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ARTIFICIAL INTELLIGENCE READINESS, TEACHER DIGITAL COMPETENCE, AND STUDENT LEARNING ENGAGEMENT: A MULTIPLE REGRESSION ANALYSIS

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Abstract

The integration of artificial intelligence (AI) into education places new demands on both institutions and teachers, yet little is known about how AI readiness and teacher digital competence jointly shape the extent to which students engage with learning. Drawing on the technology acceptance literature and the digital competence framework for educators, this study examines the effects of AI readiness and teacher digital competence on student learning engagement. A cross-sectional, quantitative survey design was used, and data from 400 respondents were analyzed using descriptive statistics, reliability analysis, Pearson correlation, and multiple regression. All scales demonstrated excellent internal consistency (Cronbach's alpha = .884 to .912; overall scale = .926). The regression model was statistically significant, $F(2, 397) = 156.00$, $p < .001$, and explained 44.0% of the variance in student learning engagement. Both AI readiness ($\beta = .287$, $p < .001$) and teacher digital competence ($\beta = .457$, $p < .001$) were significant positive predictors, with teacher digital competence emerging as the stronger predictor. AI readiness was also strongly correlated with teacher digital competence ($r = .580$), and no multicollinearity concern was detected (VIF = 1.51). All four hypotheses were supported. These findings indicate that technological readiness alone is insufficient: teachers' digital competence is the more powerful correlate of student engagement. Implications for teacher professional development, institutional AI strategy, and future research are discussed.

Introduction

Artificial intelligence is reshaping how teaching and learning are designed, delivered, and assessed. Adaptive tutoring systems, learning analytics, automated feedback, and generative tools are increasingly available to educational institutions, promising more personalized and responsive learning experiences (Chen et al., 2020; Holmes et al., 2019; Luckin et al., 2016). Whether these promises are realized, however, depends less on the availability of technology than on the capacity of educational actors to adopt and use it

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meaningfully (Zawacki-Richter et al., 2019). Two capacities are especially salient: the readiness of institutions and individuals to adopt AI, and the digital competence of the teachers who mediate between technology and students.

AI readiness refers to the extent to which an educational setting and its members possess the awareness, attitudes, knowledge, and infrastructure needed to adopt and use AI productively (Ng et al., 2021; Long & Magerko, 2020). It builds on the long-standing technology acceptance tradition, in which perceived usefulness and ease of use shape willingness to adopt new systems (Davis, 1989; Venkatesh et al., 2003). Teacher digital competence, by contrast, concerns the knowledge, skills, and pedagogical judgment that teachers need to use digital technologies effectively in their professional practice (Redecker, 2017; Mishra & Koehler, 2006). Research consistently indicates that technology adoption in classrooms is determined not only by access but by teachers' competence and beliefs (Ertmer et al., 2012; Tondeur et al., 2017).

Student learning engagement — the behavioral, emotional, and cognitive investment students make in their learning — is widely regarded as a proximal driver of academic success (Fredricks et al., 2004; Carini et al., 2006). Technology-mediated learning environments present both opportunities and risks for engagement, and the evidence suggests that the effect of technology depends on how it is used pedagogically (Henrie et al., 2015; Bond et al., 2020). It is therefore plausible that AI readiness and teacher digital competence jointly influence the degree to which students engage with learning.

Despite this plausibility, empirical evidence that simultaneously examines AI readiness and teacher digital competence as predictors of student learning engagement remains limited. Much of the AI-in-education literature has focused on technical applications and has paid little attention to the role of educators (Zawacki-Richter et al., 2019), while the digital competence literature has rarely incorporated AI-specific readiness (Fernández-Batanero et al., 2022; Instefjord & Munthe, 2017). The relative importance of institutional-level technological readiness versus teacher-level competence therefore remains unclear.

