

AI COMPETENCY MODEL OF TEACHERS FOR HIGHER EDUCATION INSTITUTIONS IN GUANGXI ZHUANG AUTONOMOUS REGION

Renjuan ZHOU¹

¹ Department of Educational Administration, Suan Sunandha Rajabhat University, Thailand; 175104392@qq.com

ARTICLE HISTORY

Received: 19 March 2026

Revised: 24 March 2026

Published: 27 March 2026

ABSTRACT

The integration of artificial intelligence (AI) into higher education has significantly transformed teaching practices and learning environments. As universities increasingly adopt AI technologies, the development of teachers' AI competency has become a critical factor influencing educational effectiveness. This study provides a comprehensive literature review to synthesize existing research on AI competency in education and to propose a theoretical model tailored to higher education institutions in Guangxi Zhuang Autonomous Region. This review examines four key themes: theoretical foundations of AI competency, applications of AI in higher education, pedagogical frameworks including AI-TPACK and GenAI-TPACK, and institutional support for AI adoption. Through critical analysis and comparison of existing studies, this paper identifies AI competency as a multidimensional construct integrating technological literacy, pedagogical integration, ethical awareness, and reflective capacity. Unlike previous studies that primarily describe AI adoption or digital competence, this study contributes by synthesizing multiple theoretical perspectives into a unified conceptual framework. Based on this synthesis, a proposed AI competency model is developed, illustrating the relationships among institutional support, AI competency, TPACK, and teaching performance. The findings provide both theoretical contributions and practical implications for teacher professional development and intelligent education policy in higher education.

Keywords: Artificial Intelligence, Teacher Competency, Higher Education

CITATION INFORMATION: Zhou, R. (2026). AI competency Model of Teachers for higher education institutions in Guangxi Zhuang Autonomous Region. *Procedia of Multidisciplinary Research*, 4(3), 65.

INTRODUCTION

Artificial intelligence (AI) has become a transformative force in higher education, reshaping instructional practices, learning environments, and institutional governance. Universities increasingly adopt AI technologies—such as intelligent tutoring systems, learning analytics, and generative AI—to enhance teaching efficiency and support personalized learning (Gao & Tan, 2025). These developments shift education toward adaptive, data-driven, and student-centered approaches. However, effective AI integration depends not only on technological availability but also on teachers' competencies. Teachers must understand, apply, and critically evaluate AI systems within pedagogical contexts (Zou et al., 2025). AI competency extends beyond technical skills to include pedagogical reasoning and ethical awareness, reflecting the complexity of teaching in AI-mediated environments (Mikeladze et al., 2024). Global frameworks, such as the UNESCO AI competency framework, emphasize human-centered and ethical competencies, suggesting that AI competency is multidimensional and shaped by both individual and institutional factors (Okada et al., 2025). Despite increasing research, existing studies remain fragmented and lack integrative models explaining how AI competency interacts with institutional support and pedagogical knowledge to influence teaching performance, particularly in Chinese higher education contexts (Fu & Ji, 2024). To address this gap, this study proposes an integrated, multilevel AI competency model that incorporates individual competencies, pedagogical mechanisms, and institutional conditions, explaining how AI competency operates and influences teaching performance in context-specific higher education environments.

THEORETICAL FOUNDATIONS OF AI COMPETENCY IN EDUCATION

Concept of Artificial Intelligence Competency

AI competency has become a central concept in educational technology and teacher development, particularly with the increasing integration of AI into higher education. Teachers are expected to understand, apply, and critically evaluate AI technologies within pedagogical contexts. AI competency refers to the knowledge, skills, and attitudes required to effectively interact with AI systems, including technological literacy, pedagogical integration, and ethical awareness (Zou et al., 2025). Unlike traditional digital literacy, it involves understanding data-driven decision-making and algorithmic processes. Existing studies emphasize its multidimensional nature. Chee et al. (2025) highlight technical understanding and ethical reasoning, while Mikeladze et al. (2024) stress the integration of technological, pedagogical, and reflective dimensions. However, definitions remain fragmented. Therefore, AI competency should be reconceptualized as an integrated construct combining technological, pedagogical, and ethical components.

