



AI Literacy and Instructional Design Readiness as Predictors of Instructional Innovation among University Faculty in Lahore: A Cross-Sectional Predictive Study

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ARTICLE INFO

Article History:

Received: November 12, 2025
Revised: December 17, 2025
Accepted: January 09, 2026
Available Online: January 30, 2026

Keywords:

AI literacy; instructional design readiness; instructional innovation; university faculty; higher education; Pakistan

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ABSTRACT

The rapid adoption of generative artificial intelligence (AI) in higher education is revolutionizing the planning, teaching and evaluation of learning among university teachers. However, adoption of AI by faculty is quite dissimilar, which raises an applied question to institutions regarding what faculty competencies are the strongest predictors of instructional innovation. This study assessed the hypothesis of the presence of association between AI literacy and instructional design preparedness with instructional innovation among university faculty in Lahore, with a non-experimental cross-sectional study design. The survey data was gathered with 108 members of the faculty in two universities; and standardized measures were used in measuring AI literacy, instructional design readiness, and instructional innovation. Moderate to high levels of all three constructs were found in terms of descriptive results. To address the comparative objective, a hierarchical regression model was estimated. Instructional design readiness alone explained 33.6% of variance in instructional innovation ($R^2 = .336$, $p < .001$). Adding AI literacy increased explained variance to 43.6% ($\Delta R^2 = .100$, $p < .001$). In the final model, AI literacy showed a significant unique association with instructional innovation ($\beta = .69$, $p < .001$), while instructional design readiness was not statistically significant after accounting for AI literacy ($\beta = -.04$, $p = .826$), consistent with substantial overlap between the two competencies ($VIF = 4.80$). The findings suggest that, within this sample, AI literacy may be the more distinctive faculty capacity linked to instructional experimentation in AI-rich teaching environments, while instructional design readiness remains foundational but less discriminating when the competencies overlap. Implications are discussed for targeted faculty development and institutional support for responsible AI-enabled teaching innovation.



Introduction

The ongoing integration of artificial intelligence (AI) technologies into higher education has led to significant changes in teaching, learning, and academic administration. As AI tools become more widely available, faculty members are expected not only to understand these technologies but also to incorporate them meaningfully into instructional practice. However, research suggests that faculty adoption of AI remains uneven and influenced by differences in individual capacities such as digital knowledge, attitudes, and professional readiness (Spathopoulou, 2025).

A central concept in understanding faculty engagement with AI is AI literacy, defined as the set of competencies that enable individuals to understand, effectively use, evaluate, and reflect on AI technologies and their ethical implications in educational contexts (Ng et al., 2021; Al-Abdullatif, 2025). Although still emerging as a field of inquiry, empirical work increasingly highlights that higher AI literacy among educators is linked to greater confidence in technology use and a stronger orientation toward pedagogical innovation (Zhao & Huang, 2025).

In parallel, research on instructional design readiness suggests that faculty who are prepared to plan, organize, and revise instructional content are more likely to implement creative and effective teaching practices (Mishra & Koehler, 2006). At its core, design readiness reflects a professional capacity to transform curricular goals into meaningful learning experiences, an ability that may be amplified, or reshaped, by the affordances of AI tools.

Despite growing interest, there remains limited quantitative evidence examining how AI literacy and instructional design readiness jointly relate to instructional innovation among university faculty. Instructional innovation refers here to the implementation of new or significantly improved teaching methods, strategies, or tools that aim to enhance learning outcomes. While qualitative and mixed-method studies have begun to illuminate faculty experiences with AI, fewer non-experimental quantitative investigations have assessed the relative contribution of these faculty characteristics to innovation outcomes.

This gap is particularly relevant in contexts where higher education institutions are actively promoting AI adoption but lack nuanced data on which faculty capacities most strongly correspond to instructional innovation. The current study addresses this gap by examining whether differences in AI literacy and instructional design readiness are associated with instructional innovation among university faculty in Lahore, Pakistan.

Research Objectives

1. Assess the current level of AI literacy among university faculty in Lahore.
2. Examine the level of instructional design readiness among faculty.
3. Examine the extent to which AI literacy and instructional design readiness are associated with instructional innovation and compare their relative contribution.