This study addresses this gap by testing a multiple regression model in which AI readiness and teacher digital competence predict student learning engagement, using data from 400 respondents. The study contributes in three ways. First, it provides evidence on the relative contribution of AI readiness and teacher digital competence within a single model. Second, it examines the association between AI readiness and teacher digital competence, clarifying how closely the two capacities are linked. Third, it offers practical guidance for institutions designing AI adoption and teacher development strategies. The remainder of the paper reviews the literature, presents the theoretical and conceptual framework and hypotheses, describes the methodology, reports the results, and discusses implications, limitations, and future directions.

Problem Statement

Educational institutions are investing in AI tools and strategies, often on the assumption that technological readiness will translate into better learning outcomes. Yet technology does not engage students on its own; it is teachers who translate digital tools into learning activities (Ertmer et al., 2012; Tondeur et al., 2017). It remains unclear whether institutional or individual readiness for AI, or the digital competence of teachers, is the stronger correlate of student learning engagement, and how the two relate to one another. Without this clarity, institutions risk allocating resources to AI infrastructure and awareness while under-investing in the teacher competencies that appear essential for converting technology into engaged learning (Zawacki-Richter et al., 2019; Fernández-Batanero et al., 2022). This study addresses the gap by empirically testing the effects of AI readiness and teacher digital competence on student learning engagement among 400 respondents.

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Research Objectives

1. To examine the effect of AI readiness on student learning engagement.
2. To examine the effect of teacher digital competence on student learning engagement.
3. To examine the relationship between AI readiness and teacher digital competence.
4. To determine the relative contribution of AI readiness and teacher digital competence in explaining student learning engagement.
5. To assess the reliability of the measurement scales and the collinearity and diagnostic adequacy of the regression model.

Literature Review

Artificial Intelligence in Education and AI Readiness

Artificial intelligence in education encompasses intelligent tutoring, adaptive learning, automated assessment, and learning analytics, all of which aim to personalize and improve learning (Chen et al., 2020; Luckin et al., 2016). Zawacki-Richter et al. (2019), reviewing AI applications in higher education, concluded that most research is driven by technologists with limited involvement of educators, and called for greater attention to the pedagogical and human dimensions of adoption. Ifenthaler and Yau (2020) similarly showed that analytics-based support improves study success only when it is embedded in sound institutional and pedagogical practice.

AI readiness extends the logic of technology acceptance to this context. Classic models hold that adoption depends on perceived usefulness, perceived ease of use, and facilitating conditions (Davis, 1989; Venkatesh et al., 2003). In the AI context, readiness additionally involves AI literacy — the ability to understand, evaluate, and use AI critically (Long & Magerko, 2020; Ng et al., 2021). Readiness is therefore a multidimensional condition combining attitudes, knowledge, and enabling conditions, and it is generally expected to precede productive use.

Teacher Digital Competence

Teacher digital competence is the set of knowledge, skills, and attitudes that enables educators to use digital technologies effectively for teaching, assessment, and professional engagement. The European DigCompEdu framework operationalizes it across six areas, including digital resources, teaching and learning, assessment, and facilitating learners' digital competence (Redecker, 2017; Ghomi & Redecker, 2019). The technological pedagogical content knowledge (TPACK) framework similarly stresses that effective technology use requires an integrated understanding of technology, pedagogy, and content rather than technical skill alone (Mishra & Koehler, 2006).

Evidence indicates that digital competence is a key determinant of technology integration. Ertmer et al. (2012) found that teacher beliefs and competence strongly shape classroom technology practices, and Tondeur et al. (2017) showed that pedagogical beliefs are closely linked to technology use. Instefjord and Munthe (2017) and Fernández-Batanero et al. (2022) further demonstrated that professional digital competence is built through deliberate development rather than emerging automatically from technology access, reinforcing the importance of teacher-level capacity.

Student Learning Engagement

Student engagement is conceptualized as a multidimensional construct comprising behavioral, emotional, and cognitive components (Fredricks et al., 2004), closely related to the vigor, dedication, and absorption described in the work engagement literature (Schaufeli et al., 2002). Carini et al. (2006) found positive, though modest, links between engagement and learning outcomes, while Kuh (2009) argued that institutions can shape engagement through the educational practices they promote. In technology-mediated settings, Henrie et al. (2015) and Bond et al. (2020) concluded that engagement is influenced by how technology is pedagogically deployed, not by its mere presence.

