Andragogi Jurnal Pendidikan dan Pembelajaran
Vol. 6, No. 2, September 2026, DOI: https://doi.org/10.31538/adrg.v6i2.2562
E-ISSN 2807-8233, pp. 422-438

AI Usage and Digital Informal Learning as Predictors Of Islamic Teachers' Functional Skills In Southern Pakistan

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Keywords:
Artificial Intelligence, Digital Learning, Functional Skills, Islamic Educators, Informal Learning, ICT self-efficacy.

Article history:
Received: 21-10-2025
Revised 11-05-2026
Accepted 16-11-2026

Abstract

This study examines the influence of artificial intelligence (AI) usage and digital informal learning, treated as two distinct independent variables, on the functional skills of Islamic secondary school teachers in Southern Pakistan. Functional skills refer to teachers' practical classroom competencies, conceptualized through three sub-variables (problem solving, reading, and writing), that enable them to adapt instruction, manage classroom tasks, and respond to pedagogical challenges. Guided by Connectivism and the Technology Acceptance Model, the study used a quantitative cross-sectional design. The study collected data from 450 Islamic secondary school teachers in four areas of Southern Punjab (Kot Addu, Muzaffargarh, Jatoi, and Shah Sultan), selected through purposive sampling, and analyzed them in SPSS 22 using multiple linear regression. Digital informal learning ($p = 0.003$) and digital competencies ($p < 0.001$) significantly predicted functional skills, whereas AI usage did not ($p = 0.065$). These findings suggest that exposure to AI tools alone is insufficient to strengthen teachers' practical competencies without pedagogical integration and supporting digital skills. The study contributes a new perspective by separating AI usage from informal learning in a rural, faith-based context and showing that self-directed digital learning, rather than AI usage alone, is associated with higher functional skills. The findings highlight the need for professional development that builds on continuous informal learning. Because the sample was purposive, the results are context-specific and transferable to similar settings rather than statistically generalizable.

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INTRODUCTION

Digital transformation is reshaping teaching and learning worldwide and changing the role of the educator, as artificial intelligence (AI) and other digital learning technologies reach not only urban but also rural and religious institutions (Zhao et al., 2002; Salehi & Salehi, 2012). In the Islamic secondary schools of Southern Pakistan, these technologies are beginning to change how content is delivered, how teachers interact with students, and how they develop professionally, although infrastructure constraints, limited training resources, and social and cultural issues remain prevalent (Hew & Brush, 2007; Mundy et al., 2012).

Under these conditions, digital informal learning has become an important pathway for teacher growth. It refers to self-directed engagement with online tools, peer collaboration, participation in digital communities, and spontaneous exploration of educational technologies (Salehi & Salehi, 2012). It is consistent with Connectivism, which locates learning in networks and connections beyond formal instruction (Siemens, 2005), and with research on informal learning at work (Marsick & Watkins, 2001; Eraut, 2004). Informal learning offers flexible professional development where standard training is unfeasible (Nazaretsky et al., 2022) and can help teachers build functional skills, defined in this study as practical classroom competencies comprising three sub-variables: problem solving (analyzing and resolving instructional and technological problems; Jonassen, 2000), reading (locating, comprehending, and critically evaluating digital texts and information; Leu et al., 2004), and writing (clearly composing lesson materials, feedback, and digital communication; Graham & Perin, 2007). These skills allow teachers to adapt instruction, manage classroom tasks, and respond to pedagogical challenges, and they are not acquired automatically through exposure to technology (Ng, 2012).

AI applications such as intelligent tutoring systems, automated assessment tools, and adaptive learning platforms can support personalized instruction and administrative efficiency, but using them effectively requires digital literacy, ethical awareness, and confidence in AI-driven decisions (Šabić et al., 2022; Zawacki-Richter et al., 2019). Recent reviews describe rapid growth of AI applications in education, including generative tools that can support reading and writing tasks, while also raising concerns about accuracy, over-reliance, and ethics (Chen et al., 2020; Hwang et al., 2020;

Kasneci et al., 2023). For Islamic educators, AI use must also respect religious principles and cultural values, particularly regarding data privacy, content appropriateness, and algorithmic fairness (Alotaibi, 2023). Although AI tools can serve as resources for self-directed learning, AI usage (the extent to which teachers use AI tools in their teaching) and digital informal learning (self-directed learning through online resources and communities) are conceptually distinct. They are therefore treated here as two separate independent variables rather than a single construct.