Research Questions

1. What are the levels of AI literacy and instructional design readiness among university faculty?
2. To what extent are AI literacy and instructional design readiness associated with instructional innovation among faculty?
3. Which variable shows the stronger unique association with instructional innovation when both are considered together: AI literacy or instructional design readiness?

Literature Review

Artificial Intelligence in Higher Education

Artificial intelligence has increasingly become embedded in higher education through applications such as adaptive learning systems, automated assessment, learning analytics, and generative tools that support content creation and feedback. Recent literature characterizes this shift not as a purely technological transition, but as a pedagogical one that reshapes how instructors design learning experiences and engage with students (Crompton & Burke, 2023). While institutional interest in AI has grown rapidly, faculty adoption remains inconsistent, often depending on individual readiness, competence, and perceived pedagogical value rather than mere availability of tools (Zawacki-Richter et al., 2019).

AI Literacy among University Faculty

AI literacy extends beyond basic technical skills to include the ability to interpret AI outputs, evaluate limitations and biases, and apply AI tools ethically and pedagogically (Ng et al., 2021). In higher education contexts, AI literacy has been linked to educators' confidence, willingness to experiment, and openness to pedagogical change (Long & Magerko, 2020). Quantitative work suggests that greater AI-related competence is associated with higher likelihood of adopting innovative instructional approaches (Zhao & Huang, 2025).

Instructional Design Readiness

Instructional design readiness refers to a faculty member's preparedness to systematically plan, structure, implement, and evaluate instructional experiences. Rooted in instructional design theory and teacher knowledge frameworks such as Technological Pedagogical Content Knowledge (TPACK), design readiness emphasizes alignment between learning objectives, instructional strategies, and assessment (Mishra & Koehler, 2006). Prior research indicates that faculty with stronger instructional design competence are more likely to implement learner-centered, technology-enhanced teaching practices (Koehler et al., 2014).

Instructional Innovation in Higher Education

Instructional innovation is commonly defined as the implementation of new or significantly improved teaching methods, tools, or practices intended to enhance student learning (OECD, 2016). Empirical research identifies faculty characteristics, rather than institutional infrastructure alone, as key determinants of instructional innovation (Kirkwood & Price, 2014).

Relationships among AI Literacy, Instructional Design Readiness, and Instructional Innovation

Existing literature suggests conceptual overlap between AI literacy and instructional design readiness, particularly in technology-enhanced teaching contexts. When related competencies are analyzed together, some predictors may lose unique explanatory power due to shared variance (Koehler et al., 2014). However, empirical studies directly comparing AI literacy and instructional design readiness remain limited, particularly in South Asian higher education contexts. This gap motivates the present study.

Conceptual Framework and Hypotheses

Guided by prior research on faculty competencies, this study positions AI literacy and instructional design readiness as independent variables and instructional innovation as the outcome variable.

These competencies are conceptualized as pre-existing faculty characteristics examined using a non-experimental (ex post facto) approach; therefore, the study does not assert causal effects.

H1: AI literacy is significantly associated with instructional innovation among university faculty.

H2: Instructional design readiness is significantly associated with instructional innovation among university faculty.

H3: When considered together, AI literacy and instructional design readiness explain variance in instructional innovation, with differential unique contribution.

Methodology

Research Design

This study employed a quantitative, non-experimental cross-sectional design (ex post facto) to examine whether differences in university faculty members' AI literacy and instructional design readiness are associated with variations in instructional innovation. This approach is appropriate when variables are naturally occurring and cannot be manipulated experimentally (Creswell & Creswell, 2018).

Population and Sample

The target population consisted of university faculty members teaching undergraduate or postgraduate courses in Lahore, Pakistan. A total of 108 faculty members participated, drawn from two universities using convenience sampling. While convenience sampling limits generalizability, it is frequently used in higher education research under access constraints.

Research Variables

Independent variables: AI literacy, Instructional Design Readiness.

Dependent variable: Instructional Innovation.

