Digital Readiness Without Digital Infrastructure: Unpacking the Paradox of E-Learning Acceptance Among Primary School Teachers in Pakistan

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Abstract
This study examined the challenges and determinants of e-learning acceptance among primary school teachers in Bahawalpur Tehsil, Punjab, Pakistan, while also capturing student perspectives on digital engagement and online learning challenges. A cross-sectional survey design was employed with a near-census sample of 130 teachers (97.7% of the population) and 400 students from public primary schools. Structured questionnaires assessed digital readiness, perceived usefulness, institutional support, infrastructure readiness, e-learning acceptance, student digital engagement, technical competency, and online challenges. Data were analysed using exploratory factor analysis, correlation, and multiple regression. Results revealed a striking discrepancy: teachers reported very high digital readiness ($M = 4.89$) and e-learning acceptance ($M = 4.93$), yet infrastructure readiness was rated extremely low ($M = 1.03$). Digital readiness emerged as the strongest predictor of e-learning acceptance ($\beta = 0.36$, $p < .001$), while institutional support and infrastructure readiness did not significantly predict acceptance. Student engagement was high, but challenges related to attention, fatigue, and device limitations were prevalent. The urban–rural gap in teacher readiness was not statistically significant, though rural teachers showed greater variability. These findings underscore that in resource-constrained settings, teachers' individual digital competence is the primary driver of e-learning adoption. Policy efforts should prioritise sustained, practice-based professional development alongside infrastructural improvements to enable sustainable technology integration at the primary level.

Keywords: e-learning, digital readiness, technology acceptance, primary education, infrastructure, Pakistan

Introduction

The integration of information and communication technology (ICT) into education has become a global priority, with e-learning systems promising to enhance pedagogical quality, access, and learner engagement (Davis, 1989; Venkatesh et al., 2003). Developing countries, however, face unique challenges in translating policy aspirations into classroom practice. In Pakistan, successive national education policies have emphasised ICT integration, yet implementation remains inconsistent, particularly in public primary schools where infrastructural, human, and institutional constraints converge (Ahmad et al., 2024; Ismail et al., 2020). Teachers' ability and willingness to adopt e-learning are central to successful technology integration, and a growing body of research underscores the importance of digital readiness, perceived usefulness, and institutional support as key determinants (Gui et al., 2026; Harsanti et al., 2025).

Digital readiness—the combination of technical competence, confidence, and access to digital tools—is widely recognised as a prerequisite for effective e-learning adoption. Studies from diverse educational contexts demonstrate that teachers who possess stronger digital skills and feel prepared to use technology are significantly more likely to incorporate it into their teaching (Azimkhan et al., 2025; Kiran et al., 2025). Conversely, deficits in digital preparedness can undermine even well-resourced initiatives (Rawal, 2024). In the Pakistani primary education system, research has documented significant gaps in teachers' technological pedagogical knowledge and inconsistent access to professional development, which hinder digital integration (Ghayyur & Mirza, 2021; Jamil et al., 2024).

Equally critical is the role of institutional support, which encompasses technical assistance, administrative encouragement, and the provision of training opportunities. Teachers who perceive their institutions as supportive are more inclined to experiment with digital tools and persevere through technical difficulties (Mardiana, 2025; Sihombing et al., 2025). However, in many Pakistani public schools, such support structures are either absent or insufficiently resourced, leaving teachers to navigate e-learning challenges largely on their own (Asad et al., 2021; Qazi et al., 2016).

Infrastructure readiness—the availability of reliable internet, functional devices, and appropriate digital platforms—constitutes the third pillar of e-learning adoption. Inadequate infrastructure remains one of the most frequently cited barriers to technology integration in developing countries (Khan et al., 2021). Within Pakistan, irregular electricity supply, limited internet connectivity, and a shortage of devices continue to impede the sustained use of e-learning in government schools (Irshad et al., 2025; Shah et al., 2026). These infrastructural deficits are particularly acute in rural areas, where a substantial proportion of primary schools are located.

While much of the existing research has examined these factors in secondary or higher education settings (Ling et al., 2025; Tun, 2025), relatively few studies have simultaneously assessed the influence of digital readiness, institutional support, and infrastructure readiness on e-learning acceptance among primary school teachers, especially in the rural-urban context of Punjab, Pakistan. Moreover, student perspectives on e-learning engagement and the challenges they face remain under-explored at the primary level (Zin & Osman, 2025). Given the near-universal enrolment in primary education and the formative role of early digital experiences, understanding both teacher and student viewpoints is essential for designing effective e-learning strategies.

The present study addresses this gap by surveying 130 teachers (representing nearly the entire population of primary school teachers in Bahawalpur Tehsil) and 400 students regarding their digital readiness, perceived usefulness, institutional support, infrastructure readiness, and e-learning acceptance. Grounded in the Technology Acceptance Model (Davis, 1989) and informed by contemporary research on digital competence (Gui et al., 2026), this study examines the following research questions: (1) What are the current levels of teacher and student perceptions across key e-learning constructs? (2) Which factors most strongly predict teacher e-learning acceptance? By integrating teacher and student data, the study provides a holistic view of the challenges and enablers of e-learning integration at the primary level, with implications for policy and professional development.

What distinguishes this study is its simultaneous integration of teacher digital readiness, institutional support, infrastructure constraints, and student perspectives within a near-complete enumeration of public primary teachers in a rural–urban Tehsil—a design seldom employed in e-learning acceptance research in Pakistan. Unlike earlier work that has predominantly examined secondary or higher education, or has looked at teachers and students in isolation, this investigation captures the interplay between individual digital competence and systemic resource gaps at the primary foundation stage, thereby offering a more complete account of the acceptance paradox.

Methodology

Research Design

This study employed a quantitative, cross-sectional survey design to investigate the challenges and determinants of e-learning integration in the primary education system of Bahawalpur Tehsil, Punjab, Pakistan. A structured questionnaire was administered to teachers and students to capture perceptions across multiple latent constructs, including digital readiness, perceived usefulness, institutional support, infrastructure readiness, e-learning acceptance, digital engagement, technical competency, and online challenges.

