EXPLORING LECTURER CORE COMPETENCIES IN ARTIFICIAL INTELLIGENCE: A SYSTEMATIC LITERATURE REVIEW (2023-2025)

Sarmila Marlini Mohd Rufin[1], Hafizul Fahri Hanafi[2]*, Warda Hanani Mohd Noor[3], Siti Sakinah Mohd Yusof[4]

[1]Faculty of Computing and Meta Technology, Universiti Pendidikan Sultan Idris Malaysia
✉ p20241000148@siswa.upsi.edu.my   iD https://orcid.org/0009-0004-7146-8679

[2] Faculty of Computing and Meta Technology, Universiti Pendidikan Sultan Idris Malaysia
✉ hafizul@meta.upsi.edu.my   iD https://orcid.org/0000-0002-3205-0956

[3] Faculty of Computing and Meta Technology, Universiti Pendidikan Sultan Idris Malaysia
✉ p20231000981@siswa.upsi.edu.my   iD https://orcid.org/0000-0002-3013-4320

[4] Faculty of Computing and Meta Technology, Universiti Pendidikan Sultan Idris Malaysia
✉ bm-1621@moe-dl.edu.my   iD https://orcid.org/0000-0002-0658-0769
*Corresponding Author

Article Info:

Abstract:

This study systematically reviews recent literature on lecturer competencies in integrating Artificial Intelligence (AI) within higher education contexts. The review responds to the increasing demand for effective, ethical and pedagogically AI enhanced teaching practices. Using the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) approach, 455 records published between 2023 and 2025 were identified through database Scopus and ERIC. After screening and eligibility assessment, 29 articles met the predefined inclusion criteria and were included in the qualitative synthesis. The review identified three key themes: (1) lecturers' core AI competencies including AI literacy, technological proficiency, pedagogical integration, ethical awareness and continuous professional development; (2) challenges and institutional needs such as limited training opportunities, ethical concerns related to privacy and bias and resource constraints; and (3) AI-based teaching and learning strategies, including project-based learning, gamification, AI-supported assessment and generative AI-assisted tutoring. The findings indicate that while lecturers demonstrate increasing levels of AI literacy, significant gaps remain in ethical readiness, pedagogical application and institutional support. This review provides a theoretically grounded synthesis of current trends and challenges in lecturer AI competency

development, offering evidence-based insights for policymakers and higher education institutions to strengthen professional training frameworks and support sustainable AI adoption in teaching and learning.

Introduction

Since the release of generative Artificial Intelligence (AI) tools in 2023, AI has undergone a rapid transformation in higher education, particularly in programming and computer science education. Platforms such as ChatGPT, Copilot and Gemini have influenced pedagogical practices offering new modes of adaptive learning, real-time feedback and inclusive teaching strategies (Cha et al., 2024). However, these advancements also bring challenges including ethical risks, data privacy issues and lecturers' readiness to adopt AI effectively (Delcker et al., 2024). Lecturers are at the forefront of this transformation. However, many lack structured training to integrate AI competently into teaching (García-Delgado et al., 2024). This review systematically analyses literature published between 2023 and 2025 to consolidate evidence on lecturer AI competencies. The analysis further identifies challenges and needs in AI integration and highlights innovative teaching and learning strategies. The outcomes aim to guide policymakers, institutions and educators in strengthening frameworks for AI competency development and inclusive teaching practices.

Conceptually, this review is anchored in established digital competence and professional competency frameworks, particularly Technological Pedagogical Content Knowledge (TPACK), UNESCO's AI Competency Framework for Teachers and Spencer and Spencer's Competency Theory. These frameworks provide a structured lens to categorize AI competencies into technological, pedagogical, ethical, and professional domains. Grounding the synthesis within these theoretical perspectives enhances conceptual coherence and strengthens the scholarly rigor of this review.