Research Instruments

Data were collected using a structured questionnaire comprising three adapted scales. AI literacy was measured with a 37-item scale informed by Ng et al. (2021). Instructional design readiness was measured with a 19-item scale grounded in instructional design theory and the TPACK framework (Mishra & Koehler, 2006). Instructional innovation was measured with a 7-item adapted scale informed by Demir (2024). All items used a five-point Likert response format (1 = strongly disagree to 5 = strongly agree). Scale scores were computed by averaging item responses. Internal consistency in this sample was strong (AI literacy $\alpha = .959$; instructional design readiness $\alpha = .917$; instructional innovation $\alpha = .852$).

Data Collection Procedure

Data were collected through an online survey distributed via institutional communication channels. Participation was voluntary and confidential, and only fully completed questionnaires were analyzed.

Data Analysis

Descriptive statistics (means, standard deviations, and frequencies) were used to summarize participant characteristics and variable distributions. To address the comparative objective, hierarchical multiple regression was conducted to examine the variance in instructional innovation explained by instructional design readiness (Model 1) and the additional variance explained by AI

literacy when added to the model (Model 2). Regression assumptions (normality, linearity, homoscedasticity, and multicollinearity) were examined prior to interpretation (Tabachnick & Fidell, 2019).

Ethical Considerations

Ethical principles of educational research were observed. Participants provided informed consent, responses were anonymized, and data were used solely for academic purposes.

Results

Preliminary Data Screening

Prior to analysis, the dataset was screened for missing values and outliers. All cases contained complete responses, and no problematic univariate outliers were detected.

Descriptive Statistics

Table 1 presents descriptive statistics and reliability for the study variables. Faculty reported moderate levels of AI literacy ($M = 3.58$, $SD = 0.55$) and instructional innovation ($M = 3.60$, $SD = 0.64$), and a high level of instructional design readiness ($M = 3.81$, $SD = 0.48$).

Table 1: Descriptive Statistics and Reliability Coefficients ($N = 108$)

Variable	Items	Mean (M)	Std. Dev. (SD)	Cronbach's α	Level
AI Literacy	37	3.58	0.55	.959	Moderate
ID Readiness	19	3.81	0.48	.917	High
Instructional Innovation	7	3.60	0.64	.852	Moderate

Note. Scale range: 1–5. Mean interpretation: 1.00–2.33 = Low; 2.34–3.66 = Moderate; 3.67–5.00 = High.

Hierarchical Regression Analysis and Relative Strength

To examine the relative contribution of instructional design readiness and AI literacy to instructional innovation, a hierarchical regression model was estimated. In Model 1, instructional design readiness was entered first and explained 33.6% of variance in instructional innovation ($R^2 = .336$, $p < .001$). In Model 2, AI literacy was added and explained an additional 10.0% of variance ($\Delta R^2 = .100$, $p < .001$), bringing total explained variance to 43.6% ($R^2 = .436$). In the final model, AI literacy showed a significant unique association with instructional innovation ($\beta = .69$, $p < .001$), whereas instructional design readiness was not statistically significant after accounting for AI literacy ($\beta = -.04$, $p = .826$). Collinearity diagnostics indicated elevated shared variance between predictors ($VIF = 4.80$), which likely reduced the unique contribution of instructional design readiness.

Table 2: Hierarchical Regression Summary Predicting Instructional Innovation ($N = 108$)

Model	Predictor(s)	R^2	ΔR^2	F	ΔF	p
1	Instructional Design Readiness	.336	—	53.72	—	< .001
2	+ AI Literacy	.436	.100	40.58	18.55	< .001

Note. Dependent variable = Instructional Innovation.

Table 3: Regression Coefficients for Final Model (Model 2) Predicting Instructional Innovation

Predictor	B	SE B	β	t	p	VIF
Constant	0.89	0.38	—	2.33	.022	—
AI Literacy	0.81	0.19	.69	4.31	< .001	4.80
Instructional Design Readiness	-0.05	0.22	-.04	-0.22	.826	4.80

Note. Dependent variable = Instructional Innovation.

Discussion

Overview of Key Findings

This study examined how AI literacy and instructional design readiness relate to instructional innovation among university faculty in Lahore. Faculty reported moderate-to-high levels of the three constructs. When considered together in a hierarchical regression model, instructional design readiness explained a substantial portion of variance in instructional innovation when entered alone; however, adding AI literacy significantly improved model explanatory power, and AI literacy showed the stronger unique association in the final model. The pattern is consistent with substantial overlap between the two competencies.