Source of Data and Instrumentation

The primary data source was a self-administered questionnaire developed after an extensive review of the literature on technology acceptance models and e-learning barriers in developing countries (Davis, 1989; Khan et al., 2021; Venkatesh et al., 2003). The instrument was further refined through consultations with five experienced primary school teachers and three parents of primary-level students to ensure cultural relevance and comprehensibility.

The final questionnaire comprised two sections:

- **Demographic information**: participant type (teacher/student), age, gender, school locality (urban/rural), teaching experience (teachers only), and grade level (students only).
- **Likert-scale items**: 20 items for teachers and 15 items for students, each rated on a five-point scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree).

Teacher items were grouped into five theoretically derived constructs based on a modified Technology Acceptance Model (TAM) and prior research on e-learning barriers: *Digital Readiness* (6 items), *Perceived Usefulness* (5 items), *E-learning Acceptance* (3 items), *Institutional Support* (2 items), and *Infrastructure Readiness* (7 items). Student items formed three constructs: *Digital Engagement* (7 items), *Technical Competency* (4 items, later split into technical skills, teacher support, and self-management), and *Online Challenges* (5 items). Items within the Infrastructure Readiness and Online Challenges constructs were negatively phrased to capture perceived barriers; these were reverse-coded during analysis so that higher scores consistently indicate more favourable perceptions or lower barriers. The complete item mapping is presented in Table 1.

Table 1: Questionnaire constructs and corresponding items

Construct	Items	Description
Teacher Scales		
Digital Readiness	T1, T2, T3, T7, T8, T19	Access, skills, and confidence in using digital tools
Perceived Usefulness / Acceptance	T5, T6, T9, T17, T18	Belief in e-learning benefits and willingness to adopt it
Acceptance subscale	T5, T17, T18	Three items used as the dependent variable in regression analysis
Institutional Support	T4, T20	Technical and administrative support received
Infrastructure Readiness (R)	T10–T16	Perceived adequacy of devices, internet, training, and platforms
Student Scales		
Digital Engagement	S1, S2, S4, S6, S8, S14, S15	Enjoyment and perceived value of e-learning
Technical Competency (split)		

Technical Ability	S3, S7	Ease of using apps, videos, and downloading materials
Teacher Support	S4	Single item: teacher explains clearly
Self-Management	S5	Single item: finishes homework on time
Online Challenges (R)	S9–S13	Difficulties with attention, instructions, battery, fatigue

Note: (R) = reverse-coded. The *Perceived Usefulness / Acceptance* factor emerged as a single latent dimension in EFA; for regression purposes, the three-item acceptance subscale was used as the outcome variable. Student Technical Competency was analysed as separate facets after reliability analysis.

Population and Sampling

The target population comprised all teachers and students in public primary schools of Bahawalpur Tehsil. According to official enrolment records for the year 2025, the teacher population was 133 (male and female teachers across 13 primary schools), and the student population was 878 (481 girls and 397 boys enrolled in primary grades). Given the manageable size of the teacher population, a census approach was adopted for teachers: all 133 were invited to participate, and 130 returned completed questionnaires, yielding a response rate of 97.7%. For students, a stratified random sampling technique was used, with school locality (urban/rural) as the stratification variable to ensure proportional representation. From the total student population of 878, 400 students were selected, reflecting a sampling fraction of approximately 45.6%. All 13 public primary schools in Bahawalpur Tehsil were included. Student enrolment lists were obtained from each school, and within each locality stratum (urban/rural), participants were randomly selected proportionally to the school's student population, yielding a final sample that matched the overall urban–rural distribution of the government primary schools in the Tehsil. This sample size was deemed adequate for the planned factor analyses and group comparisons based on the rule of thumb of 10–20 observations per item (Hair et al., 2010). The final sample (n = 530) consisted of 130 teachers and 400 students. Detailed demographic characteristics are presented in the Results chapter (Table 1). The teacher sample covered 97.7% of the entire teacher population of the Tehsil, lending substantial representativeness to the findings. The student sample achieved a 66.2% rural and 33.8% urban distribution, mirroring the actual locality profile of government schools in the region.

Data Collection Procedure

Formal permission was obtained from the office of the District Education Officer (DEO) Bahawalpur before commencing the study. School principals were then contacted to arrange data collection. Questionnaires were administered both electronically (via Google Forms) and in paper format, depending on internet availability at the school. For schools with limited connectivity, printed questionnaires were delivered and collected in person.

Teachers completed the questionnaire independently. For students, particularly those in Grades 1–3, teachers or research assistants read the questions aloud and explained the meaning without influencing responses. Parents/guardians provided informed consent for all student participants. Participants were briefed about the voluntary nature of the study, the confidentiality of their responses, and their right to withdraw at any stage. Data collection spanned six weeks to accommodate the school schedules and ensure maximum participation.

Data Analysis

Data were entered and verified in Microsoft Excel before being imported into R (version 4.3.1) and SPSS (version 26) for analysis. The analysis proceeded in several stages.

First, data screening and cleaning were performed. No missing values were present because the online form required all items to be completed, and paper forms were checked for completeness at the time of collection. Negatively worded items were reverse-coded (6 – original score). Composite scores for each construct were computed as the mean of the constituent items, yielding continuous variables for all latent dimensions.

Second, psychometric properties of the instruments were examined. Internal consistency was assessed using Cronbach's alpha, with values ≥ 0.70 considered acceptable. The Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity were used to evaluate the factorability of the correlation matrices. Exploratory factor analysis (EFA) with principal axis factoring and oblimin rotation was performed on the teacher items to verify the hypothesised factor structure, as the sample of 130 teachers was deemed adequate for a 20-item scale (ratio > 6:1). For student items, a similar EFA was conducted to confirm the three-factor engagement–competency–challenges model.

Third, descriptive statistics (means, standard deviations, percentages) were calculated for all demographic variables and constructs. Group comparisons between urban and rural teachers were made using independent-samples t-tests; effect sizes were reported as Cohen's d. Pearson correlation coefficients were computed to examine bivariate relationships among the teacher and student constructs.