Teachers' digital competencies and ICT self-efficacy, that is, their belief that they can use digital technologies competently, also shape adoption. Teachers with high self-efficacy are more willing to use AI applications, manage virtual learning environments, and innovate their teaching, whereas low self-efficacy leads to technological avoidance (Bandura, 1997; Fanni et al., 2013). In rural areas such as South Punjab, where institutional support for digital training is minimal, teachers must develop these competencies largely on their own or through peer learning (Mundy et al., 2012), helped by growing access to smartphones, mobile internet, and social media. Teachers' pedagogical beliefs further influence whether technology is used meaningfully in teaching (Tondeur et al., 2017).

The research gap is therefore explicit. Despite growing global interest in AI in education and digital teacher development, existing research remains concentrated in urban, higher-education, or non-religious contexts, and little attention has been given to Islamic secondary schools in rural Pakistan, where technological, cultural, and institutional constraints shape teachers' engagement with digital tools. Moreover, previous studies tend to examine AI usage, digital competencies, and informal learning as separate constructs rather than testing their influence on teachers' functional skills within one model. How these factors relate to teacher functional skills in under-resourced Islamic educational settings therefore remains poorly understood.

To address this gap, the present study investigates the influence of AI usage, digital competencies, and digital informal learning on the functional skills of Islamic secondary school teachers in Southern Pakistan, drawing on Connectivism and the Technology Acceptance Model (Davis, 1989; Venkatesh et al., 2003) and on data from 450 teachers. It contributes empirical evidence from a rural, faith-based context and a conceptual distinction between AI usage and informal learning, and its findings are expected to inform teacher training, educational policy, and curriculum development

aimed at strengthening digital readiness and instructional effectiveness in resource-constrained environments.

METHOD

This study adopted a quantitative cross-sectional design to examine the influence of AI usage, digital competencies, and digital informal learning on the functional skills of Islamic secondary school teachers in Southern Pakistan, as a quantitative approach allows the systematic collection of numerical data and the statistical testing of relationships among variables (Creswell & Creswell, 2018). The study was conducted in four areas of Southern Punjab, namely Kot Addu, Muzaffargarh, Jatoi, and Shah Sultan, which are predominantly rural and socioeconomically constrained, with limited access to educational resources and teacher training. Islamic secondary schools in this region provide both religious and academic instruction, and growing access to mobile internet and smartphones has enabled some digital engagement among teachers, particularly through informal learning channels, making the region a relevant context for examining digital integration in education.

The target population consisted of Islamic secondary school teachers working in rural and semi-urban schools. Participants were selected through purposive sampling so that only information-rich respondents relevant to the research objectives were included (Etikan et al., 2016), namely teachers who were currently serving in Islamic secondary schools and who had exposure to or engagement with digital learning platforms, AI tools, or informal digital learning practices. Of the 500 teachers approached, 450 returned the questionnaire (a 90% response rate), and 440 complete responses from male and female teachers were used in the analysis. Because the sampling was non-probabilistic, the findings are not statistically generalizable, but they offer analytical and contextual insights applicable to similar educational settings in rural Pakistan.

Data were collected through a structured, self-administered questionnaire developed in Google Forms and distributed both online and through school and teacher networks, so that connected and less-connected teachers could respond. The questionnaire covered demographic information, digital learning practices, AI usage, digital informal learning experiences, and functional skills, the latter measured through three sub-variables, namely problem solving, reading, and writing, which were combined into a composite score. All items were rated on a four-point Likert scale

(strongly agree, agree, disagree, strongly disagree). The instrument was adapted from established studies on digital learning, AI integration, and teacher competencies, reviewed by specialists in educational technology and teacher education to ensure content validity, and pilot-tested with a small group of teachers to ensure clarity before full deployment. All item correlations exceeded the critical value of 0.1891 at the 0.05 significance level, and Cronbach's alpha for every construct exceeded the accepted threshold of 0.70 (Nunnally & Bernstein, 1994; Tavakol & Dennick, 2011). Ethical approval was obtained from the relevant institutional authorities, participation was voluntary, informed consent was obtained from all respondents, and confidentiality and anonymity were maintained throughout the study.