Documents by country or territory
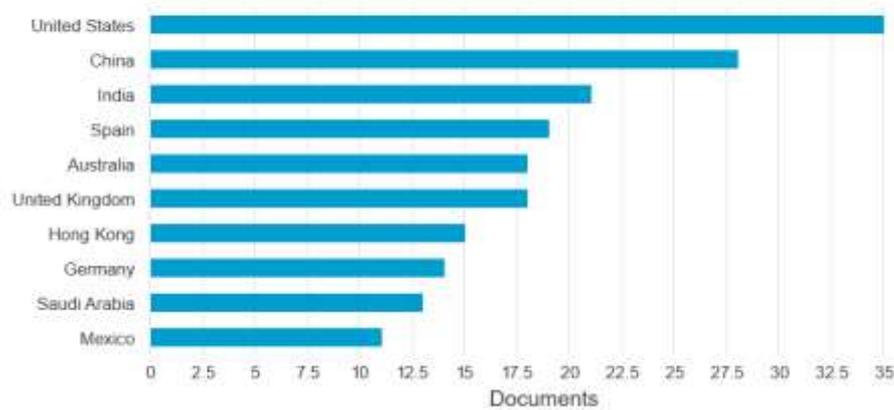Compare the document counts for up to 15 countries/territories.

Figure 1: Documents By Country

Figure 1 illustrates the global distribution of AI competency research in higher education, revealing the dominance of the United States and China as the leading contributors. While several developed countries show moderate research output, contributions from developing countries including Malaysia remain comparatively limited. This imbalance indicates a lack of localized empirical evidence that reflects the unique educational contexts, curriculum structures and pedagogical challenges faced by pre-university institutions such as Malaysia's Matriculation Colleges. Consequently, there is a pressing need for specific studies that focus on developing AI competencies among programming lecturers to support effective teaching and learning in local higher education settings.

Documents by type
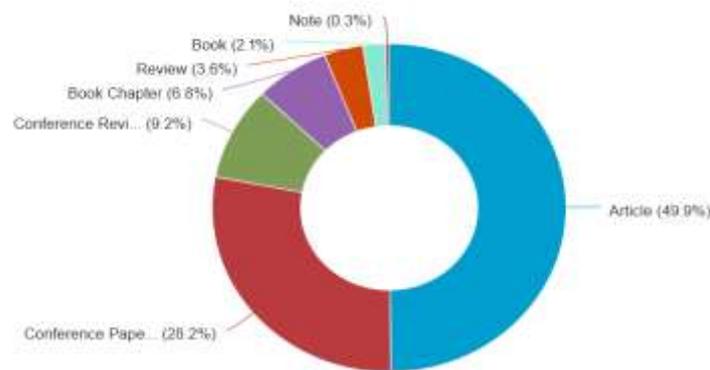
Figure 2: Documents By Type

Figure 2 shows that the majority of documents are articles (49.9%) and conference papers (28.2%), indicating a focus on disseminating primary research and academic discussion. However, the relatively low representation of book chapters (6.8%) and reviews (3.6%) indicates a lack of consolidated theoretical work and comprehensive literature analysis. Conference reviews (9.2%) suggest some level of reflective discussion, but minimal contributions from books (2.1%) and notes (0.3%) point to limited long-form explorations and brief insights, potentially constraining broader conceptual debates and foundational discourse in the field.

Figure 3: Documents By Subject Area

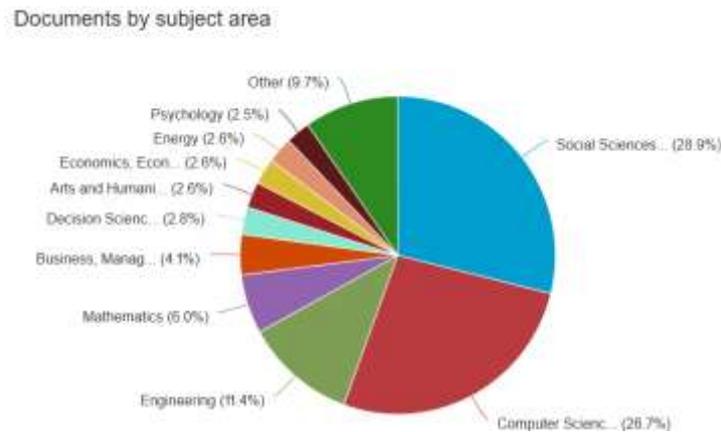Figure 3 illustrates that research is concentrated in Social Sciences (28.9%) and Computer Science (26.7%), reflecting an interdisciplinary focus on AI in education. However, limited representation in fields like Psychology (2.5%) and Arts and Humanities (2.6%) highlights potential gaps in exploring AI's social and cultural impacts. Contributions from Engineering (11.4%) and Mathematics (6.0%) indicate a solid technical foundation. Nonetheless, the low presence of Decision Sciences (2.8%) and Business Management (4.1%) suggests that there are underexplored opportunities in human-AI interaction studies.