Fourth, a multiple linear regression model was fitted to identify predictors of teacher e-learning acceptance. The predictor set included digital readiness, institutional support, infrastructure readiness, teaching experience (years), and school locality (urban coded as 1, rural as 0). Assumptions of linearity, homoscedasticity, and normality of residuals were checked via residual plots and the Shapiro-Wilk test; no serious violations were detected. Standardised regression coefficients (β) are reported to facilitate comparisons of predictor strength.

The conceptual framework guiding the analysis is depicted in Figure 1. The model posits that digital readiness (H1), institutional support (H2), and infrastructure readiness (H3) positively influence e-learning acceptance, with the regression analysis serving as the direct test of these hypotheses.

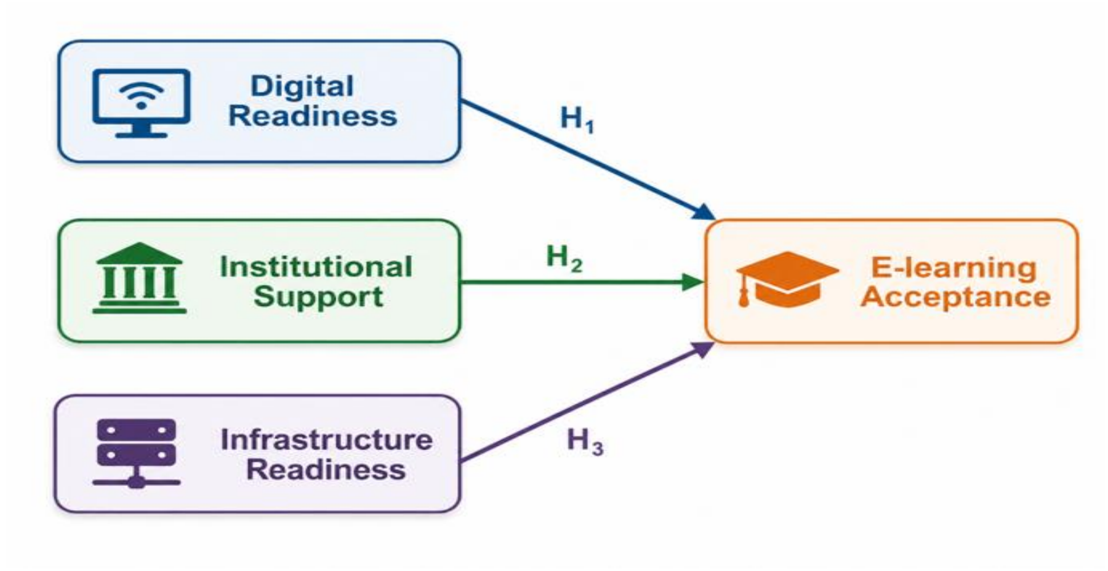

Figure 1 *Conceptual framework of factors influencing teacher e-learning acceptance.*
Note: H1, H2, and H3 denote hypothesised positive paths from digital readiness, institutional support, and infrastructure readiness to e-learning acceptance, respectively.

Results

Demographic Characteristics

A total of 530 participants were included in the study, comprising 130 teachers (24.5%) and 400 students (75.5%). The gender distribution was nearly balanced, with 48.7% female and 51.3% male respondents. School locality was predominantly rural (66.2%), consistent with the government primary school landscape of Bahawalpur Tehsil, while 33.8% of participants were from urban settings. Full demographic details are presented in Table 2.

Table 2. Demographic characteristics of the sample

Variable	Category	n	Percentage
Participant Type	Student	400	75.5%
	Teacher	130	24.5%
Gender	Female	258	48.7%
	Male	272	51.3%
School Locality	Rural	351	66.2%
	Urban	179	33.8%

Psychometric Properties of the Instrument

Construct Reliability and Descriptive Statistics

Both teacher and student scales demonstrated satisfactory to very good internal consistency, as evidenced by Cronbach's alpha coefficients. Table 3 summarises the descriptive statistics and reliability estimates for all latent constructs. Teacher constructs showed mean scores ranging from 1.03 (*Infrastructure Readiness*, indicating very low perceived adequacy of technological infrastructure) to 4.93 (*E-learning Acceptance*), reflecting strong acceptance attitudes. Student constructs were similarly positive, with *Digital Engagement* and *Technical Ability* both above 4.90, while *Positive Experience* (reverse-coded challenges) remained low (M = 1.02).

Cronbach's alpha values for teacher scales were generally robust: *Digital Readiness* (α = 0.802), *Infrastructure Readiness* (α = 0.770), and *Institutional Support* (α = 0.802). The *Perceived Usefulness* (α = 0.566) and *E-learning Acceptance* (α = 0.382) scales had lower internal consistency, likely due to the small number of items and the need for further refinement. The low alpha for the three-item acceptance scale reflects its brevity and the restricted variance (M = 4.93, SD = 0.20); however, the items were retained because they are grounded in the TAM framework and the exploratory factor analysis supported a single factor for perceived usefulness/acceptance. Among student scales, *Digital Engagement* (α = 0.780) and *Positive Experience* (α = 0.702) reached acceptable thresholds, whereas *Technical Ability* (α = 0.570) fell below the ideal 0.70 level, suggesting that the items measuring this construct may capture distinct facets of student competency rather than a unidimensional trait.

Table 3 Descriptive statistics and reliability of latent constructs

Construct	Items (n)	Mean	SD	Cronbach's α
Teacher scales				
Digital Readiness	6	4.892	0.275	0.802
Perceived Usefulness	5	4.890	0.289	0.566
E-learning Acceptance	3	4.928	0.203	0.382
Institutional Support	2	4.877	0.369	0.802
Infrastructure Readiness	7	1.027	0.126	0.770
Student scales				
Digital Engagement	7	4.908	0.230	0.780
Technical Ability	4	4.907	0.233	0.570
Positive Experience	5	1.015	0.085	0.702

Note: All constructs are scored on a 1–5 Likert scale; higher scores indicate greater endorsement. Student Positive Experience reflects reverse-coded challenge items (higher score = better experience).

