Available on: https://jmrr.ep-journals.org/ E-ISSN: 3051-3588, P-ISSN: 3051-357X

Journal of Management Research and Review

Volume: 02 Issue: 10 October-2026

University Lecturers' Digital Competence and Training Quality in the Context of Generative Artificial Intelligence: An Integrative Review and Proposed Impact Framework

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Published Date: October 29, 2026 **Article DOI: 10.65150/EP-jmrr/V2E10/2026-09**

ABSTRACT: Generative artificial intelligence (GenAI) is changing how university lecturers design learning environments, provide feedback, and assess students, while raising new risks related to bias, data security, and academic integrity. This study addresses four research questions concerning the components of lecturers' digital competence, the mechanisms through which this competence influences training quality, the contextual conditions that moderate this influence, and a conceptual framework that integrates these relationships. Based on a directed integrative literature review, the study identifies five competence domains: digital pedagogy; technology and data literacy; GenAI competence; digital ethics and safety; and professional learning. These competences influence training quality through six pedagogical mechanisms: learning design, interactive engagement, personalization, feedback, authentic assessment, and scaffolding for self-regulated learning. The study proposes a four-layer impact framework and recommends that higher education institutions organize professional development around authentic teaching tasks, align institutional AI governance with pedagogical goals, and evaluate training quality using evidence of student learning, cognitive engagement, equity, and assessment validity.

KEYWORDS: Digital competence, university lecturers, training quality, generative artificial intelligence, digital pedagogy, authentic assessment.

1. INTRODUCTION

Generative artificial intelligence (GenAI) has become a major driver of digital transformation in higher education. It offers new possibilities for generating learning materials, differentiating questions, providing iterative feedback, and simulating interactive dialogue, while also introducing risks related to inaccurate outputs ("hallucinations"), the reproduction of biases, and the protection of student data (Kasneci et al., 2023; Miao and Holmes, 2023). In this context, university lecturers' digital competence can no longer be understood narrowly as the ability to operate devices or individual software tools. The European Framework for the Digital Competence of Educators (DigCompEdu) describes digital competence as a set of professional competences embedded in teaching, assessment, and learner empowerment (Redecker, 2017). Similarly, the Higher Education Digital Competence (HeDiCom) framework identifies four dimensions specific to higher education: teachers' digital practice, empowering students for a digital society, teachers' digital literacy, and teachers' professional learning (Tondeur et al., 2023).

In the GenAI era, lecturers need the professional judgment to identify appropriate uses, verify AI outputs, protect academic data, and design assessment tasks that capture students' own capabilities. The UNESCO AI Competency Framework for Teachers comprises five dimensions: a human-centered mindset, the ethics of AI, AI foundations and applications, AI pedagogy, and AI for professional development (Miao and Cukurova, 2024). In a systematic review of 56 studies published between 2000 and 2021, Basilotta-Gómez-Pablos et al. (2022) found that most research relied on teachers' self-assessment, that teachers generally rated their digital competence as low or medium-low, and that more practical and personalized training was needed. However, less is known about how lecturers' digital competence is translated into training quality. This study therefore addresses four research questions: (RQ1) What are the core components of lecturers' digital competence in the GenAI context? (RQ2) Through which pedagogical mechanisms does this competence influence training quality? (RQ3) Which contextual conditions moderate this influence? (RQ4) What conceptual framework can integrate these relationships to guide professional development and future empirical research?

2. RESEARCH CONTENT

2.1 Theoretical foundations

In this study, university lecturers' digital competence is defined as the integrated capacity to mobilize knowledge, skills, attitudes, and professional judgment to select, use, and evaluate digital technologies for the purposes of teaching, assessment, collaboration, and professional development. This construct goes beyond operational digital literacy. A lecturer may use a learning management system (LMS) fluently and yet lack the

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pedagogical capacity to design goal-oriented learning activities, organize meaningful peer interaction, or interpret learning analytics to provide differentiated support. Consistent with the synthesis of Basilotta-Gómez-Pablos et al. (2022), lecturers' digital competence is multidimensional, combining technical, informational, communicative, and ethical dimensions with pedagogical requirements for integrating technology into academic practice.