Dimensions and Structure of AI Competency

Scholars consistently conceptualize AI competency as multidimensional. Technological competence forms the foundation for integrating AI into teaching (Khalil & Alsenaidi, 2024), but it is insufficient on its own. Delcker et al. (2025) identify technological knowledge, pedagogical application, and ethical responsibility as core dimensions, while emphasizing teachers' self-perceptions. Asio and Sardina (2025) further demonstrate that AI self-efficacy reduces anxiety and supports competency development, highlighting affective factors. Moreover, AI competency

requires continuous learning and reflective practice due to rapid technological change (Mikeladze et al., 2024). Despite consensus, existing studies often treat these dimensions separately. Therefore, an integrative framework is required to connect technological, pedagogical, ethical, and psychological components.

Ethical and Reflective Dimensions of AI Competency

Ethical awareness has become increasingly central, particularly with the rise of generative AI. These technologies introduce challenges related to academic integrity, data privacy, and algorithmic bias. Okada et al. (2025), based on the UNESCO framework, emphasize ethical reasoning and human-centered AI design. Lan et al. (2025) incorporate ethical awareness into the GenAI-TPACK framework, highlighting the need to critically evaluate AI-generated content. Zou et al. (2025) further argue that teachers should guide students in understanding AI limitations. Despite its importance, ethical awareness is often treated as supplementary. This limits model development. Therefore, ethical and reflective competencies should be positioned as core components of AI competency.

Critical Analysis of AI Competency Frameworks

Several limitations remain. First, many frameworks lack empirical validation (Mikeladze et al., 2024). Second, AI competency is often conflated with digital literacy, overlooking its distinct characteristics. Third, research focuses on individual competencies while neglecting institutional influences (Fu & Ji, 2024). Finally, context-specific research remains limited. These gaps highlight the need for integrative models linking individual, pedagogical, and institutional factors. AI competency should therefore be understood as a multidimensional and context-dependent construct.

ARTIFICIAL INTELLIGENCE APPLICATIONS IN HIGHER EDUCATION

AI Technologies in Higher Education Contexts

Artificial intelligence (AI) technologies are increasingly adopted in higher education to enhance teaching, learning, and administrative processes. Gao and Tan (2025) identify key applications, including adaptive learning systems, intelligent tutoring systems, and automated assessment tools. These technologies enable large-scale data analysis and support personalized learning, thereby improving efficiency. However, their effectiveness depends largely on how they are integrated into pedagogical practices rather than on technological availability alone.

AI and Personalized Learning

AI technologies are widely applied in higher education to enhance teaching and learning. Key applications include adaptive learning systems, intelligent tutoring systems, and automated assessment tools (Gao & Tan, 2025). These technologies support data-driven decision-making and personalized learning. Overall, the evidence suggests that personalization is not solely a technological outcome but a pedagogical process. Effective implementation requires teachers to adapt instructional strategies and align AI tools with learning objectives, highlighting the central role of teacher competency.

Generative AI in Teaching and Learning

Generative AI expands instructional possibilities by supporting content creation and instructional design (Lan et al., 2025). Lu et al. (2024) show that it enhances professional development and higher-order thinking. However, these benefits are accompanied by risks. Over-reliance on AI may reduce students' critical thinking and increase concerns related to academic integrity. Thus, generative AI introduces both opportunities and challenges, requiring teachers to develop competencies for critical and responsible use.

Challenges and Limitations of AI Integration

Despite its potential, AI integration faces significant challenges. Taheri et al. (2025) identify factors such as perceived usefulness, ease of use, and institutional support as key determinants of adoption. Bothe (2023) notes that insufficient training and pedagogical support hinder effective implementation, while Bokhove et al. (2026) emphasize the need for evidence-based and critically informed technology use. These studies suggest that barriers to AI adoption are not purely technical but involve pedagogical, institutional, and cognitive dimensions.

Critical Synthesis of AI Applications

A synthesis of the literature indicates that AI applications in higher education are shaped by the interaction of technological, pedagogical, and institutional factors. While AI enables personalized and adaptive learning, its effectiveness depends on teachers' competencies and organizational support. Furthermore, generative AI introduces new ethical and pedagogical challenges, shifting the focus from tool-based adoption to reflective and responsible integration. Therefore, AI should be understood as part of a broader educational ecosystem. Technological innovation alone cannot ensure effective learning outcomes; rather, success depends on aligning AI tools with pedagogical objectives. This perspective underscores the need for pedagogical frameworks that explain how AI-related competencies are translated into instructional practices, particularly through the integration of technological, pedagogical, and disciplinary knowledge in AI-enhanced learning environments.