The data were analyzed using SPSS version 22. Descriptive statistics were first used to summarize respondent characteristics and the study variables. Before hypothesis testing, the regression assumptions of normality, heteroscedasticity, and multicollinearity were examined (Tabachnick & Fidell, 2013). Multiple linear regression was then used to estimate the effects of digital informal learning, AI usage, and digital competencies on teachers' functional skills (Field, 2018), and the significance of each predictor was assessed with the t-test at the 0.05 level.

As shown in Figure 1.1, AI usage and digital informal learning were positioned as two distinct independent variables and teachers' functional skills as the dependent variable, while digital competencies were included in the regression model as an additional predictor. Digital informal learning is grounded in Connectivism (Siemens, 2005), AI usage in the Technology Acceptance Model (Davis, 1989), and digital competencies in research on teacher self-efficacy (Bandura, 1997; Fanni et al., 2013). Based on this framework, the study tested whether digital informal learning, AI usage, and digital competencies each have a positive and significant effect on teachers' functional skills (H1, H2, and H3, respectively).

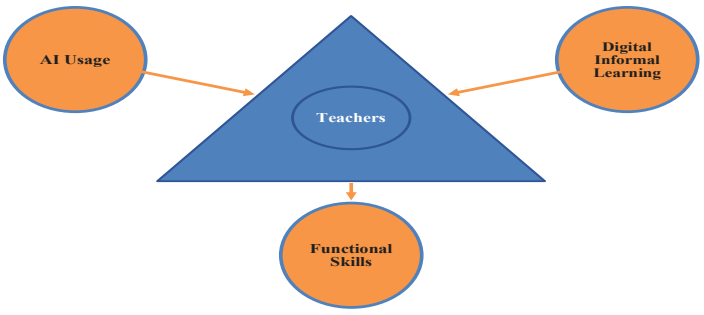


Figure 1.1. Conceptual framework of the study

RESULTS AND DISCUSSION

Results

Table 1. AI usage among secondary school teachers by area and gender

	Kot addu	M.garh	Jatoi	Shah Sultan
Male	19.62%	11.18%	14.09%	17.44%
Female	1.32%	12.65%	08.76%	15.97%
Total	20.94%	25.83%	20.84%	31.39%

Table 1 presents the distribution of AI usage among secondary school teachers across four areas. The highest share of AI usage is observed in Shah Sultan (31.39%), followed by Muzaffargarh (25.83%), Kot Addu (20.94%), and Jatoi (20.84%). In Kot Addu, male teachers account for 19.62% of AI usage compared with 1.32% for female teachers, a pronounced gender gap. In Muzaffargarh, female teachers (12.65%) slightly exceed male teachers (11.18%), and in Shah Sultan the shares are close (17.44% male, 15.97% female). These figures are descriptive: they show regional and gender differences in AI usage but are not evidence of causal relationships.

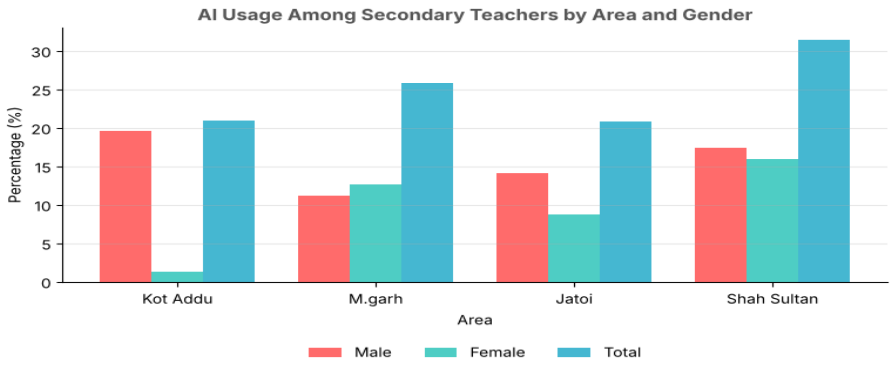


Table 2. Use of digital informal learning technology for educational purposes by area and gender

	Kot addu	M.garh	Jatoi	Shah Sultan
Male	13.44%	17.13%	6.59%	14.42%
Female	11.30%	08.96%	17.00%	21.95%
Total	24.74%	26.07%	23.59%	36.37%

Table 2 presents the extent to which secondary school teachers use digital informal learning technologies for educational purposes in Kot Addu, Muzaffargarh (M.garh), Jatoi, and Shah Sultan. The share is highest in Shah

Sultan (36.37%), followed by Muzaffargarh (26.07%), Kot Addu (24.74%), and Jatoi (23.59%), with comparable shares in the latter three areas.