Digital pedagogical competence is the core of this construct. It refers to the ability to align intended learning outcomes, teaching strategies, learning resources, interaction, and assessment. Educational technologies add value only when they support deep cognitive processing, timely formative feedback, and active student engagement; increasing the number of digital platforms does not in itself improve teaching quality.

Lecturers' GenAI competence involves understanding the basic principles and limitations of AI models, identifying pedagogically appropriate uses, formulating effective prompts, verifying outputs against reliable sources, and managing ethical and pedagogical risks. GenAI can generate scenarios, adjust task difficulty, draft preliminary feedback, and support simulations, but its outputs may contain factual errors, reproduce social biases, or obscure the origin of ideas. GenAI competence must therefore include the verification of content, transparency about AI use, the protection of student data, and a commitment to preserving human agency in learning (Miao and Cukurova, 2024; Miao and Holmes, 2023).

In this study, training quality is defined as the extent to which the learning environment enables students to achieve intended learning outcomes, engage in meaningful academic inquiry, receive equitable support, develop self-regulated learning, and be assessed in a valid and transparent manner. Training quality thus extends beyond examination scores or course satisfaction ratings to include cognitive engagement, the student learning experience, equity, the development of self-regulation, and the validity of assessment.

Table 1. Comparison of frameworks and approaches to lecturers' digital competence

Author / organization	Framework / key work	Focus and components	Value for this study	Limitations in the GenAI context
Redecker (2017)	DigCompEdu	6 areas and 22 competences covering educators' professional and pedagogical practice	Clear structure; readily applicable to lecturer training	Does not treat GenAI and large language models as distinct competences
Basilotta-Gómez-Pablos et al. (2022)	Systematic review of teachers' digital competencies in higher education	56 studies (2000–2021); predominance of self-assessment; low to medium-low self-reported competence	Identifies research trends and the need for practical, personalized training	Conducted before the widespread adoption of GenAI in higher education
Tondeur et al. (2023)	HeDiCom framework	4 dimensions: digital practice; empowering students; teachers' digital literacy; professional learning	Developed specifically for higher education	Does not address GenAI risks or AI governance
Miao and Cukurova (2024)	AI Competency Framework for Teachers (UNESCO)	5 dimensions: human-centered mindset, ethics of AI, AI foundations and applications, AI pedagogy, AI for professional development	Explicitly integrates responsible and ethical AI use into pedagogy	A competency standard rather than a model of impact mechanisms

Source: Synthesized by the author.

2.2 Directed integrative review methodology

This study employs a directed integrative literature review, an approach suitable for combining theoretical frameworks, empirical evidence, and policy documents to develop new conceptual models (Whittemore and Knafl, 2005). The review followed five phases: (1) problem formulation; (2) literature search; (3) evaluation of the quality and relevance of sources; (4) deductive and inductive thematic coding; and (5) narrative synthesis and development of the conceptual framework. Selected elements of the PRISMA 2020 statement were applied to increase transparency (Page et al., 2021). However, the review is not a full systematic review, as it did not involve protocol registration, complete records of exclusions at each screening stage, or a formal risk-of-bias assessment.

The literature search covered Scopus, Web of Science, ERIC, Google Scholar, PubMed Central, and the policy repositories of UNESCO, the OECD, and the European Union. Search strings combined the terms "digital competence", "university lecturer", "higher education faculty", "training quality", "student engagement", "learning outcomes", "generative AI", "AI competence", and "AI pedagogy" using Boolean operators. Priority was given to publications from 2018 to 2026, with earlier foundational works included where necessary. Sources were included if they were peer-reviewed journal articles or official reports of international organizations; focused on teaching and learning in higher education; substantively addressed lecturers' digital or AI competence; and had a DOI or a permanent URL. Opinion pieces without peer review, studies limited to the operation of hardware, and sources without identifiable authorship were excluded. The extracted data were organized into four thematic matrices: components of competence, mediating pedagogical mechanisms, indicators of training quality, and contextual moderators and risks.