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Linking AI Readiness, Teacher Digital Competence, and Engagement

Taken together, this literature implies that both AI readiness and teacher digital competence should be positively related to student learning engagement. AI readiness captures the conditions and attitudes that enable AI-supported learning, while teacher digital competence captures the capacity to turn such tools into engaging learning experiences (Ertmer et al., 2012; Redecker, 2017). The two are also expected to be related: readiness, including AI literacy and favorable attitudes, is likely to accompany higher digital competence, because competent teachers are better positioned to understand and adopt emerging tools (Venkatesh et al., 2003; Ng et al., 2021). Because teacher competence operates directly at the point where technology meets students, it is expected to be the stronger correlate of engagement. The present study tests these expectations using multiple regression, which allows the unique contribution of each predictor to be estimated while controlling for the other (Tabachnick & Fidell, 2019).

Theoretical Framework

This study draws on the Technology Acceptance Model (Davis, 1989) and the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003), which explain readiness and willingness to adopt new technologies and thus ground the AI readiness construct. It also draws on the TPACK framework (Mishra & Koehler, 2006) and the DigCompEdu framework (Redecker, 2017), which hold that the educational value of technology depends on teachers' integrated technological and pedagogical competence. Finally, it draws on the student engagement framework of Fredricks et al. (2004), in which engagement is shaped by contextual features of the learning environment, including teaching practices. Integrating these perspectives, AI readiness and teacher digital competence are theorized as complementary contextual conditions that influence student learning engagement, with teacher digital competence expected to exert the more proximal and therefore stronger influence.

Conceptual Framework

The conceptual model positions AI readiness and teacher digital competence as independent variables and student learning engagement as the dependent variable. Both independent variables are expected to influence engagement positively and are expected to be positively associated with one another. The model corresponds to a standard multiple regression with two predictors, in which the unique effect of each predictor on engagement is estimated while controlling for the other, and the association between the predictors is examined through correlation.

Hypotheses

H1: AI Readiness and Student Learning Engagement

AI readiness has a significant positive effect on student learning engagement.

H2: Teacher Digital Competence and Student Learning Engagement

Teacher digital competence has a significant positive effect on student learning engagement.

H3: AI Readiness and Teacher Digital Competence

AI readiness is significantly and positively related to teacher digital competence.

H4: Teacher Digital Competence and Student Learning Engagement (Bivariate Association)

Teacher digital competence is significantly and positively associated with student learning engagement.

Research Methodology

This study employed a quantitative, cross-sectional survey design, appropriate for testing hypothesized associations among perceptual variables measured at a single point in time (Sekaran & Bougie, 2016). Data were collected through a structured, self-administered questionnaire. A total of 400 usable responses were retained for analysis (the regression degrees of freedom of 399 in the ANOVA table

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confirm N = 400), which exceeds commonly cited guidance for survey research (Krejcie & Morgan, 1970) and is ample for a two-predictor regression model (Cohen, 1992; Tabachnick & Fidell, 2019). Three constructs were measured on five-point Likert scales ranging from 1 (strongly disagree) to 5 (strongly agree): AI readiness (6 items), teacher digital competence (7 items), and student learning engagement (6 items), for a total of 19 items. Items were designed to reflect, respectively, the AI readiness and AI literacy literature (Ng et al., 2021; Long & Magerko, 2020), the digital competence of educators framework (Redecker, 2017; Ghomi & Redecker, 2019), and the multidimensional engagement literature (Fredricks et al., 2004; Schaufeli et al., 2002).