AI-TPACK AND GENERATIVE AI PEDAGOGICAL FRAMEWORKS

Evolution from TPACK to AI-TPACK

The Technological Pedagogical Content Knowledge (TPACK) framework provides a foundational model for understanding how teachers integrate technology into instruction through the interaction of technological, pedagogical, and content knowledge. However, the emergence of artificial intelligence challenges the sufficiency of traditional TPACK. Unlike conventional tools, AI systems involve algorithmic processes, data-driven decision-making, and adaptive learning, fundamentally transforming instructional environments. To address this shift, Karataş and Ataç (2025) propose the AI-TPACK framework, which incorporates AI-related competencies into TPACK. Their findings indicate that AI knowledge enhances pedagogical integration and represents a transformation in instructional design rather than a simple extension of technological knowledge. Supporting this view, Hava and Babayiğit (2025) and Setiyawan et al. (2025) confirm

that AI-TPACK is a multidimensional construct requiring alignment among technological, pedagogical, and contextual knowledge.

Generative AI and the Emergence of GenAI-TPACK

The rapid development of generative AI introduces new dimensions to teacher competency frameworks. Unlike traditional AI, generative AI can produce original content, shifting teacher roles from knowledge transmitters to facilitators and evaluators. Lan et al. (2025) extend AI-TPACK by proposing the GenAI-TPACK framework, integrating technological knowledge, pedagogical strategies, and ethical awareness. A key contribution is its emphasis on ethical considerations, including academic integrity, misinformation, and algorithmic bias. Lu et al. (2024) show that generative AI can enhance professional development and higher-order thinking, while also warning against over-reliance. Liu and Xiao (2025) further highlight that its applications vary across instructional stages, requiring context-sensitive competencies. These findings indicate a shift from tool-based usage toward reflective, critical, and ethically informed pedagogical practices.

Pedagogical Implications of AI-TPACK and GenAI-TPACK

AI-TPACK and GenAI-TPACK highlight that effective AI integration requires rethinking instructional design rather than simply adopting new technologies. Tan et al. (2025) identify TPACK as a mediating mechanism linking AI competency to teaching performance, suggesting that competency influences outcomes through pedagogical transformation. AI-supported environments also demand adaptive teaching strategies due to increasingly dynamic interactions among teachers, students, and technologies. Yildirim and Akcan (2024) emphasize the importance of professional development in supporting this transition. Overall, these frameworks demonstrate that pedagogical alignment is central to effective AI integration and that competency development must extend beyond technical skills to include instructional design and adaptability.

Critical Analysis of AI Pedagogical Frameworks

Despite their contributions, existing frameworks face several limitations. First, many remain conceptual, with limited empirical validation. Second, AI competency and pedagogical knowledge are often treated separately, restricting integrated explanations of their interaction. Third, institutional factors are frequently overlooked, despite their influence on competency application. These limitations highlight the need for comprehensive models that integrate individual competencies with organizational and contextual conditions. While AI-TPACK and GenAI-TPACK provide valuable insights into pedagogical integration, they do not fully capture the institutional environments shaping competency development. Therefore, a more holistic perspective is required to understand how AI competency operates within complex educational systems, incorporating both pedagogical mechanisms and institutional contexts.

INSTITUTIONAL SUPPORT AND TEACHER AI COMPETENCY DEVELOPMENT

Institutional Support as a Determinant of AI Adoption

Institutional support is widely recognized as a critical factor influencing the adoption and integration of artificial intelligence in higher education. It encompasses technological infrastructure, professional development, leadership strategies, and policy frameworks that enable the effective use of AI in teaching and learning. Empirical studies consistently confirm its central role. Institutional conditions, particularly access to training and technological resources, significantly shape teachers' perceptions of AI competency (Delcker et al., 2025). Similarly, institutional support has been identified as a key external determinant of AI adoption, influencing teachers' behavioral intentions alongside individual attitudes (Taheri et al., 2025). Moreover, it interacts with perceived usefulness and ease of use, reinforcing its influence on adoption decisions (Hazzan-Bishara et al., 2025). Collectively, the literature demonstrates that institutional support should not be viewed merely as a contextual background but as a structural determinant that enables or constrains AI adoption in higher education.