Sampling Adequacy and Factor Structure

The suitability of the correlation matrices for exploratory factor analysis (EFA) was confirmed through the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity (Table 4). The KMO value for the teacher questionnaire (0.667) was above the acceptable threshold of 0.60, and Bartlett's test was significant ($\chi^2 = 1{,}226.29$, $p < 0.001$). The student questionnaire demonstrated good sampling adequacy (KMO = 0.770) with a highly significant Bartlett's test ($\chi^2 = 1{,}501.86$, $p < 0.001$).

Table 4 KMO and Bartlett's test results

Scale	KMO	χ^2	p
Teacher questionnaire	0.667	1,226.29	<0.001
Student questionnaire	0.770	1,501.86	<0.001

A principal axis factor analysis with oblimin rotation was performed on the 20 teacher items, extracting four factors with eigenvalues > 1.0 that explained 58.2% of the total variance. The rotated factor loadings are presented in Table 5. The solution clearly aligned with the hypothesised measurement model. Factor 1 (MR3) captured infrastructure-related challenges (items T10, T11, T12, T13, T14, T16), Factor 2 (MR4) represented *Digital Readiness* (T1, T2, T3, T7, T8, T19), Factor 3 (MR2) corresponded to *Perceived Usefulness / E-learning Acceptance* (T5, T6, T9, T17, T18), and Factor 4 (MR1) tapped *Institutional Support* (T4, T20). All primary loadings exceeded 0.55, and cross-loadings were minimal, supporting the factorial validity of the teacher instrument. Item T15 ("parents lack awareness") exhibited low loadings across all factors and may require further scrutiny. The EFA results for the student questionnaire (not tabulated) similarly supported a three-factor structure consistent with the proposed engagement, competency, and challenges dimensions.

Table 5 Rotated factor loadings for teacher EFA (oblimin)

Item	Factor 1 (Infra.)	Factor 2 (Readiness)	Factor 3 (Usefulness)	Factor 4 (Support)
T1	0.001	**0.681**	0.033	-0.025
T2	-0.007	**0.772**	-0.161	0.094
T3	-0.017	**0.790**	-0.017	0.001
T4	-0.013	0.082	-0.020	**0.876**
T5	0.014	-0.035	**0.657**	0.061
T6	-0.019	0.075	**0.468**	-0.048
T7	0.018	**0.616**	0.138	-0.097
T8	0.006	**0.553**	0.100	-0.028
T9	0.009	0.030	**0.629**	-0.030
T10	**0.174**	-0.020	-0.032	-0.063

T11	**0.901**	0.011	0.001	-0.055
T12	**0.604**	0.013	-0.003	-0.042
T13	**0.845**	0.015	-0.004	-0.025
T14	**0.627**	-0.027	-0.044	-0.073
T15	-0.028	-0.044	-0.043	-0.041
T16	**0.911**	-0.017	0.012	0.111
T17	-0.029	-0.057	**0.680**	-0.020
T18	0.000	0.041	**0.820**	0.026
T19	0.012	**0.758**	0.077	-0.007
T20	0.019	-0.108	0.055	**0.778**
Note: Loadings > 0.30 are bolded. Extraction method: Principal axis factoring; rotation: oblimin.				

Teacher Perceptions Toward E-learning

Teachers' overall perceptions regarding the major components of e-learning integration are displayed in Figure 2 and summarised in Table 3. The mean Likert scores, accompanied by 95% confidence intervals, revealed a generally positive disposition toward digital learning. E-learning acceptance received the highest mean rating (M = 4.93), indicating a strong willingness to adopt online methodologies. This was closely followed by digital readiness (M = 4.89), perceived usefulness (M = 4.89), and institutional support (M = 4.88). These high, tightly clustered means suggest that teachers across the sample view themselves as digitally capable and perceive tangible benefits from e-learning, while also acknowledging administrative backing.

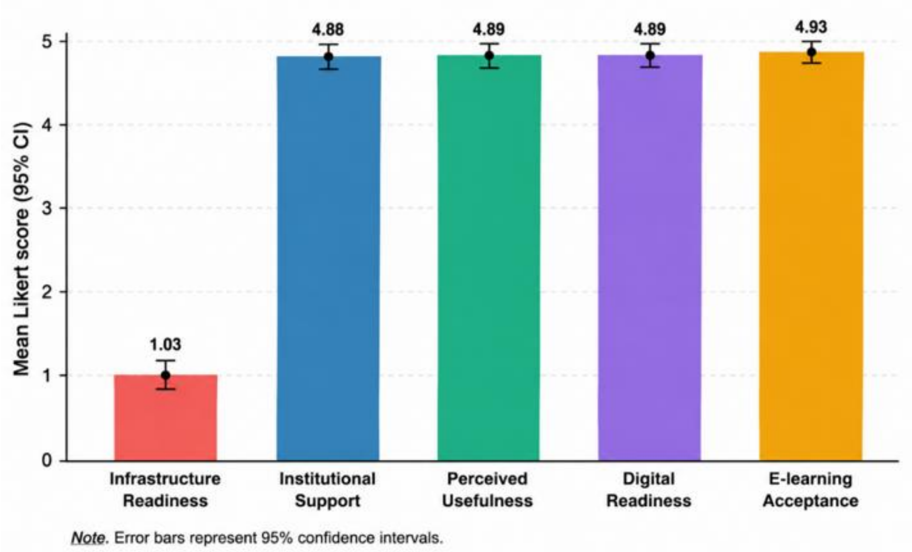

Figure 2. Teacher perceptions toward e-learning integration (mean scores with 95% CI)

In stark contrast, infrastructure readiness was rated remarkably low (M = 1.03), pointing to a critical deficit in the availability of reliable internet, devices, and technical platforms. The gap between positive teacher attitudes and poor infrastructural provisions underscores a key barrier: teachers are willing and able, but the physical and technological environment does not yet support consistent e-learning delivery.