Data were analyzed using statistical software. Descriptive statistics, including skewness and kurtosis, were computed to characterize the variables and screen for normality, with absolute skewness below 2 and kurtosis below 7 treated as acceptable (Kline, 2016). Internal consistency was assessed using Cronbach's alpha (Cronbach, 1951), with .70 as the minimum acceptable threshold (Nunnally, 1978). Pearson correlations examined bivariate relationships. Hypotheses were tested using standard multiple regression with student learning engagement as the dependent variable and AI readiness and teacher digital competence as simultaneous predictors. Model adequacy was evaluated using R^2, adjusted R^2, the ANOVA F-test, tolerance and variance inflation factor statistics for collinearity (Field, 2013; Hair et al., 2019), and the Durbin-Watson statistic for independence of residuals (Durbin & Watson, 1951). Effect size was interpreted using Cohen's (1988) conventions. Common method bias was addressed procedurally through respondent anonymity and varied item wording (Podsakoff et al., 2003).

Analyses and Interpretations

Descriptive Statistics

Table 1. Descriptive Statistics of Study Variables (N = 400)

Variable	Mean	SD	Skewness	Kurtosis
AI Readiness	3.42	0.78	-0.32	-0.41
Teacher Digital Competence	3.56	0.74	-0.45	-0.28
Student Learning Engagement	3.48	0.81	-0.38	-0.35

Table 1 reports the descriptive statistics. Teacher digital competence recorded the highest mean (M = 3.56, SD = 0.74), followed by student learning engagement (M = 3.48, SD = 0.81) and AI readiness (M = 3.42, SD = 0.78). All means lie above the scale midpoint, indicating moderately favorable perceptions across constructs, with AI readiness the lowest, suggesting that readiness for AI lags behind teachers' general digital competence. Skewness values ranged from -0.45 to -0.32 and kurtosis values from -0.41 to -0.28, all well within acceptable limits (Kline, 2016), indicating approximately normal distributions suitable for parametric analysis.

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Reliability Analysis

Table 2. Reliability Analysis (Cronbach's Alpha)

Variable	Items	Cronbach's Alpha
AI Readiness	6	0.884
Teacher Digital Competence	7	0.912
Student Learning Engagement	6	0.897
Overall Scale	19	0.926

Table 2 shows that all scales exceeded the .70 threshold (Nunnally, 1978). Alpha ranged from .884 (AI readiness) to .912 (teacher digital competence), and the overall 19-item scale achieved α = .926, indicating excellent internal consistency and confirming that the instruments measured their constructs reliably.

Correlation Analysis

Table 3. Pearson Correlation Matrix

Variables	AI Readiness	Teacher Digital Competence	Student Learning Engagement
AI Readiness	1	.580**	.550**
Teacher Digital Competence	.580**	1	.620**
Student Learning Engagement	.550**	.620**	1

Note. $^{**}p < .01$.

Table 3 shows that all three variables were significantly and positively intercorrelated. AI readiness correlated strongly with teacher digital competence ($r = .580$, $p < .01$) and with student learning engagement ($r = .550$, $p < .01$), and teacher digital competence correlated most strongly with student learning engagement ($r = .620$, $p < .01$). Following Cohen's (1988) conventions, all correlations are large. The correlations among predictors, while substantial, remained below the level that typically signals collinearity problems, which is confirmed in Table 7.

Multiple Regression Analysis

Table 4. Model Summary (Dependent Variable: Student Learning Engagement)

R	R^2	Adjusted R^2	Std. Error of the Estimate
0.663	0.440	0.437	0.608

Table 4 presents the model summary. The two predictors together yielded $R = .663$ and $R^2 = .440$, meaning that AI readiness and teacher digital competence jointly explained 44.0% of the variance in student learning engagement (adjusted $R^2 = .437$). The negligible gap between R^2 and

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adjusted R^2 indicates that the estimate is stable and not inflated by the number of predictors. By Cohen's (1992) conventions, this corresponds to a large effect ($f^2 = .786$).

Table 5. ANOVA

Model	SS	df	MS	F	Sig.
Regression	115.42	2	57.71	156.00	<.001
Residual	146.78	397	.370		
Total	262.20	399			

Table 5 shows that the regression model was statistically significant, $F(2, 397) = 156.00$, $p < .001$. The regression explained 115.42 of the 262.20 total sum of squares, confirming that the predictors, taken together, significantly improve prediction of student learning engagement over the mean alone.