Methodology

Identification

Guided by the PRISMA framework, this review implemented a structured search strategy across the Scopus and ERIC databases in September 2025. The search focused on peer-reviewed journal articles published in English between January 2023 and September 2025. The identification process involved three stages. First, relevant keywords were developed using thesauri, dictionaries, encyclopedias, and previous studies. The final keywords included: "Artificial Intelligence," "AI competencies," "skills," "lecturers," "educators," "higher education," "integration," and "teaching strategies." Second, search strings were applied to the two databases (see Table 1). Second, database searching, the Scopus search produced 337 records, while the ERIC search produced 118 records. Finally, the records from both databases were combined, resulting in a total of 455 records, which formed the basis for the subsequent screening process.

Table 1: The Search String

Database	Search String
Scopus **Search Date:** September 2025	TITLE-ABS-KEY (((("Artificial Intelligence" OR "AI") AND ("competencies" OR "skills" OR "proficiency") AND ("programming lecturers" OR "teachers" OR "educators") AND ("matriculation college" OR "pre-university" OR "higher education")) OR (("challenges" OR "barriers" OR "issues")

	AND ("AI integration" OR "adoption of AI" OR "use of Artificial Intelligence") AND ("programming education" OR "teaching programming") AND ("matriculation college" OR "pre-university" OR "higher education")) OR (("teaching strategies" OR "methods" OR "approaches") AND ("AI tools" OR "AI applications" OR "AI technologies") AND ("programming learning" OR "project-based learning" OR "problem-solving") AND ("matriculation college" OR "pre-university" OR "higher education"))))
ERIC **Search Date: September 2025**	(artificial AND intelligence) AND (lecturer OR educator OR teacher) AND (competency OR competencies OR skills) AND (higher education) Literature type: Article https://eric.ed.gov/?q=(+artificial+AND+intelligence+)+AND+(+student+)+AND+(+disabilities+)+pubyearmin%3a2022&ff1=pubJournal+Articles

Screening

Titles and abstracts of the retrieved records were screened to ensure relevance to the review objectives. At this stage, non-English articles, studies published prior to 2021, book chapters, conference proceedings and in-press papers were filtered out. The screening phase subsequently retained 144 records from Scopus and 63 records from ERIC remained, giving a total of 207 records to be assessed in the eligibility phase.

Eligibility

During the eligibility phase, the remaining 207 records underwent further assessment. Following the removal of 25 duplicate entries, 182 full-text articles were examined to determine their suitability for inclusion. A substantial number of studies were subsequently excluded based on predefined criteria, including those that fell outside the research scope (n = 44), lacked sufficient relevance at the title level (n = 40), did not adequately address the study objectives at the abstract stage (n = 44), or were unavailable in full-text form (n = 25). In total, 153 articles were excluded during this phase. As a result, 29 studies fulfilled all inclusion requirements and were retained for qualitative synthesis, as illustrated in Figure 4 and summarised in Table 2. Articles were selected based on predefined inclusion criteria focusing on empirical and conceptual studies addressing lecturer competencies in AI integration within higher education contexts.