4.4 Bivariate Relationships Among Constructs

Pearson correlations among the teacher constructs are presented in Table 6, with the full correlation heatmap visualised in Figure 3. The strongest positive association was observed between perceived usefulness and e-learning acceptance ($r = 0.642$, $p < 0.001$), indicating that teachers who find e-learning beneficial are substantially more likely to embrace it. Digital readiness also correlated moderately with e-learning acceptance ($r = 0.507$, $p < 0.001$) and, to a lesser extent, with perceived usefulness ($r = 0.129$, $p < 0.001$), suggesting that technological confidence enhances both the perception of utility and the acceptance of e-learning.

Institutional support and infrastructure readiness showed negligible correlations with all other constructs (rs < |.10|), implying that these institutional and infrastructural factors, in isolation, bear little linear relationship with teachers' attitudinal variables. This pattern may reflect the overwhelming infrastructural deficits that affect nearly all schools uniformly, reducing variability.

Student-level correlations (depicted in Figure 3) were weaker overall. Digital engagement was positively associated with technical ability ($r = 0.17$, $p < 0.001$), but positive experience (freedom from online challenges) demonstrated minimal association with engagement or technical ability, suggesting that enjoyable e-learning experiences are contingent on more than mere technical skill.

Table 6 Correlation matrix among teacher constructs

Construct	1	2	3	4	5
1. Digital Readiness	1.000				
2. Perceived Usefulness	0.129	1.000			
3. E-learning Acceptance	0.507	0.642	1.000		
4. Institutional Support	0.006	-0.007	0.019	1.000	
5. Infrastructure Readiness	0.060	0.033	0.063	0.014	1.000

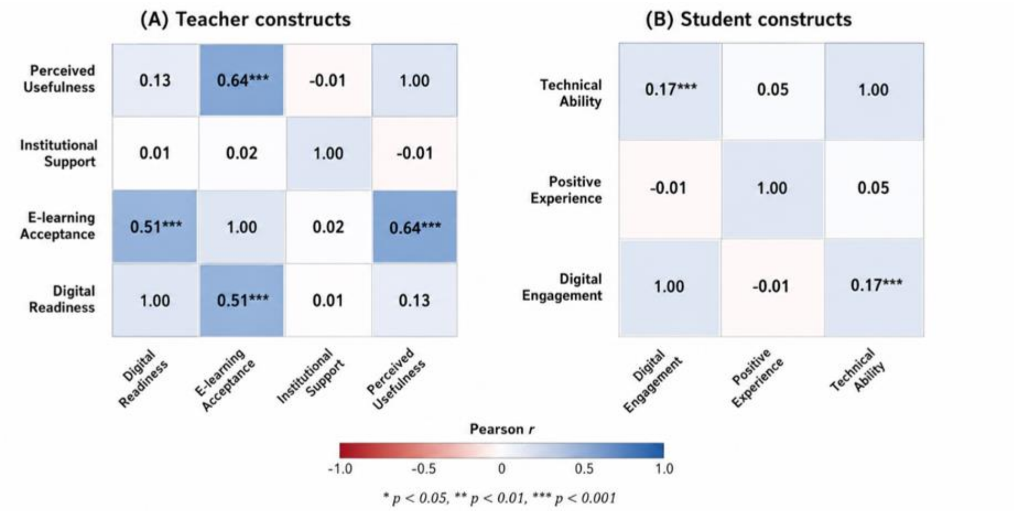

Figure 3. Correlation heatmap among teacher and student e-learning constructs

Digital Readiness by School Locality

A comparison of teacher digital readiness scores between rural and urban schools is illustrated in Figure 4. Both locality groups exhibited high readiness, with median scores near the upper boundary of the scale. Urban teachers displayed slightly more homogeneous and marginally higher readiness levels, whereas rural teachers showed greater variability, including a wider range of lower scores. An independent-samples t-test indicated that the difference between the two groups was not statistically significant (t(128) = -1.76, p = 0.080), although the trend favoured urban teachers.

This finding suggests that the rural–urban gap in digital preparedness among teachers may be narrowing, although the greater dispersion in rural areas highlights that some teachers still face significant obstacles in accessing or utilising digital tools.

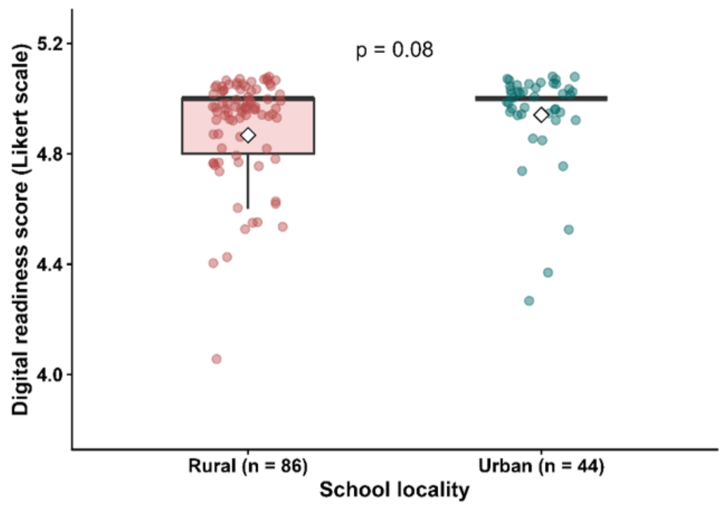

Figure 4. Teacher digital readiness scores by school locality

Predictors of E-learning Acceptance

To identify the determinants of teacher e-learning acceptance, a multiple linear regression analysis was conducted using digital readiness, institutional support, infrastructure readiness, teaching experience, and school locality as predictors. The overall model was significant ($F(5, 124) = 12.43$, $p < 0.001$, $R^2 = 0.334$). As shown in Table 7 and Figure 5, digital readiness emerged as the strongest predictor ($\beta = 0.360$, $p < 0.001$), confirming that a one-unit increase in digital readiness is associated with a 0.36-unit increase in e-learning acceptance, holding other factors constant.