Professional Development and Teacher Competency Enhancement

Professional development plays a central role in enabling teachers to acquire and continuously update AI-related competencies. Given the rapid evolution of AI technologies, ongoing learning is essential for maintaining instructional relevance. Research indicates that effective training programs must integrate technical, pedagogical, and ethical dimensions of AI competency (Sun et al., 2026). In addition, generative AI has been shown to support professional development by enhancing instructional design and reflective practices (Lu et al., 2024). Structured training initiatives further improve teachers' confidence and competence in AI integration (Yildirim & Akcan, 2024). These studies indicate that professional development should move beyond technical training toward a more comprehensive approach that aligns technological skills with pedagogical strategies and ethical considerations.

Policy Context and AI Talent Development

Policy frameworks also play a significant role in shaping AI competency development. National and regional policies increasingly emphasize digital transformation and the integration of AI into education systems. Collaboration between government and universities has been identified as essential for AI talent development, as policy initiatives influence both institutional strategies and professional learning opportunities (Fu & Ji, 2024). Regional policies further promote interdisciplinary development and educational innovation. However, challenges such as uneven resource distribution and implementation gaps persist. This suggests that policy effects are context-dependent and require further investigation in specific educational environments.

Critical Analysis of Institutional Support in AI Competency Models

Despite its recognized importance, institutional support is often treated as a background variable rather than an integral component of competency models. Existing frameworks tend to prioritize individual competencies while overlooking organizational and contextual influences. Moreover, limited attention has been given to the interaction between institutional support and pedagogical frameworks, restricting the ability to explain how competencies are enacted in practice. These limitations indicate the need for integrative models that combine individual competencies with institutional conditions. Incorporating institutional support as a core component provides a more

comprehensive explanation of how AI competency develops and translates into teaching performance in higher education contexts.

Theoretical Synthesis And Conceptual Integration

The literature indicates that AI competency is a multidimensional construct integrating technological, pedagogical, and ethical dimensions. AI-TPACK, GenAI-TPACK, and the UNESCO framework collectively provide a comprehensive theoretical foundation.

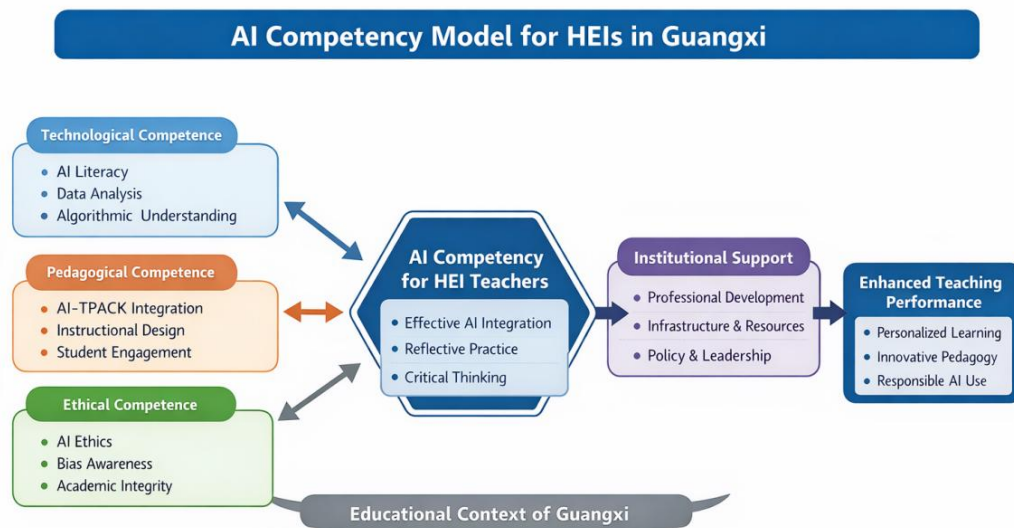


Figure 1 presents the proposed model. Institutional support functions as a structural determinant influencing both AI competency and teaching performance. AI competency affects performance directly and indirectly through TPACK, which acts as a mediating mechanism translating competencies into practice. This model integrates individual competencies, pedagogical mechanisms, and institutional conditions within a multilevel framework, offering a comprehensive explanation of how AI competency operates in higher education contexts.

Proposed Ai Competency Model

Based on a systematic synthesis of the literature, this study proposes an integrated AI competency model tailored to higher education institutions in Guangxi Zhuang Autonomous Region. The model comprises four core constructs: Institutional Support, AI Competency, Technological Pedagogical Content Knowledge (TPACK), and Teaching Performance. Institutional Support is conceptualized as an exogenous factor, including professional development, technological infrastructure, leadership, and policy frameworks that enable competency development. AI Competency is defined as a multidimensional construct encompassing technological literacy, pedagogical integration, and ethical awareness, reflecting teachers' ability to effectively apply and evaluate AI in education. TPACK functions as a mediating mechanism, translating AI competency into pedagogically effective practices. Teaching Performance represents the outcome, including instructional effectiveness, innovation, student engagement, and learning outcomes in AI-supported environments.