Table 2: Inclusion and Exclusion Parameters Applied in the Review Process

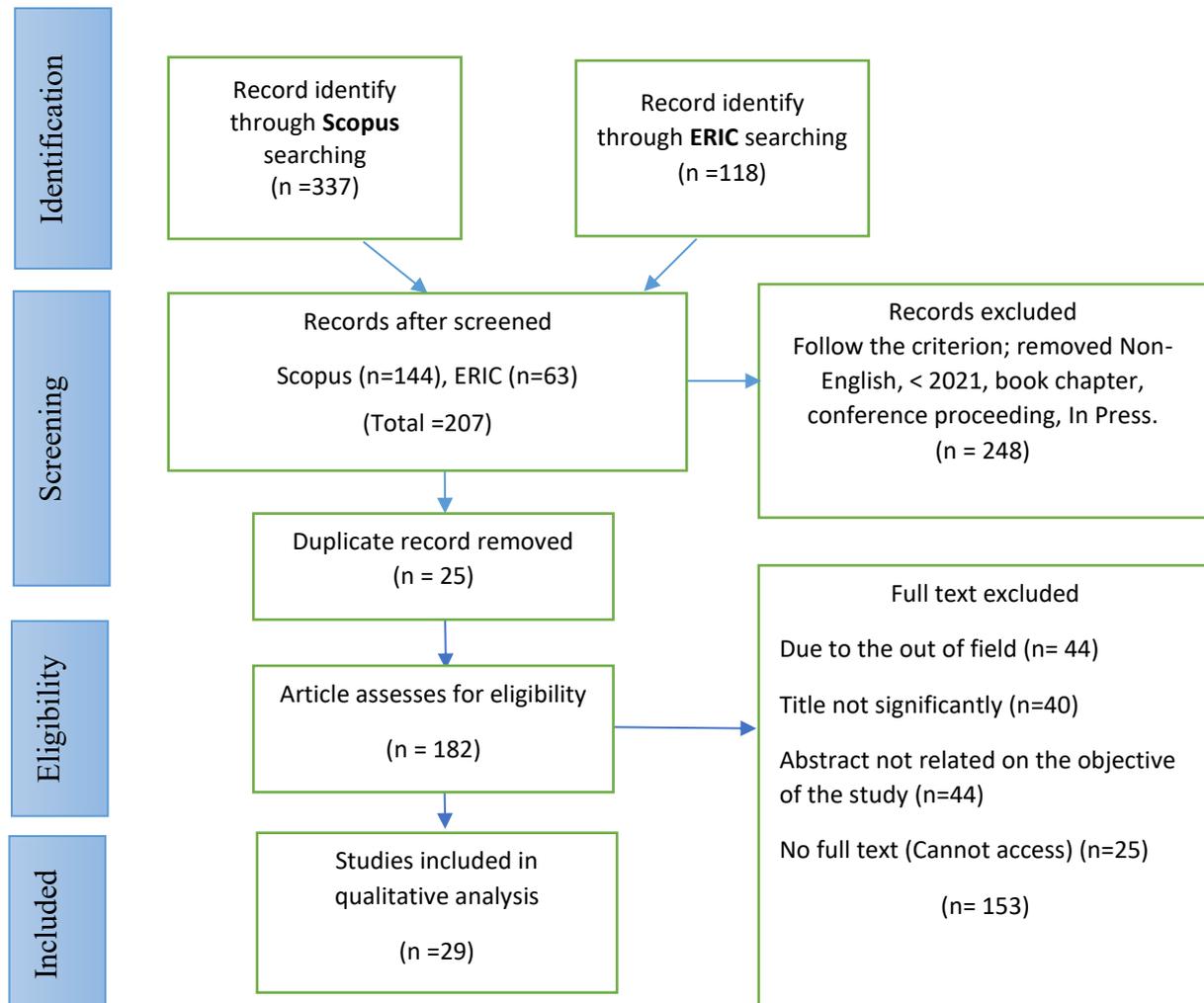| Parameter	Inclusion Criteria	Exclusion Criteria
Language	English	Non-English
Timeline	2023 – 2025	< 2023
Literature type	Journal Article	Conference, Book, review
Publication Stage	Final Published Articles	In Press

Figure 4: Flow Diagram of The Systematic Searching Process (Moher D, Liberati A, Tetzlaff J, 2009)

Data Abstraction and Analysis

Data from the 29 selected studies were synthesized using a thematic analysis approach. This process incorporated evidence from quantitative, qualitative and mixed-method designs. To ensure rigour, relevant information such as research focus, methodology, and major findings was extracted systematically. The authors collaboratively developed themes through iterative coding, comparison, and discussion to resolve discrepancies. An audit trail was systematically

developed to capture key analytical decisions and reflective insights throughout the review process. In addition, two experts in AI education independently examined and refined the emerging themes to enhance their clarity, coherence, and alignment with the study objectives.

Results and Findings

The findings of this systematic review reveal three dominant themes related to AI in higher education teaching: (i) Lecturer Core Competencies in AI (ii) Challenges and Needs in AI-Based Teaching and (iii) Teaching and Learning Strategies supported by AI. These themes reflect consistent patterns across the reviewed studies and illustrate how AI is conceptualized and implemented within higher educational contexts.