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2.3 Core components of lecturers' digital competence in the GenAI era

The synthesis identifies five interrelated domains of lecturers' digital competence:

1. Digital pedagogical competence: This domain covers the design of blended learning pathways, the coordination of face-to-face and online learning spaces, the organization of student–student and student–content interaction, and the use of technology for formative assessment. Both DigCompEdu and HeDiCom emphasize that technology should serve as a means of supporting learning rather than as an end in itself (Redecker, 2017; Tondeur et al., 2023).

2. Technology and data literacy: This domain involves selecting tools aligned with course objectives, curating digital learning resources, interpreting learning analytics dashboards, and recognizing the limitations of digital indicators. Login frequency or submission times may signal disengagement, but they do not reflect students' motivation or depth of thinking; such indicators therefore require careful interpretation and triangulation with other evidence.

3. GenAI competence: This domain includes a basic understanding of how large language models (LLMs) work, prompt formulation, output verification, the pedagogically appropriate integration of GenAI, and the assessment of students' own authorship. Kasneci et al. (2023) note that, although LLMs offer considerable potential for differentiated content and interactive dialogue, they also carry persistent risks of bias and inaccurate content. The key competence is therefore not the rapid generation of outputs but the organization of verification processes in which humans remain responsible for the final result.

4. Digital ethics and safety: This domain requires compliance with personal data protection regulations and copyright, transparent communication of the permitted scope of AI use, and attention to the digital divide among students. A complete ban on GenAI is difficult to sustain pedagogically, whereas unrestricted use may undermine learning. Institutional and course-level rules should therefore specify which forms of AI assistance are acceptable for specific learning objectives.

5. Professional learning and digital reflexivity: Given the rapid development of educational technologies, lecturers need to engage in classroom experimentation, evidence collection, peer consultation, and reflective redesign. Basilotta-Gómez-Pablos et al. (2022) indicate that training for lecturers is most effective when it is practical and personalized, which supports a view of professional learning as a continuous, practice-based process.

2.4 Mechanisms linking digital competence to training quality

Lecturers' digital competence does not translate automatically into better training quality. Its effects depend on how lecturers design learning activities, facilitate collaboration, interpret data, provide feedback, and design assessment. In a study of 626 lecturers, Dang et al. (2024) found that all six DigCompEdu dimensions had a positive effect on student learning value. This finding supports the relationship between lecturers' competence and learning outcomes, but it also highlights the need to examine the pedagogical practices through which this relationship operates rather than assuming a direct causal link. The synthesis identifies six such mechanisms.

The first mechanism is learning design. Digitally competent lecturers select teaching modes aligned with learning outcomes, combine multimodal resources, and offer differentiated learning pathways. GenAI can help develop case studies, simulations, and tiered exercises, but lecturers must review AI-generated materials for accuracy, conceptual depth, and appropriateness before using them in class.

The second mechanism is interactive engagement. Asynchronous forums, collaborative digital workspaces, and peer review systems give quieter students additional opportunities to participate. However, interaction metrics such as click counts or numbers of posts do not in themselves capture cognitive engagement. Collaboration becomes meaningful when tasks require students to justify their views, respond to critique, solve complex problems, and construct new knowledge.

The third mechanism is personalization and adaptive support. Using learning analytics and AI responsibly, lecturers can identify students who need timely support and focus teaching time on difficult concepts. However, algorithmic recommendations should not be treated as final judgments; personalized pathways require ongoing interpretation by lecturers, dialogue with students, and human oversight.

The remaining three mechanisms concern feedback, assessment, and self-regulation. Regarding feedback, AI tools can identify common errors, comment on language, and generate preliminary formative observations quickly, but lecturers remain responsible for the accuracy and pedagogical relevance of the feedback that students receive. Regarding authentic assessment, protecting academic integrity in the GenAI era requires a shift toward authentic, process-oriented tasks, such as successive drafts, reflective learning logs, problem-solving portfolios, oral defenses, and critical reflection on students' use of AI. This approach makes use of technology while ensuring that assessment evidence reflects students' actual capabilities. Finally, regarding scaffolding for self-regulated learning, lecturers can build goal setting, self-monitoring prompts, and reflection on AI use into course activities, so that GenAI supports rather than replaces students' own planning and thinking. Table 2 summarizes how the five competence domains operate through these mechanisms.