School locality (urban) had a small but statistically significant positive effect ($\beta = 0.068$, $p = 0.042$), indicating that teachers in urban schools were slightly more likely to accept e-learning after adjusting for readiness and other variables. Infrastructure readiness ($\beta = 0.044$, $p = 0.721$), institutional support ($\beta = 0.003$, $p = 0.952$), and years of experience ($\beta = 0.001$, $p = 0.704$) did not reach significance, reinforcing the primacy of individual digital competence over contextual or demographic factors in shaping acceptance.

Table 7 Multiple regression predicting teacher e-learning acceptance

Predictor	B (Unstd.)	SE	β (Std.)	t	p
(Intercept)	3.074	0.366		8.405	<0.001
Digital Readiness	0.360	0.057	0.468	6.339	<0.001
Institutional Support	0.003	0.042	0.005	0.060	0.952
Infrastructure Readiness	0.044	0.124	0.026	0.357	0.721
Experience Years	0.001	0.003	0.030	0.382	0.704
Locality (Urban)	0.068	0.033	0.154	2.058	0.042

Note: $R^2 = 0.334$, $F(5, 124) = 12.43$, $p < 0.001$.

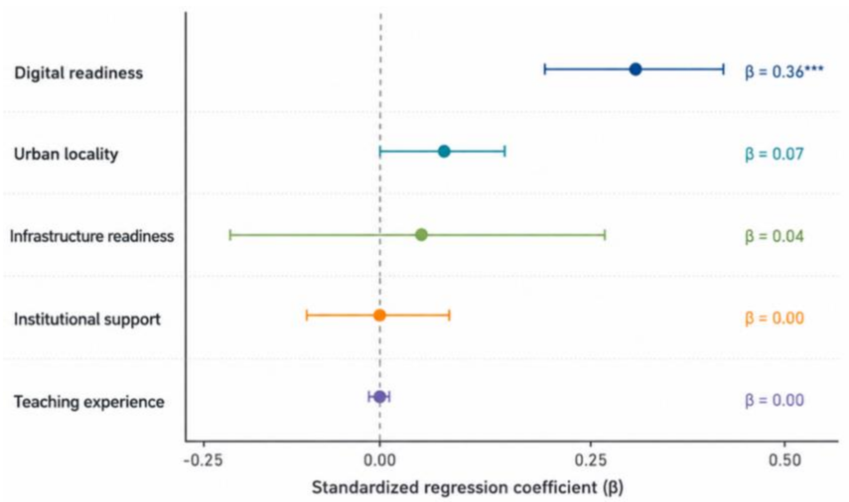

Figure 5. Standardised regression coefficients (β) for predictors of teacher e-learning acceptance

The integrated results from the descriptive, correlational, and regression analyses (Figures 1–5) converge on three major insights. First, teachers possess high levels of digital readiness and strong positive attitudes toward e-learning, but they are constrained by severely inadequate infrastructure. Second, the conceptual model hypothesising positive pathways from digital readiness, institutional support, and infrastructure readiness to e-learning acceptance was partially supported: digital readiness was the dominant driver, while institutional and infrastructural factors played negligible independent roles. Third, rural–urban disparities exist but are smaller than anticipated; the remaining variability in readiness suggests that targeted professional development, rather than mere resource provision, may be most effective in boosting acceptance. These findings collectively underscore that empowering teachers through digital skill development is the most immediate and impactful strategy for sustainable e-learning integration in the primary education system of Bahawalpur Tehsil.

Discussion

The findings of this study reveal a striking contrast between teachers' high levels of digital readiness and acceptance and the severely inadequate state of infrastructure readiness, confirming a pattern frequently observed in developing educational contexts (Khan et al., 2021; Qazi et al., 2016). Teacher digital readiness emerged as the strongest predictor of e-learning acceptance in the regression model, corroborating a growing body of literature that positions individual digital competence as the primary driver of technology adoption (Gui et al., 2026; Kiran et al., 2025). This indicates that teachers who are confident in their ability to navigate digital tools and troubleshoot basic issues are substantially more willing to embrace e-learning, regardless of other external constraints. The finding aligns with recent work by Li et al. (2025) (Li et al., 2025), who demonstrated a direct pathway from digital competence to adaptive technology use among Chinese schoolteachers, and with Purwita et al. (2025), who reported that digital literacy significantly predicts behavioural intention (Purwita et al., 2025).

The non-significant contribution of institutional support in the regression model is noteworthy. While teachers rated institutional support relatively highly in descriptive terms, its independent predictive power was negligible once digital readiness was accounted for. This suggests that supportive policies and administrative encouragement, although valued, may not directly translate into acceptance unless teachers themselves are digitally equipped. Similar results have been reported in other contexts: Mardiana (2025) found that institutional support influenced adoption of green digital technologies only indirectly through psychological readiness (Mardiana, 2025), and Harsanti et al. (2025) observed that perceived usefulness mediated the relationship between digital leadership and teachers' intention to use artificial intelligence (Harsanti et al., 2025). In the present study, it is possible that institutional support acts as an enabling background condition rather than a direct motivator, a hypothesis that warrants further investigation through mediation analyses.

Infrastructure readiness, measured through a composite of barriers such as insufficient devices, unreliable internet, and lack of practical training, showed the lowest mean score among all constructs and did not significantly predict acceptance. This finding may seem counter-intuitive given the well-documented infrastructural challenges in Pakistani schools (Irshad et al., 2025; Ismail et al., 2020). However, the near-uniformly low ratings of infrastructure (with very little variance) likely suppressed its predictive utility; when almost all teachers report similarly poor conditions, infrastructure cannot differentiate between those who accept e-learning and those who do not. This does not imply that infrastructure is unimportant but rather that in a context of systemic deprivation, individual factors become the salient differentiators. As Rawal (2024) argued, the impact of digital infrastructure on teacher competency is often indirect and mediated by access to professional development, a dynamic that cross-sectional regression may not fully capture (Rawal, 2024).