Lecturer Core Competencies in AI

The most prominent theme concerns lecturer core competencies in AI, with studies emphasizing that effective AI integration requires multidimensional capabilities. Key domains frequently identified include AI literacy, technological proficiency, pedagogical integration, ethical awareness and continuous professional development. Several studies consistently proposed validated competency frameworks or assessment instruments, indicating a convergence towards structured and evidence-based approaches in evaluating lecturers' AI readiness across different educational contexts. Systematic reviews further confirmed the consistency of these competency domains across diverse educational settings, highlighting the importance of balancing technical skills with ethical and pedagogical considerations. These recurring competency domains indicate a shared understanding of essential AI-related capabilities among lecturers, as summarized in Table 4.

Table 4: Summary of Studies on Lecturer Core Competencies in AI

Authors	Title	Methodology	Major Findings
Delcker et al. (2024)	Evidence-based approach to develop an instrument for measuring teachers' self-perceived competence in artificial intelligence.	Quantitative survey of 480 teachers; instrument validation	Six competency dimensions: literacy, ethics, technical, pedagogy, assessment, and professional development
Cha et al. (2024)	Empowering University Educators to Support Generative AI-enabled Learning: Proposing a Competency Framework	Conceptual framework integrating Technological Pedagogical and Content Knowledge (TPACK) & DigCompEdu	Three competencies: self-empowerment, pedagogical proficiency, student empowerment
García-Delgado et al. (2024)	A competency-based AI training programme to support professional learning among primary school teachers.	Mixed-method; Delphi validation of training program	Structured training improved AI teaching competencies

Authors	Title	Methodology	Major Findings
MacDowell et al. (2024)	Preparing Educators to Teach and Create With Generative Artificial Intelligence	Self-study with 35 lecturers in a multimedia AI-integrated course	Developed the Scaffolded AI Literacy framework for AI literacy
Lu & Liu (2024)	Applied learning strategies, facilitated by university lecturers, in enhancing students' artificial intelligence knowledge.	A narrative review was conducted using the Analyze, Design, Develop, Implement, and Evaluate (ADDIE) instructional model as a guiding framework.	Applied learning enhanced AI knowledge and skills
Shi et al. (2025)	Assessing Teachers' Generative Artificial Intelligence Competencies	Instrument development & validation (T-GAIC) with 600 teachers	Five dimensions: technological proficiency, pedagogical compatibility, student preparation, professional development, ethical awareness
Zhou, T., Tondeur, J., et al. (2025)	AI Competency Frameworks for Teachers: A Systematic Review	Systematic review of 20 frameworks (2015–2024)	Identified five core constructs: cognition, application, ethics, evaluation, and professional development
Tan, X. et al. (2024)	Artificial intelligence in teaching and teacher professional development	Systematic review (2015–2024)	Highlighted trends, barriers, and the importance of institutional support
Chiu, T. K. F. et al. (2025)	Artificial intelligence literacy and competency: definitions, frameworks, and implications	Conceptual study; framework analysis	Clarified AI literacy vs AI competency; proposed integrated frameworks
Mor, Y., et al. (2024)	An Artificial Intelligence Competency Framework for Teachers and Students: Co-created With Teachers	Design-based research, co-created with teachers	Teacher-informed AI competency framework emphasizing collaboration, ethics, and pedagogy

Challenges and Needs in AI-Based Teaching

The second theme addresses challenges and needs in AI-based teaching. The findings indicate that lecturers often face limitations in AI knowledge, pedagogical confidence and institutional support. In addition, conceptual ambiguity between AI literacy and AI competency as well as ethical concerns related to responsible AI use, remains a significant barrier. Consequently,

multiple studies emphasize the need for targeted professional development and structured training programs to strengthen lecturers' AI competencies in AI-based teaching contexts. Collectively, these findings indicate that the challenges faced by lecturers are not isolated but systemic, requiring coordinated efforts at individual, institutional, and policy levels. The studies addressing these challenges and needs are summarized in Table 5.