By gender, male teachers show a higher percentage of digital informal learning use than female teachers in Kot Addu (13.44% vs. 11.30%) and Muzaffargarh (17.13% vs. 8.96%). In Jatoi the pattern is reversed, with female teachers reporting much higher use (17.00%) than male teachers (6.59%), and Shah Sultan likewise shows a female lead (21.95% vs. 14.42%).

Overall, digital informal learning is present in all four areas, but gender patterns differ by location. As with Table 1, these percentages are descriptive and do not indicate causal relationships; the associations between these variables and functional skills are tested in the regression analysis below.

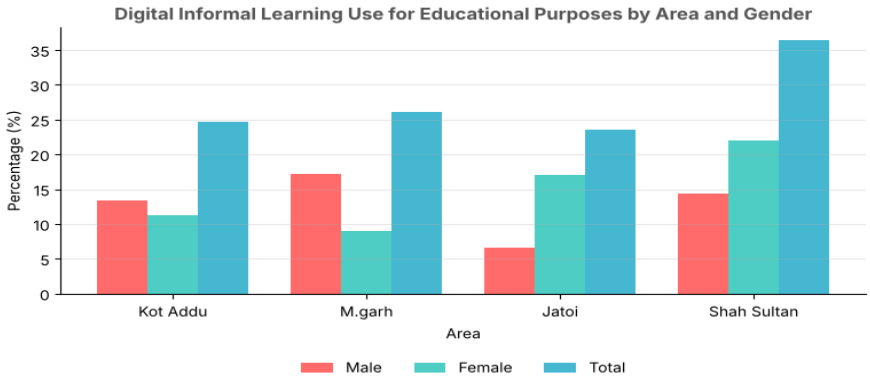


Table 3. Combined AI usage and digital informal learning in relation to teachers' functional skills by area and gender (descriptive)

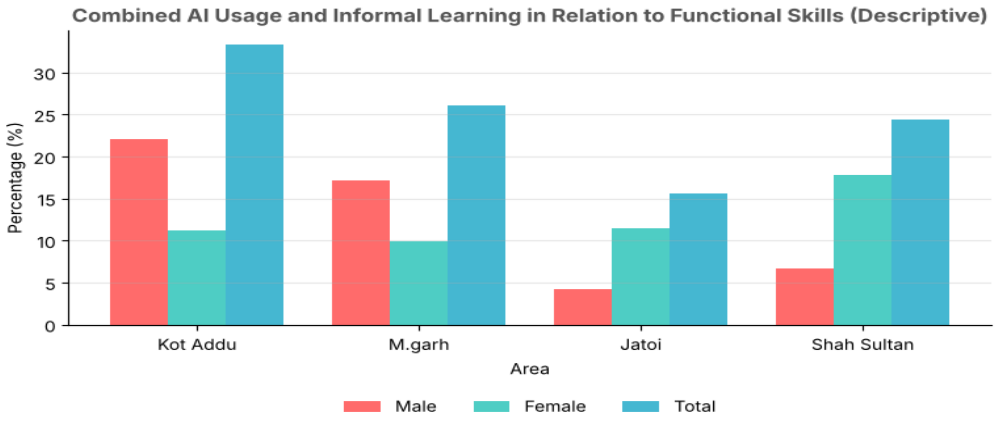
	Kot addu	M.garh	Jatoi	Shah Sultan
Male	22.05%	17.13%	4.22%	6.67%
Female	11.24%	9.96%	11.45%	17.77%
Total	33.29%	26.09%	15.67%	24.44%

Table 3 presents the combined pattern of AI usage and informal learning in relation to teachers' functional skills across Kot Addu, Muzaffargarh, Jatoi, and Shah Sultan. Kot Addu records the largest share (33.29%), followed by Muzaffargarh (26.09%), Shah Sultan (24.44%), and Jatoi (15.67%), which is the lowest of the four.

By gender, male teachers record higher shares than female teachers in Kot Addu (22.05% vs. 11.24%) and Muzaffargarh (17.13% vs. 9.96%). The pattern is reversed in

Shah Sultan (female 17.77%, male 6.67%) and Jatoi (female 11.45%, male 4.22%), where the overall share is low.