The student data provide additional nuance. Student digital engagement was relatively high, yet the composite originally labelled "Technical Competency" exhibited low internal consistency, necessitating its disaggregation into three sub-components: technical ability (S3, S7), teacher support (S4), and self-management (S5). This decision is theoretically supported by the work of Zin and Osman (2025) (Zin & Osman, 2025), who differentiated among perceived ease of use, self-efficacy, and digital literacy as distinct predictors of online learning motivation. The weak association between student technical ability and positive online experience (i.e., fewer challenges) suggests that even digitally skilled young learners encounter substantial difficulties with attention, fatigue, and device limitations, consistent with the broader literature on primary-level e-learning challenges (Khan et al., 2021).

The finding that student digital engagement was high despite pervasive infrastructural challenges mirrors the teacher-side paradox: individual motivation and basic digital skills can sustain positive attitudes even when systemic support is lacking. However, the weak correlation between students' technical ability and their positive online experience (freedom from challenges) suggests that technical proficiency alone does not overcome issues of attention, fatigue, and device constraints. This underscores the argument that e-learning acceptance and successful implementation require more than device distribution—they demand age-appropriate pedagogical design and teacher facilitation, further reinforcing the pivotal role of teacher digital readiness as the bridge between infrastructure and meaningful student engagement.

The urban–rural comparison yielded a non-significant difference in teacher digital readiness, a finding that departs from earlier studies reporting a pronounced rural disadvantage (Shah et al., 2026). The narrowing of this gap may reflect recent government efforts to distribute digital devices and provide basic ICT training in rural schools, although the greater variability among rural teachers indicates that some still lag behind. This underscores the need for targeted, context-sensitive professional development that addresses the specific constraints of rural settings (Ghayyur & Mirza, 2021).

Overall, the results reinforce the centrality of teacher digital readiness as a lever for e-learning acceptance, while highlighting the paradox that infrastructural deficits, though severe, do not independently predict teachers' attitudinal acceptance. This suggests that initiatives focusing solely on hardware provision may be insufficient; parallel investments in developing teachers' digital competence are essential. As Gui et al. (2026) and Azimkhan et al. (2025) emphasised, sustained professional development that enhances both technological skills and pedagogical confidence is critical for translating infrastructure into meaningful educational outcomes (Gui et al., 2026; Azimkhan et al., 2025).

Conclusion

This study investigated the factors influencing e-learning acceptance among primary school teachers in Bahawalpur Tehsil, alongside student perceptions of digital engagement, competency, and challenges. The results paint a picture of a teaching workforce that is highly motivated and digitally ready, yet severely constrained by inadequate technological infrastructure. Teacher digital readiness emerged as the dominant predictor of e-learning acceptance, whereas institutional support and infrastructure readiness, although valued, did not independently explain variations in acceptance. Student data revealed generally positive engagement with e-learning but also highlighted substantial challenges related to attention, fatigue, and device limitations.

The practical implications are clear. Policy interventions must move beyond one-time hardware distributions toward continuous, practice-based professional development that strengthens teachers' digital skills and pedagogical integration strategies. Given the near-complete coverage of the teacher population in this study, the findings offer a reliable baseline for educational authorities seeking to design targeted e-learning initiatives. The disaggregation of student competency into technical ability, teacher support, and self-management suggests that young learners require structured guidance and age-appropriate digital content, not merely device access.

Several limitations must be acknowledged. The cross-sectional design precludes causal inferences, and the reliance on self-report measures may introduce social desirability bias. Because all data were collected through self-report questionnaires, social desirability and common-method bias may have inflated the uniformly high mean scores on attitudinal constructs. Although anonymity was assured and participation was voluntary, future research should incorporate objective indicators of digital competence and infrastructure quality, and triangulate findings with qualitative or observational data. The student sample, while large, included children as young as six years, whose responses may have been influenced by the assistance provided during questionnaire administration. The three-item e-learning acceptance scale ($\alpha = 0.38$) and the perceived usefulness scale ($\alpha = 0.57$) exhibited low reliability, likely due to their small number of items and ceiling effects. These constructs were retained because they are theoretically anchored in the Technology Acceptance Model and their unidimensionality was confirmed by EFA; nonetheless, their limited reliability may attenuate observed relationships and should be addressed in future studies with expanded item sets. Future research should employ longitudinal designs to track changes in digital readiness and infrastructure over time, and qualitative methods to explore the mechanisms linking institutional support to teacher behaviour.

In sum, the study confirms that in resource-constrained settings, teachers' digital readiness is the strongest asset for e-learning adoption. Building this readiness through sustained, high-quality professional development, while simultaneously addressing infrastructural gaps, offers the most promising pathway toward sustainable technology integration in primary education. ***

Declaration

Ethical Approval and Consent to Participate
This study did not receive formal approval from an institutional ethics review committee, as such a body was not available at the researcher's institution at the time of data collection. Nonetheless, all procedures were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and the American Psychological Association's ethical guidelines. Permission to conduct the study was obtained from the District Education Officer (DEO) Bahawalpur, and additional consent was granted by the principals of participating schools. Written informed consent was obtained from all teacher participants. For student participants, written informed consent was provided by parents or legal guardians, and verbal assent was secured from each child before data collection. Participants were informed of the voluntary nature of the study, their right to skip any question, and their freedom to withdraw at any time without consequence. Anonymity was guaranteed through the use of numerical participant codes.

Conflict of Interest
The author declares no competing interests, financial or non-financial, that could have influenced the design, execution, or reporting of this study.

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Data Availability
The dataset generated and analysed during the current study is available from the author upon reasonable request. A synthetic version of the data, preserving the structure and statistical properties of the original, is provided as supplementary material for methodological verification.

Author Contributions
M.M. conceived and designed the study, developed the methodology, collected data, performed the analysis, and prepared the initial manuscript draft. S.A.F. contributed to

supervision, conceptual refinement, and critical review of the manuscript. N.J. assisted with data interpretation, literature review, and manuscript revision. M.Ar. contributed to literature support, manuscript review, and final revisions. M.Am. contributed to data organisation, formatting, and final manuscript editing. All authors reviewed and approved the final version of the manuscript.