Table 5: Studies Addressing Challenges and Needs in AI-Based Teaching

Authors	Title	Methodology	Major Findings
Yan, Y., Liu, H., & Chau, T. (2025)	A Systematic Review of AI Ethics in Education: Challenges, Policy Gaps, and Future Directions	Systematic review	Identified key ethical concerns in AI education (privacy, bias, transparency, accountability) and highlighted the policy and practice gaps
Zawacki-Richter, O., Bai, J. Y. H., Lee, K., Slagter van Tryon, P. J., & Prinsloo, P. (2024)	New advances in artificial intelligence applications in higher education?	Review of recent developments	Showed rapid growth of AI in higher education; highlighted ethical issues, infrastructure gaps, and low lecturer readiness
Uygun, D. (2024)	Teachers' perspectives on artificial intelligence in education	Survey (74 teachers)	Teachers saw AI as applicable for personalization and saving time, but worried about privacy, security and ethical issues
Ahmed, J., Soomro, A. K., & Naqvi, S. H. F. (2025)	Barriers to AI adoption in education: Insights from teachers' perspectives	Qualitative study (open-ended survey, thematic analysis)	Lack of training, technical limits, unreliable content, and privacy concerns; risk of overdependence, reducing creativity
Quy, V. K., Thanh, B. T., Chehri, A., Linh, D. M., & Tuan, D. A. (2023)	AI and digital transformation in higher education: Vision and approach of a specific university in Vietnam	Case study (Hung Yen University, Vietnam)	AI supports digital transformation in management and learning, but gaps remain in infrastructure, policy and lecturer skills
Riordan, A., Echeverria, V., Jin, Y., Yan, L., wiecki, Z., Gašević, D., & Martinez-Maldonado, R. (2024)	Human-centred learning analytics and AI in education: A systematic literature review	Systematic review	Limited lecturer involvement in AI learning analytics; need human-centred design and trust
Al-kfairy, M., Mustafa, D.,	Ethical challenges and solutions of	Systematic review	Plagiarism, authenticity, privacy, and bias issues

Kshetri, N., Insiew, M., & Alfandi, O. (2024)	generative AI		need ethical frameworks and policies
Rachbauer, T., Graup, J., & Rutter, E. (2023)	Digital literacy and artificial intelligence literacy in teacher training	Design-based Research with an online survey	Need for institutional support and continuous development

Teaching and Learning Strategies with AI

The third theme focuses on teaching and learning strategies with AI, highlighting the adoption of applied learning, scaffolded instruction, and collaborative design approaches. These strategies were reported to enhance pedagogical relevance and instructional effectiveness. Overall, the findings suggest that lecturer competency development, pedagogical strategy and institutional support must be aligned to enable meaningful and responsible AI integration in higher education. A summary of the reviewed studies is presented in Table 6.

Table 6: Studies Addressing Teaching and Learning Strategies with AI

Authors	Title	Methodology	Major Findings
Schofield, D. & Zhou, X. (2025)	Rethinking Teaching Approaches to Integrating AI in Higher Education	Conceptual framework; case illustrations	Proposed five-step approach for integrating AI tools in pedagogy, focusing on student engagement and critical thinking
Kassenkhan, A. M., Moldagulova, A. N., & Serbin, V. V. (2023)	Gamification and artificial intelligence in education: A review of innovative approaches to fostering critical thinking	Bibliometric & systematic review	AI with gamification boosts motivation, engagement and critical thinking
Saud, D. S. (2025)	Generative AI in English language teaching: Opportunities and challenges	Phenomenological study	Enhanced personalization, practice, and accessibility; challenges in accuracy, ethics, training and cost
Xu, Z. (2024) Groothuijsen, S., van den Beemt, A., Remmers, J.	AI in education: Enhancing learning experiences and student outcomes	Case study (Mathematics classroom, China)	AI improved academic performance, engagement, feedback, and confidence in learning
C., & Van Meeuwen, L. W. (2024)	AI chatbots in programming education: Students' use in a scientific computing course and consequences for learning	Mixed-method case study	Students used ChatGPT for debugging, code generation, and explanations; benefits for learning, but risks of reduced code quality and collaboration
García-Peñalvo, F.	AI-Powered Assessment and Feedback in Higher	Policy and practice analysis	Demonstrated the capacity of artificial intelligence to

(2024)	Education		enhance formative assessment practices and provide timely feedback to learners.
Chiu, T. K. F. et al. (2025)	Pedagogical Implications of AI Literacy Frameworks	Conceptual study	Suggested embedding AI literacy within curricula as a teaching strategy

Discussion

Since 2023, the rapid advancement of generative AI technologies has significantly reshaped teaching and learning practices in higher education. The reviewed literature demonstrates increasing scholarly attention toward defining and measuring lecturer AI competencies. However, despite this growing interest, disparities persist in ethical preparedness, pedagogical alignment and institutional readiness. Anchored in TPACK, UNESCO's AI Competency Framework and Spencer and Spencer's Competency Theory, the identified competency domains reflect the intersection of knowledge, skills, attitudes and professional responsibility. The findings suggest that AI competence extends beyond technical literacy to include ethical judgment, pedagogical adaptability, and reflective professional development. This multidimensional interpretation aligns with contemporary views of digital competence as a dynamic and context-dependent construct.