Taken together, Tables 1–3 are descriptive. They show that AI usage and informal learning vary across areas and between male and female teachers, but they are not causal evidence, and on this basis no area can be regarded as a model of successful implementation. The relationships between these variables and functional skills are examined inferentially in the regression analysis below.



Instrument Validity, Reliability, and Assumption Tests

Table 4. Teachers' responses to questionnaire items on digital competencies, AI usage, and informal learning

Statement	SA	A	D	SD
Digital Competencies				
I am confident in using basic digital tools such as MS Word, Excel, and PowerPoint.	24	75	5	2
I can effectively integrate multimedia (audio, video, images) into my teaching.	19	80	3	4
I use online resources (YouTube, digital libraries, educational websites) to prepare lessons.	16	72	18	0
I understand how AI can personalize learning for different student needs.	9	58	37	2
AI usage				
I feel confident in evaluating the accuracy and bias of AI-generated content.	11	63	28	4

I use AI tools (like ChatGPT, automatic grading tools, or adaptive learning platforms) in my teaching.	7	61	34	4
I have received training or guidance on how to use AI tools in education.	22	79	5	0
AI tools help me manage classroom activities more effectively.	14	85	7	0
Digital Informal Learning				
I regularly learn new teaching techniques through online platforms (e.g., YouTube, blogs, webinars).	18	72	14	2
I discuss educational technology with peers or online communities to improve my practice.	13	72	20	1
I can independently design and deliver lessons using digital platforms.	14	58	31	3
I can adapt digital content based on student needs and classroom context.	12	61	28	5

Note. SA = strongly agree; A = agree; D = disagree; SD = strongly disagree.

Instrument validity and reliability were examined before the regression analysis. The study involved 450 secondary school teachers and four main variables: digital informal learning (X1), AI usage (X2), digital competencies (X3), and functional skills (Y). All items were tested for validity, and all correlation coefficients exceeded the critical value of 0.1891 at the 0.05 significance level, confirming their validity. The items reflect practical competencies such as troubleshooting minor digital issues, confidence in using digital platforms, and perceived effectiveness of technology in enhancing student learning.

Reliability was strong, with Cronbach's alpha values above the accepted 0.70 standard: 0.873 for digital competencies, 0.883 for self-efficacy in informal learning, and 0.959 for trust in AI tools. The combined trust in and usage of AI tools showed an overall reliability of 0.917, confirming internal consistency across the scales.

To assess the distribution of the data, skewness and kurtosis tests were applied. The skewness ratios for AI trust and digital competency were −0.438 and 0.455, respectively, and those for informal learning self-efficacy were 0.132 and 0.35, indicating approximately normal distributions.

The Glejser test, with Abs_RES as the dependent variable, returned significance values of 82.6% for digital informal learning (X1), 15.1% for AI usage (X2), and 7.7% for digital competencies (X3), all above the 5% threshold, indicating no

heteroscedasticity. Collinearity diagnostics showed a condition index of 46.609 and an eigenvalue below 0.01; because this exceeds the conventional threshold of 30, the regression coefficients are interpreted with caution.

In summary, the instrument showed acceptable validity and reliability, and the normality and heteroscedasticity checks were satisfied, so the regression analysis could proceed.

Table 5. Descriptive Statistics

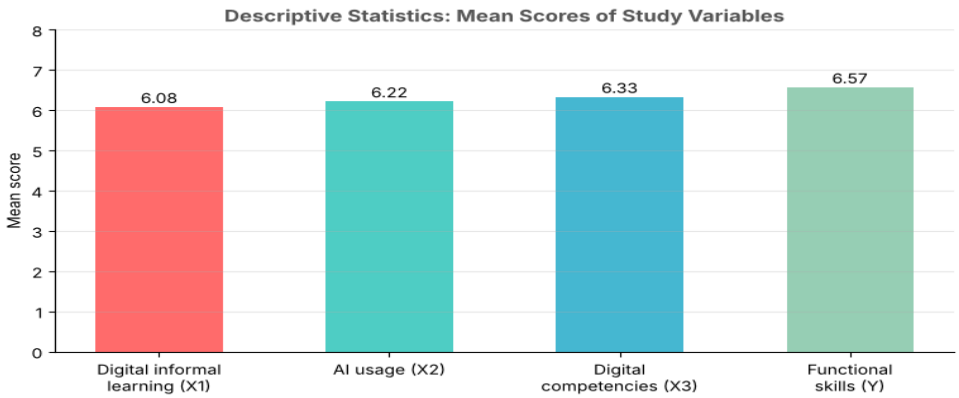
	N	Range	Min	Max	Means	Std. Deviation	Variances
AI usage (X2)	440	5	3	9	6.22	1,470	2,159
Digital informal learning (X1)	440	8	3	10	6.08	1,455	2,120
Functional skills (Y)	440	8	3	12	6.57	1,877	3,519
Digital competencies (X3)	440	7	3	8	6.33	1,677	3,420
Valid N (listwise)							