AI Literacy as a Distinctive Competence for Instructional Innovation

The finding that AI literacy shows a strong unique association with instructional innovation aligns with conceptualizations of AI literacy as an enabling competence that supports educators' ability to understand, evaluate, and apply AI tools responsibly in pedagogically meaningful ways (Ng et al., 2021). In AI-rich teaching environments, faculty who can critically interpret AI outputs, recognize limitations and bias, and select tools appropriately may be more willing to experiment with new instructional approaches (Crompton & Burke, 2023).

Instructional Design Readiness: Foundational but Overlapping

Instructional design readiness explained meaningful variance in instructional innovation when modeled alone, supporting the view that instructors who feel prepared to align objectives, learning activities, and assessments are generally more inclined toward innovative practice (Mishra & Koehler, 2006). However, its unique contribution diminished once AI literacy was included, likely reflecting shared variance between related competencies rather than irrelevance. Such attenuation is common in multivariate models where predictors overlap conceptually and operationally (Koehler et al., 2014).

Contextual Interpretation

The relative salience of AI literacy should be interpreted in light of contextual realities in Lahore and Pakistan's higher education environment, where formal instructional design support structures may be uneven. Under rapid diffusion of generative AI tools, faculty who independently build AI literacy may be more capable of experimenting with AI-enabled teaching practices, even in the absence of systematic design consultation.

Implications

Implications for Higher Education Policy

AI literacy should be treated as a strategic faculty competency rather than a peripheral technical skill. Policy efforts should move beyond infrastructure toward competence-driven digital transformation where AI literacy is embedded in faculty standards and quality enhancement mechanisms (OECD, 2021).

Implications for Institutional Practice

Universities seeking instructional innovation should prioritize structured faculty development that integrates AI literacy with pedagogical and instructional design support. Teaching and learning centers can embed AI literacy into course design consultations rather than offering isolated tool-focused workshops (Crompton & Burke, 2023).

Implications for Faculty Professional Development

Professional development should combine practice-oriented AI literacy with instructional design principles, emphasizing ethical and critical engagement with AI (Ng et al., 2021).

Limitations

To begin with, the non-experimental cross-sectional design does not allow drawing a causal conclusion or sequencing events in time; that is why the results can be interpreted as associative and not causal (Creswell and Creswell, 2018).

Second, the use of self-report measures makes the data prone to the social desirability bias and the common-method variance (Podsakoff et al., 2012).

Thirdly, the sample was also limited to faculty members in Lahore, making it difficult to extrapolate the findings in other geographical areas or institutional settings.

Fourthly, the predictors had very high multicollinearity (VIF= 4.80), which does not contribute to the ability to interpret distinct effects, and the measurement tools may be improved by further differentiating between general design competence and AI-specific instructional capability in future studies.

Lastly, the AI literacy scale had an extraordinarily high internal consistency ($\alpha = .959$), a factor that could indicate redundancy between items and possibly exaggerate shared variance by constructs.

Conclusion

The study examined the correlation between AI literacy, readiness in instructional design, and instructional innovation among the university faculty in Lahore. The mentioned levels of AI literacy and instructional innovation, as well as a high level of instructional design readiness, were reported by faculty participants.

A hierarchical regression analysis was used in accordance with the comparative objective. Incremental predictive validity showed instructional design readiness explained a statistically significant proportion of instructional innovation when by itself; adding AI literacy resulted in statistically significant increase in the proportion of explained variance. Instructional innovation had the best unique relation with AI literacy in the overall model.

Since these two constructs share a similar variance, the results are to be seen as a criticism of their comparative statistical impact but not a conceptual replacement. Practically speaking, such findings provide the impetus to believe that enhancing AI literacy, when paired with specific instructional design assistance, can expedite the process of instructional innovation adoption in the context of AI-driven pedagogy. Future research should use bigger and more heterogeneous samples, as well as improve measurement tools more competently to separate overlapping competencies, and use longitudinal designs to clarify the dynamics over time.

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