Furthermore, this review reveals that challenges including limited resources, insufficient institutional readiness, and unresolved ethical dilemmas remain prevalent across educational contexts, aligning with trends reported in recent studies (Holmes et al., 2023; Nouri et al., 2025). At the same time, emerging teaching strategies such as project-based learning, gamification, AI supported assessment, and the use of generative AI tools demonstrate promising potential in enhancing student engagement and learning outcomes. Taken together, the findings indicate that effective integration of artificial intelligence in higher education depends on the alignment of technological capabilities, ethical considerations and innovative pedagogical practices.

Conclusion

This systematic literature review synthesized 29 studies published between 2023 and 2025 to examine lecturer AI competencies, challenges in AI integration and emerging teaching and learning strategies in higher education. The findings indicate that lecturers are increasingly developing core AI related competencies, particularly in literacy, pedagogy and professional development. However, substantial gaps remain in ethical preparedness, institutional support, and structured professional training. Persistent barriers include limited infrastructure, conceptual ambiguity between AI literacy and AI competency, and concerns regarding responsible AI implementation. Conversely, innovative strategies such as project-based learning, gamification, adaptive AI tutoring, and AI-powered assessment demonstrate strong potential to enhance engagement and learning outcomes.

Overall, this review underscores the importance of embedding AI competencies within structured professional development frameworks informed by established competency theories. Sustainable and responsible AI integration in higher education requires alignment between technological capability, ethical governance, pedagogical innovation, and institutional

commitment. These findings highlight the importance of developing structured competency models that support lecturers in integrating AI responsibly and effectively in higher education.

Conflict of Interest Statement:	The authors confirm that no conflicts of interest exist in relation to the publication of this manuscript. All authors contributed to the study and have reviewed and approved the final version submitted to the International Journal of Modern Education (IJMOE).
Ethics Statement:	This study adhered to established ethical research principles and received approval from the Research and Innovation Management Center (Approval No. 2025-0747-01). Prior to data collection, informed consent was obtained from all participants, whose involvement was entirely voluntary. Participants were assured that their responses would remain confidential and anonymous, and that all data collected would be used exclusively for academic purposes.
Author Contribution Statement:	All authors contributed significantly to the development of this manuscript. Sarmila Marlini Mohd Rufin was responsible for the conceptualization, methodology, and overall supervision of the study. Hafizul Fahri Hanafi handled data collection, analysis, and interpretation of results. Warda Hanani Mohd Noor and Siti Sakinah Mohd Yusof contributed to the literature review, drafting, and critical revision of the manuscript. All authors read and approved the final version of the manuscript prior to submission.

References

Ahmed, J., Soomro, A. K., & Naqvi, S. H. F. (2025). Barriers to AI adoption in education: Insights from teachers' perspectives. *International Journal of Innovations in Science and Technology, 7*(1), 411–421. https://doi.org/10.33411/ijist/202571411421

Al-kfairy, M., Mustafa, D., Kshetri, N., Insiew, M., & Alfandi, O. (2024). Ethical challenges and solutions of generative AI: An interdisciplinary perspective. *Informatics, 11*(3), 58. https://doi.org/10.3390/informatics11030058

Cha, Y., Dai, Y., Lin, Z., Liu, A., & Lim, C. P. (2024). Empowering University Educators to Support Generative AI-enabled Learning: Proposing a Competency Framework. *Procedia CIRP*, *128*, 256–261. https://doi.org/10.1016/j.procir.2024.06.021

Chiu, T. K. F., Chen, G., & Wang, Y. (2025). Artificial intelligence literacy and competency: Definitions, frameworks, and implications. *Interactive Learning Environments, 33*(5), 678–695. https://doi.org/10.1080/10494820.2025.2514372

Delcker, J., Heil, J., & Ifenthaler, D. (2024). Evidence-based development of an instrument for the assessment of teachers' self-perceptions of their artificial intelligence competence. *Educational Technology Research and Development*. https://doi.org/10.1007/s11423-024-10418-1

