educational philosophy, I design innovative ways to integrate AI into teaching (e.g., personalized learning pathways or supporting student-led inquiry).
Q12	I understand that AI may involve privacy and data security issues, including the protection of teachers' and students' information.
Q13	I can identify ethical risks associated with AI tools (e.g., privacy breaches or data misuse) and am attentive to mitigating these risks.
Q15	I emphasize AI ethics in my teaching to help students learn how to use these tools responsibly.
Q17	I integrate AI ethics into course design (e.g., by creating discussion activities on ethical dilemmas) to encourage critical reflection on AI's societal impact.
Q18	I am familiar with common AI tools and their basic functions.
Q19	I try using AI tools to streamline routine tasks.
Q20	I can competently use multiple AI tools to efficiently handle complex tasks.
Q22	I innovatively integrate AI tools (e.g., embedding AI into learning platforms or office software) to develop customized solutions for complex needs.
Q24	I have begun using AI tools to design instructional materials (e.g., generating practice questions or simulated scenarios).
Q25	I understand how AI tools can enhance classroom interaction (e.g., by using AI-generated content to engage students).
Q27	I use AI tools to analyze student learning data (e.g., identifying difficulties and providing personalized feedback).
Q28	I use AI to grade assignments or quizzes and adjust my teaching strategies based on the results.
Q29	I design innovative AI-supported teaching scenarios (e.g., project-based learning or virtual environments) to enable students to explore and solve real-world problems.
Q30	I understand how AI tools can potentially support my professional growth (e.g., by improving efficiency or fostering innovation).
Q31	I follow the latest developments of AI in education, broaden my knowledge, and experiment with applying them in my teaching.
Q33	I use AI tools to evaluate my work performance and refine my strategies based on data analysis to enhance professional competence.
Q34	I adapt or integrate existing AI tools according to my needs (e.g., developing customized AI solutions) to better support my work and advance my professional development.

Table 6 Mapping of Scale Dimensions to Proficiency Levels and Items

Dimension	Progression		
	Acquire	Deepen	Create
Human-centred mindset	Items:Q6、Q7 Understand the principle of human-centred education	Item:Q8 Apply human-centred principles in teaching practice	Item:Q11 Design and innovate teaching models grounded in a human-centred

Dimension	Progression		
	Acquire	Deepen	Create
			approach
	Items:Q12、Q13	Item:Q15	Item:Q17
Ethics of AI	Understand ethical issues related to AI (e.g., privacy, data security)	Apply AI ethics principles in instructional contexts	Design AI-integrated activities that address ethical considerations
	Item:Q18	Items:Q19、Q20	Item:Q22
AI foundations and applications	Understand basic AI concepts and tools	Apply AI tools to solve practical teaching or administrative tasks	Innovatively integrate or customize AI tools for complex needs
	Items:Q24、Q25	Items:Q27、Q28	Item:Q29
AI pedagogy	Understand how AI can support teaching and learning	Use AI tools to enhance instruction and provide feedback	Design innovative AI-supported teaching scenarios (e.g., project-based or immersive learning)
	Item:Q30	Items:Q31、Q33	Item:Q34
AI for professional development	Recognize AI's potential impact on professional growth	Use AI tools to reflect on and improve professional practice	Adapt or develop AI solutions to advance professional capabilities

5.0 CONCLUSIONS AND DISCUSSION

5.1 Conclusions

This study developed an AI literacy assessment tool for faculty in higher education institutions based on UNESCO's AI Competency Framework for Teachers (AI-CFT). Through rigorous item analysis, reliability, and validity assessments, the instrument was refined to ensure both theoretical alignment and practical utility. The final 21-item scale demonstrated high internal consistency (Cronbach's $\alpha = 0.914$) and explained a substantial portion of variance (75.675%) across five dimensions—human-centred mindset, AI ethics, AI foundations and applications, AI pedagogy, and AI for professional development—each with three proficiency levels: acquire, deepen, and create.

The optimized scale provides a reliable and valid means to assess AI literacy among faculty in Chinese higher education institutions. This tool can support large-scale surveys aimed at understanding the current state of AI literacy among educators and guide targeted interventions for professional development.

5.2 Limitations

Despite the methodological rigor employed in this study, several limitations must be acknowledged:

Sample Size: The pilot sample size of 40 participants is relatively small, which may limit the stability of statistical analyses, particularly in exploratory factor analysis (EFA). A larger sample is needed to conduct confirmatory factor analysis (CFA) to further validate the factor structure and psychometric properties of the scale.

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Demographic Representation: Although the pilot sample covered a range of academic disciplines, ranks, and years of experience, it may not fully represent the diversity of faculty in Chinese higher education institutions. Future studies should aim for broader sampling to ensure the applicability of the scale across different institutional contexts and teacher profiles.

Cross-Validation: While the initial validation results are promising, additional cross-validation with diverse samples is necessary to confirm the generalizability of the findings. This includes testing the scale with teachers from various regions, institution types, and educational backgrounds.

5.3 Future Research Directions

Based on the identified limitations and open-ended feedback collected during the study, several avenues for future research are suggested:

Scale Optimization and Validation: Collect large-scale survey data to conduct CFA and refine the factor structure and psychometric properties of the scale. This will enhance the robustness of the instrument and ensure its suitability for widespread use.

Survey of AI Literacy Among Higher Education Faculty: Conduct comprehensive surveys to assess the current state of AI literacy among faculty in higher education institutions. Analyze variations in AI literacy across demographic characteristics such as gender, academic discipline, rank, and years of teaching experience. This will provide valuable insights into areas where targeted interventions may be needed.

Investigation of Influencing Factors and Mechanisms: Extract key themes from open-ended responses to identify critical factors influencing AI literacy among faculty (e.g., access to training resources, technical support, personal motivation). Investigate the underlying mechanisms through which these factors impact AI literacy. This knowledge can inform the development of effective intervention strategies.

Development of AI Literacy Training Programs: Based on the findings from the survey, design and implement tailored professional development programs aimed at enhancing AI literacy among faculty. Explore innovative training models and strategies that promote sustainable improvements in AI literacy and integration into teaching practices.

5.4 Practical Implications

The validated AI literacy assessment tool offers several practical implications for policymakers, educational administrators, and faculty developers:

Policy Development: The scale can serve as a benchmark for developing national or institutional policies aimed at promoting AI literacy among faculty. Policymakers can use the tool to monitor progress and allocate resources effectively.

Professional Development: Educational institutions can utilize the scale to assess faculty needs and tailor professional development programs accordingly. By identifying strengths and

gaps in AI literacy, institutions can offer targeted training and support to enhance faculty capabilities.

Global Application: While the scale was developed within the Chinese context, its theoretical foundation rooted in UNESCO's AI-CFT makes it potentially applicable to other countries and educational systems. Cross-cultural validation studies could extend its utility globally.

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