Table 6. Regression Coefficients (Dependent Variable: Student Learning Engagement)

Predictor	B	SE	Beta	t	Sig.
Constant	.842	.171	—	4.924	<.001
AI Readiness	.291	.048	.287	6.063	<.001
Teacher Digital Competence	.492	.052	.457	9.462	<.001

Table 6 presents the regression coefficients. AI readiness was a significant positive predictor of student learning engagement ($B = .291$, $\beta = .287$, $t = 6.063$, $p < .001$): each one-unit increase in AI readiness was associated with a .291-unit increase in engagement, holding teacher digital competence constant. Teacher digital competence was also a significant positive predictor and the stronger of the two ($B = .492$, $\beta = .457$, $t = 9.462$, $p < .001$). Comparing standardized coefficients, the contribution of teacher digital competence was roughly 1.6 times that of AI readiness (.457 versus .287). The two predictors therefore make distinct contributions, but the teacher-level competence is the more influential correlate of engagement.

Collinearity and Model Diagnostics

Table 7. Collinearity Statistics

Predictor	Tolerance	VIF
AI Readiness	.662	1.51
Teacher Digital Competence	.662	1.51

Table 7 shows tolerance values of .662 and VIF values of 1.51 for both predictors. These are far from the conventional problem thresholds of tolerance below .10 or VIF above 5 to 10 (Field, 2013; Hair et al., 2019), indicating that although the predictors are correlated, they are sufficiently

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distinct for their unique effects to be estimated reliably.

Table 8. Model Diagnostics

Statistic	Value
Durbin-Watson	1.92
R	.663
R^2	.440
Adjusted R^2	.437

Table 8 summarizes model diagnostics. The Durbin-Watson statistic of 1.92 lies close to 2, indicating no meaningful autocorrelation among residuals and satisfying the independence-of-errors assumption (Durbin & Watson, 1951). Together with the acceptable collinearity statistics and the approximately normal distributions reported in Table 1, the diagnostics support the validity of the regression estimates.

Hypothesis Testing

Table 9. Summary of Hypothesis Testing

Hypothesis	Relationship	β	t	p	Decision
H1	AI Readiness → Student Learning Engagement	.287	6.063	<.001	Supported
H2	Teacher Digital Competence → Student Learning Engagement	.457	9.462	<.001	Supported
H3	AI Readiness → Teacher Digital Competence	.580	—	<.001	Supported
H4	Teacher Digital Competence → Student Learning Engagement	.620	—	<.001	Supported

Note. For H1 and H2, β is the standardized regression coefficient from Table 6. For H3 and H4, the coefficient reported is the bivariate Pearson correlation from Table 3.

Table 9 summarizes the hypothesis tests. H1 was supported: AI readiness positively predicted student learning engagement ($\beta = .287$, $p < .001$). H2 was supported: teacher digital competence positively predicted student learning engagement ($\beta = .457$, $p < .001$). H3 was supported: AI readiness was strongly and positively related to teacher digital competence ($r = .580$, $p < .001$). H4 was supported: teacher digital competence was strongly associated with student learning engagement at the bivariate level ($r = .620$, $p < .001$). H2 and H4 address the same relationship at different levels of analysis; the bivariate association (.620) is larger than the standardized regression coefficient (.457) because the latter removes the variance that teacher digital competence shares with AI readiness. All four hypotheses were therefore supported.

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Discussion

The results provide strong support for the proposition that both AI readiness and teacher digital competence are positively related to student learning engagement. Together they explained 44.0% of its variance, a large effect that indicates the two capacities are substantively important correlates of how engaged students are. This is consistent with research showing that technology's contribution to engagement depends on the conditions and practices surrounding its use (Henrie et al., 2015; Bond et al., 2020; Fredricks et al., 2004).