García-Delgado, C., Pinto-Llorente, A.-M., & del-Moral Marcos, M. T. (2024). *Design, Validation, and Implementation of a Competency-Based Training Program on Artificial Intelligence for Primary Education Teachers* (pp. 1396–1403). https://doi.org/10.1007/978-981-97-1814-6_138

Kassenkhan, A. M., Moldagulova, A. N., & Serbin, V. V. (2023). Gamification and artificial intelligence in education: A review of innovative approaches to fostering critical thinking. *Education and Information Technologies, 28*(12), 13745–13766. https://doi.org/10.1007/s10639-023-12115-2

Lu, F., & Liu, S. (2024). Applied learning for developing knowledge on artificial intelligence among students: The role of university lecturers. *International Journal of Knowledge Management (IJKM), 20*(3), 45–61. https://doi.org/10.4018/IJKM.356493

MacDowell, P., Moskalyk, K., Korchinski, K., & Morrison, D. (2024). Preparing Educators to Teach and Create With Generative Artificial Intelligence. *Canadian Journal of Learning and Technology*, *50*(4), 1–23. https://doi.org/10.21432/cjlt28606

Mor, Y., Avital, A., & Blau, I. (2024). An artificial intelligence competency framework for teachers and students: Co-created with teachers. *European Journal of Open, Distance and E-Learning, 27*(1), 1–15. https://doi.org/10.2478/eurodl-2024-0012

Quy, V. K., Thanh, B. T., Chehri, A., Linh, D. M., & Tuan, D. A. (2023). AI and digital transformation in higher education: Vision and approach of a specific university in Vietnam. *Sustainability, 15*(14), 11093. https://doi.org/10.3390/su151411093

Rachbauer, T., Graup, J., & Rutter, E. (2023). Digital literacy and artificial intelligence literacy in teacher training. *Education Sciences, 13*(11), 1107. https://doi.org/10.3390/educsci13111107

Riordan, A., Echeverria, V., Jin, Y., Yan, L., Swiecki, Z., Gašević, D., & Martinez-Maldonado, R. (2024). Human-centred learning analytics and AI in education: A systematic literature review. *Computers and Education: Artificial Intelligence, 5*, 100215. https://doi.org/10.1016/j.caeai.2024.100215

Saud, D. S. (2025). Generative AI in English language teaching: Opportunities and challenges. *Journal of Jayaprithvi Multiple Campus, 1*, 44–59. https://doi.org/10.3126/jjmc2.v1i1.81437

Shi, L., Chen, Y., & Zhang, H. (2025). Assessing teachers' generative artificial intelligence competencies: Instrument development and validation. *Education and Information Technologies, 30*(2), 1123–1140. https://doi.org/10.1007/s10639-025-13684-5

Schofield, L., & Zhou, X. (2025). *Rethinking teaching approaches to integrating AI in teaching and learning. Intelligent Technologies in Education*. Advance online publication. https://doi.org/10.70770/f7239y88

Tan, X., Li, J., & Wang, Y. (2024). Artificial intelligence in teaching and teacher professional development: A systematic review. *Computers and Education: Artificial Intelligence, 5,* 100204. https://doi.org/10.1016/j.caeai.2024.100204

Uygun, D. (2024). Teachers' perspectives on artificial intelligence in education. *Advances in Mobile Learning Educational Research, 4*(1), 931–939. https://doi.org/10.25082/AMLER.2024.01.005

Xu, Z. (2024). AI in education: Enhancing learning experiences and student outcomes. *Proceedings of the 4th International Conference on Signal Processing and Machine Learning* (pp. 104–111). https://doi.org/10.54254/2755-2721/51/2024118

Yan, Y., Liu, H., & Chau, T. (2025). A systematic review of AI ethics in education: Challenges, policy gaps, and future directions. *Journal of Global Information Management, 33*(1), 1–27. https://doi.org/10.4018/JGIM.386381

Zawacki-Richter, O., Bai, J. Y. H., Lee, K., Slagter van Tryon, P. J., & Prinsloo, P. (2024). New advances in artificial intelligence applications in higher education? *International Journal of Educational Technology in Higher Education, 21*(32), 1–4. https://doi.org/10.1186/s41239-024-00464-

Zhou, T., Tondeur, J., & Zhu, C. (2025). AI competency frameworks for teachers: A systematic review. *British Journal of Educational Technology, 56*(1), 99–118. https://doi.org/10.1111/bjet.13556