References

Ahmad, N., Alam, A., & Shah, I. (2024). Higher education in 21st century: An analysis of ICT integration for teaching and learning in Pakistan. *Knowledge Management & E-Learning*, *16*(4), 612–637. https://doi.org/10.34105/j.kmel.2024.16.028

Asad, M. M., Hussain, N., Wadho, M., Khand, Z. H., & Churi, P. P. (2021). Integration of e-learning technologies for interactive teaching and learning process: An empirical study on higher education institutes of Pakistan. *Journal of Applied Research in Higher Education*, *13*(3), 649–663. https://doi.org/10.1108/JARHE-04-2020-0103

Azimkhan, S., Abildinova, G., Khamzina, A., Karymsakova, A., & Karaca, C. (2025). Developing teacher digital competence through mobile and interactive technologies: A systematic review using the TPACK framework. *International Journal of Engineering Pedagogy*, *15*(3). https://doi.org/10.3991/ijep.v15i3.51653

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319–340. https://doi.org/10.2307/249008

Ghayyur, T. S., & Mirza, N. A. (2021). Exploring TPACK skills of prospective teachers and challenges faced in digital technology integration in Pakistan. *Journal of Development and Social Sciences*, *2*(4), 226–241. https://doi.org/10.47205/jdss.2021(2-IV)19

Gui, Q., Omar, M. K., & Harithuddin, A. S. M. (2026). Teachers' professional development on self-efficacy, attitudes, and digital competencies in the digital era. *Acta Psychologica*, *265*, 106683. https://doi.org/10.1016/j.actpsy.2026.106683

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7 (ed.)). Prentice Hall.

Harsanti, H. R., Sudibjo, N., Riady, S., & Yu, P. (2025). Exploring Indonesian teachers' intention to use artificial intelligence in schools: The impact of digital leadership, digital readiness, and perceived usefulness. *Cogent Social Sciences*, *11*(1), 2593596. https://doi.org/10.1080/23311886.2025.2593596

Irshad, A., Munawar, U., Iqbal, M., & Bakr, M. A. (2025). Teaching and learning with technology: Effectiveness of ICT integration in public schools of District Sargodha, Punjab, Pakistan. *Journal of Media Horizons*, *6*(5), 227–246. https://doi.org/10.5281/zenodo.17283427

Ismail, S. A. M. M., Jogezai, N. A., & Baloch, F. A. (2020). Hindering and enabling factors towards ICT integration in schools: A developing country perspective. *Elementary Education Online*, *19*(3), 1537–1547. https://doi.org/10.17051/ilkonline.2020.733176

Jamil, M., Aslam, M., & Shahzad, A. (2024). Technology integration in teaching and learning: Exploring prospective teachers' perceptions, practices and challenges. *International Journal of Social Sciences*, *2*(2). https://doi.org/10.59075/ijss.v2i2.346

Khan, M. A., Nabi, M. K., & Khojaye, M. A. (2021). Challenges of e-learning in Pakistan: A review of literature. *Journal of Educational Technology Systems*, *50*(2), 205–223.

Kiran, N., Gardezi, S. M. Z., Nawaz, A. R., & Shah, S. Z. A. (2025). Teachers' digital competence and its impact on technology-enhanced teaching practices in secondary schools. *Social Sciences & Humanity Research Review*, *3*(4). https://doi.org/10.63468/sshrr.236

Li, Y., Zhang, X., & Chen, M. (2025). The path from digital competence to adaptive use: An empirical analysis of 9,726 primary and secondary school teachers. *International Journal of Chinese Education*, *14*(3). https://doi.org/10.1177/2212585X251409386

Ling, C. F., Ismail, H. H., & Yunus, M. M. (2025). *A quantitative study on the influence of readiness and perceived usefulness on teachers' intention to integrate digital learning*. https://doi.org/10.47772/IJRISS.2025.91100242

Mardiana, H. (2025). Educators' adoption of green digital technologies: The role of psychological readiness, digital competence, and institutional support. *Athena: Journal of Social, Culture and Society*, *3*(4), 615–631. https://doi.org/10.58905/athena.v3i4.464

Purwita, A. W., Elfaiz, E. A., & Rahmaningrum, A. (2025). *Teachers and technology acceptance: The role of digital literacy, technology anxiety, and cognitive perceptions in predicting behavioral intention*. https://doi.org/10.1109/ICITISEE68184.2025.11355052

Qazi, A., Mustafa, Y., & Sheikh, S. (2016). School leadership's technology readiness for ICT integration in schools in developing countries like Pakistan. *Proceedings of the 2nd International Conference on Emerging Trends in Engineering, Management and Sciences (ICETEMS-2016)*.

Rawal, D. M. (2024). Mapping of school teachers' digital competency in the context of digital infrastructure: A systematic review and empirical study of India. *Journal of Professional Capital and Community*, *9*(3), 173–195. https://doi.org/10.1108/JPCC-01-2024-0016

Shah, R., Hussain, R. Y., & Al Rassas, A. H. (2026). Digital literacy and learning motivation as determinants of ICT integration: Challenges and opportunities for university students in Pakistan. *Cogent Education*, *13*(1), 2658225. https://doi.org/10.1080/2331186X.2026.2658225

Sihombing, L. H., Muliasari, D. N., Herlambang, Y. T., Fadilah, E. R., & Supriatna, N. (2025). Teachers' readiness for integrating technology in English language education: The roles of institutional support, self-efficacy, and technological competence. *International Journal of Educational Qualitative Quantitative Research*, *4*(2), 42–50. https://doi.org/10.58418/ijeqqr.v4i2.175

Tun, W. W. W. (2025). Technology acceptance among in-service teachers in Myanmar. *AsTEN Journal of Teacher Education*. https://doi.org/10.56278/asten.vi.3361

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425–478. https://doi.org/10.2307/30036540

Zin, A. F. M., & Osman, S. Z. M. (2025). The influence of perceived ease of use, perceived usefulness, self-efficacy, digital literacy, and perceived enjoyment on online learning motivation among secondary school students in Baling, Kedah. *EDUCATUM Journal of Social Sciences*, *11*(2), 63–75. https://doi.org/10.37134/ejoss.vol12.sp.8.2026