Table 2. Mechanisms linking lecturers' digital competence to training quality

Competence domain	Typical practice	Mediating mechanism	Expected quality outcomes	Enabling conditions	Risks
Digital pedagogy	Design of blended courses	Alignment of objectives, activities, and assessment	Achievement of learning outcomes; active participation	Clear course design and curriculum standards	Digitizing outdated lecture slides
Technology and data literacy	Learning analytics and progress monitoring	Early identification of learning gaps and timely support	Persistence and self-regulated learning	Accurate, ethical, and transparent dashboards	Climate of surveillance; misinterpretation of metrics

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GenAI competence	Generating scenarios, feedback, and simulations	Differentiated content and scalable support	Richer learning experience; faster feedback	Human verification; transparent disclosure of AI use	Inaccurate content; student dependence on AI
Digital ethics and safety	Student data governance and copyright compliance	An equitable and responsible digital learning culture	Trust, data privacy, and academic fairness	Institutional policies on AI ethics and copyright	Personal data leakage; unequal access to tools
Professional learning	Classroom experimentation and reflection	Continuous evidence-based improvement of teaching	Sustained course quality and pedagogical adaptability	Active peer communities and dedicated time for development	Superficial, trend-driven workshop attendance

Source: Proposed by the author based on the integrative review.

2.5 Proposed conceptual impact framework

Based on the identified competence domains, mediating practices, and contextual conditions, this study proposes a four-layer conceptual framework that explains how lecturers' digital competence is converted into training quality. Rather than treating digital competence as an isolated set of skills, the framework conceptualizes it as a professional input whose educational value is realized only through pedagogical mechanisms. The framework also emphasizes that this conversion is moderated by contextual conditions at the institutional and course levels.

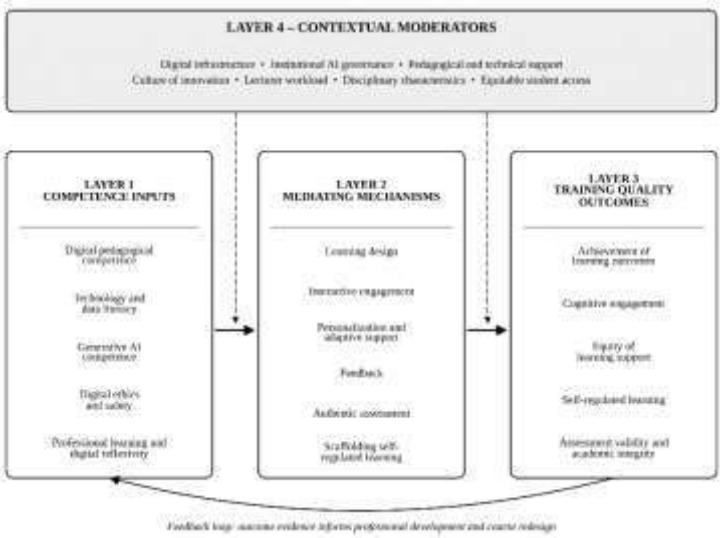


Figure 1. Four-layer framework for converting lecturers' digital competence into training quality
(Source: Proposed by the author based on the integrative review)

The framework operates sequentially from competence inputs through pedagogical mechanisms to quality outcomes. Knowledge of how AI works does not by itself improve training quality; its value is realized only when lecturers use it, for example, to design verified feedback processes or tasks that assess complex thinking. The contextual moderators, namely digital infrastructure, institutional AI governance, pedagogical and technical support, a culture of innovation, lecturer workload, disciplinary characteristics, and equitable student access, influence every transition. Inadequate infrastructure disrupts teaching, unclear policies encourage risk avoidance, and excessive workloads promote unverified reliance on AI. The framework also includes a feedback loop: evidence collected at the outcome layer should inform subsequent professional development and course redesign.