The finding that AI readiness significantly predicts engagement (β = .287) is consistent with technology acceptance theory (Davis, 1989; Venkatesh et al., 2003), which holds that favorable attitudes, knowledge, and enabling conditions are prerequisites for effective use, and with the AI literacy literature emphasizing the importance of understanding and critically using AI (Ng et al., 2021; Long & Magerko, 2020). Settings that are better prepared for AI appear to provide learning experiences that students find more engaging, in line with the argument that adoption readiness precedes productive use (Zawacki-Richter et al., 2019).

Teacher digital competence was the stronger predictor (β = .457), exceeding the contribution of AI readiness by a substantial margin. This aligns with the TPACK and DigCompEdu perspectives, which emphasize that the pedagogical value of technology is realized through teachers' integrated competence (Mishra & Koehler, 2006; Redecker, 2017), and with evidence that teacher competence and beliefs are central determinants of technology integration (Ertmer et al., 2012; Tondeur et al., 2017). It also supports the conclusion of Zawacki-Richter et al. (2019) that educators, not technology alone, are decisive. In practical terms, readiness for AI without corresponding teacher competence is unlikely to yield equivalent gains in engagement.

The strong association between AI readiness and teacher digital competence (r = .580) suggests that the two capacities develop together: teachers who are digitally competent are more likely to be, or to work in settings that are, ready for AI. Because the study is cross-sectional, this association should not be read as evidence of direction. The overlap between the predictors also explains why the standardized coefficient for teacher digital competence (.457) is lower than its bivariate correlation with engagement (.620); part of its apparent influence is shared with AI readiness. Because collinearity statistics were acceptable (VIF = 1.51) and diagnostics were satisfactory (Durbin-Watson = 1.92), the unique effects reported are interpretable. Together with the excellent reliability of the scales (α = .884 to .912), these results lend confidence to the conclusions.

Conclusion

This study examined the effects of AI readiness and teacher digital competence on student learning engagement using multiple regression on data from 400 respondents. The model was significant and explained 44.0% of the variance in engagement. Both AI readiness and teacher digital competence were significant positive predictors, with teacher digital competence the stronger, and the two were strongly related to each other. All four hypotheses were supported. The findings indicate that institutional and individual readiness for AI matters for student engagement, but that the digital competence of teachers is the more powerful correlate, because teachers are the point at which technology is converted into learning experiences. Educational institutions seeking to benefit from AI should therefore treat teacher development and technological readiness as complementary investments rather than substitutes.

Recommendations

Institutions adopting AI should pair investments in AI infrastructure and awareness with sustained teacher professional development, since teacher digital competence emerged as the stronger correlate of student engagement (Redecker, 2017;

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Fernández-Batanero et al., 2022). Professional development should be pedagogically grounded rather than purely technical, reflecting the integrated knowledge described in the TPACK framework (Mishra & Koehler, 2006). Institutions should also build AI literacy among staff and students through training and clear guidance, given the significant contribution of AI readiness (Ng et al., 2021; Long & Magerko, 2020). Because AI readiness and teacher competence are strongly related, development programs should address them jointly, and institutions should monitor both through regular assessment. Policymakers should support teacher training pathways and resources so that readiness initiatives are matched by educator capacity.

Limitations

This study has several limitations. The cross-sectional design precludes causal conclusions, and the direction of the relationships, particularly between AI readiness and teacher digital competence, cannot be established. All data were self-reported from a single source, raising the possibility of common method bias (Podsakoff et al., 2003). The model included only two predictors and explained 44.0% of the variance, leaving 56.0% unexplained by other factors such as pedagogy, motivation, or institutional support. Finally, the sample may not generalize to other educational levels, institutions, or cultural contexts. Longitudinal and multi-source designs, and models that test whether teacher digital competence mediates the effect of AI readiness, would strengthen future research.

Significance of the Study

This study contributes to the literature on AI in education by showing, within a single model, that teacher digital competence is a stronger correlate of student learning engagement than AI readiness, thereby foregrounding the role of educators in an area often dominated by technological perspectives (Zawacki-Richter et al., 2019). Practically, it offers evidence to guide institutional leaders and policymakers in balancing investments in AI readiness with teacher development, and it provides a reliable measurement and analytic template that future studies can replicate and extend.

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