Analytical Propositions

Rather than testing formal hypotheses, this study proposes analytical propositions derived from the literature. AI competency is conceptualized as a multidimensional construct integrating technological literacy, pedagogical integration, and ethical awareness. Institutional support is posited as a foundational factor that facilitates competency development and directly enhances teaching performance. AI competency positively influences teachers' TPACK, which serves as a key mechanism linking competency to instructional effectiveness. Additionally, AI competency exerts a direct effect on teaching performance. TPACK further mediates the relationship between AI competency and teaching outcomes, connecting individual capabilities with pedagogical practices.

CONCLUSION

This study develops a theoretically grounded and context-specific AI competency model for higher education. It conceptualizes AI competency as a multidimensional construct integrating technological, pedagogical, and ethical dimensions. The study contributes by synthesizing multiple frameworks, introducing a multilevel model, and identifying TPACK as a mediating mechanism. It provides a foundation for empirical research and highlights the importance of systemic support for competency development. Focusing on Guangxi, the study offers a context-sensitive perspective and demonstrates how global frameworks can be adapted to regional settings. Future research should empirically validate the model and examine cross-regional differences, particularly in the context of generative AI.

REFERENCES

- Asio, J. M. R., & Sardina, D. P. (2025). Gender differences on the impact of AI self-efficacy on AI anxiety through AI self-competency. *Journal of Pedagogical Research*.
- Bokhove, C., Hoyes, L., & Hyde, R. (2026). Using technology for questioning evidence in teacher education. *Journal of New Approaches in Educational Research*.
- Bothe, S. (2023). Incorporating digital technologies into teacher education. *Australian Journal of Teacher Education*.
- Chee, H., Ahn, S., & Lee, J. (2025). AI literacy competency framework. *British Journal of Educational Technology*.
- Delcker, J., Heil, J., & Ifenthaler, D. (2025). Assessment of teachers' AI competence. *Educational Technology Research and Development*.
- Fu, T., & Ji, Y. (2024). Government-university relationship in AI talent development. *Sage Open*.
- Gao, H., & Tan, Y. (2025). AI applications in higher education. *Higher Education Studies*.
- Hava, K., & Babayiğit, Ö. (2025). AI-TPACK and digital proficiency. *Education and Information Technologies*.
- Hazzan-Bishara, A., Kol, O., & Levy, S. (2025). Factors affecting teachers' AI adoption. *Education and Information Technologies*.
- Karataş, F., & Ataç, B. A. (2025). When TPACK meets AI. *Education and Information Technologies*.
- Khalil, H., & Alsenaidi, S. (2024). Teachers' digital competencies for AI integration. *Journal of Education and E-Learning Research*.
- Lan, G., Feng, X., Du, S., Song, F., & Xiao, Q. (2025). GenAI-TPACK framework. *Education and Information Technologies*.
- Lu, J., Zheng, R., Gong, Z., & Xu, H. (2024). Generative AI and teacher development. *IEEE Transactions on Learning Technologies*.

- Mikeladze, T., Meijer, P., & Verhoeff, R. (2024). AI competence frameworks for educators. *European Journal of Education*.
- Okada, A., Sherborne, T., Panselinas, G., & Kolionis, G. (2025). UNESCO AI competency framework. *International Journal of Artificial Intelligence in Education*.
- Sun, D., Ba, S., Cha, Y., et al. (2026). Generative AI competency framework. *Computers and Education: Artificial Intelligence*.
- Taheri, R., Nazemi, N., Pennington, S., Clark, J., & Dadgostari, F. (2025). Factors influencing educators' AI adoption. *Computers and Education: Artificial Intelligence*.
- Tan, X., Cheng, G., & Ling, M. H. (2025). Mediating role of TPACK in AI competency. *Computers and Education: Artificial Intelligence*.
- Yildirim, B., & Akcan, A. (2024). AI professional development model. *Journal of Education in Science, Environment and Health*.
- Zou, D., Xie, H., & Kohnke, L. (2025). Pedagogic AI competence framework. *European Journal of Education*.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Conflicts of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.



Copyright: © 2026 by the authors. This is a fully open-access article distributed under the terms of the Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0).