The main theoretical contribution of the framework is that it moves beyond static lists of competences. DigCompEdu, the UNESCO AI Competency Framework for Teachers, and HeDiCom describe what lecturers should be able to do (Miao and Cukurova, 2024; Redecker, 2017; Tondeur et al., 2023), whereas the proposed framework explains how this competence generates educational value and under which conditions. This distinction also cautions against relying solely on self-reported competence: a lecturer may report high confidence in using GenAI, but if the assessment tasks they design encourage students to outsource their thinking, their competence remains insufficient in terms of its effects on learning.

The framework also provides a basis for multi-level empirical research. Competence inputs can be measured through scenario-based assessments and the analysis of course documents; mediating mechanisms through task designs, feedback records, and interaction data; and outcomes through measures of learning achievement, self-regulation, and assessment fairness. Institutional policy, technical support, and infrastructure can be modeled as moderating variables. Longitudinal and quasi-experimental designs would provide stronger evidence than cross-sectional surveys.

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For professional development, the framework implies that training should move away from abstract demonstrations of technology and focus on authentic teaching tasks, such as redesigning course assessment to account for GenAI, developing rubric-aligned prompts for preliminary feedback, or analyzing learning data to support students at risk. Lecturers should test changes on a small scale, collect evidence from students, engage in peer review, and refine their course designs accordingly. Institutions should issue guidelines on AI use for specific tasks, provide approved AI platforms, and define clearly which sensitive data must not be entered into third-party systems. In line with Chan's (2023) AI policy framework, which covers pedagogical, governance, and operational dimensions, individual capacity building should be embedded in institutional governance. This study has several methodological limitations. As a directed integrative review, it does not include a statistical meta-analysis or complete records of the screening process and cannot establish causal effects. In addition, standards of training quality differ across disciplines and accreditation bodies, and GenAI technologies evolve faster than the publication cycle. The proposed framework therefore requires empirical testing and periodic adjustment in different higher education contexts.

3. CONCLUSIONS AND POLICY RECOMMENDATIONS

3.1 Conclusions

This integrative review shows that university lecturers' digital competence in the GenAI era comprises five domains: digital pedagogical competence; technology and data literacy; GenAI competence; digital ethics and safety; and professional learning and digital reflexivity. This competence does not influence training quality directly. Its effects are mediated by pedagogical practices, including learning design, interactive engagement, personalization and adaptive support, feedback, authentic assessment, and scaffolding for self-regulated learning.

The strength of these effects depends on contextual moderators, including the stability of digital infrastructure, institutional AI governance, pedagogical and technical support, a culture of innovation, lecturer workload, disciplinary characteristics, and equitable student access. The study therefore proposes a four-layer conceptual framework linking competence inputs, mediating mechanisms, training quality outcomes, and contextual moderators. The framework clarifies how digital competence generates educational value and provides a basis for targeted professional development and future empirical research.

3.2 Strategic recommendations

3.2.1 For higher education institutions

Higher education institutions should develop digital competence frameworks for lecturers that are linked to their actual professional tasks. Institutional regulations on GenAI should address learning design, testing and assessment, data governance, privacy, and copyright. Investment in digital infrastructure and software should be accompanied by pedagogical advice, technical support, and quality assurance mechanisms. The effectiveness of these measures should be evaluated using evidence of student learning, cognitive engagement, equity, and assessment reliability rather than the number of software licenses or login counts.

3.2.2 For academic departments and professional development units

Units responsible for professional development should organize training around authentic disciplinary content, teaching scenarios, and pedagogical problems. Each development cycle should include collaborative design, classroom piloting, collection of student evidence, peer review, and course refinement. Lecturers should model transparent AI use, verify AI-generated content, and require students to explain the reasoning, methodological choices, and analysis underlying their work.

3.2.3 For educational researchers and policymakers

Researchers and policymakers should develop instruments for assessing competence based on professional scenarios, analysis of course artifacts, and classroom observation. Measures of lecturers' competence should be triangulated with data on student engagement, learning perceptions, and learning outcomes. Future studies should use longitudinal, quasi-experimental, and multilevel structural equation modeling designs to test the pathways proposed in the framework. Throughout this process, AI integration should remain subordinate to human-centered pedagogical goals, educational equity, and academic responsibility.

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