According to the descriptive statistics (Table 5), 440 secondary school teachers provided complete responses on the study variables, so the regression analysis is based on N = 440. The three main variables were digital informal learning (X1), AI usage (X2), and functional skills (Y), together with digital competencies (X3). Scale scores ranged from 3 to 9 for AI usage, 3 to 10 for digital informal learning, and 3 to 12 for functional skills.

AI usage (X2) had a mean of 6.22 (SD = 1.470) and digital informal learning (X1) a mean of 6.08 (SD = 1.455), indicating moderate levels with noticeable variation across teachers, which may reflect differences in experience, confidence, or exposure to AI-supported teaching practices.

Functional skills (Y), a composite of problem solving, reading, and writing that reflects the practical ability to apply technology in teaching, recorded the highest mean (6.57, SD = 1.877) and the widest range (3–12; variance = 3.519). This indicates considerable variability in how effectively teachers translate digital tools into classroom practice: some teachers are highly proficient, while others lack foundational skills.

This high variation indicates disparities in digital pedagogical capacity among teachers. Some can apply digital and AI tools effectively in instruction, while others remain at a basic level, which makes targeted professional development urgent, especially for teachers at the lower end of the scale, so that AI and informal learning can be integrated more consistently in secondary education.



Hypothesis Testing: Multiple Regression (t-test)

Table 6. Multiple regression coefficients (t-test)

Model	Unstandardized Coefficients		Standardized Coefficient	t	Sig.
	B	Std. Error	Betas		
1 (constant)					
Digital Informal Learning (X1)	1,539	,547		2,949	,003
AI usage (X2)	,657	,335	,468	1,868	,065
Digital competencies (X3)	,716	,162	,678	4,123	,000

Note. Dependent variable: functional skills (Y). B = unstandardized coefficient.

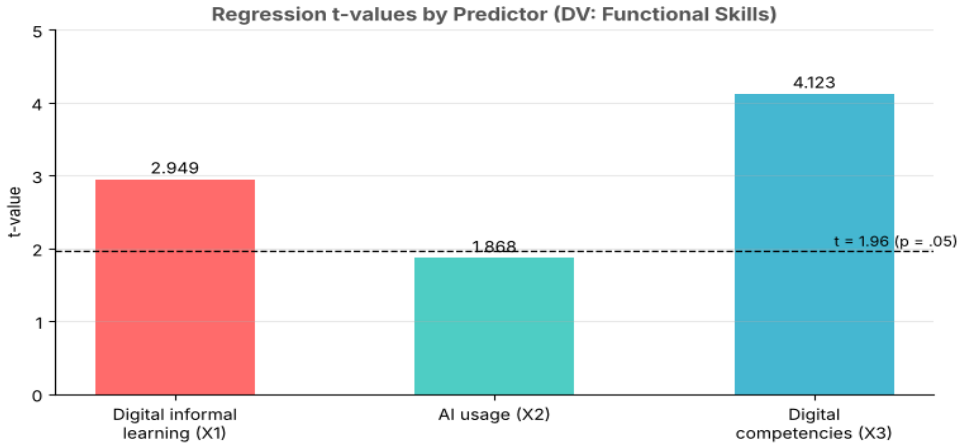


Table 6 reports the multiple regression coefficients with functional skills as the dependent variable. Digital informal learning was a positive and statistically significant predictor of functional skills (B = 1.539, t = 2.949, p = .003), so H1 is supported. Digital competencies were also a significant predictor (B = .716, t = 4.123, p < .001), so H3 is supported. AI usage was not a significant predictor (B = .657, t = 1.868, p = .065 > .05), so H2 is not supported. Each coefficient reflects the contribution of a predictor with the others held constant, and because the design is cross-sectional the results indicate association rather than causation.

The non-significant result for AI usage means that there is no statistical evidence in this sample that AI usage alone is associated with functional skills; it does not show that AI is ineffective. It suggests that AI has not yet been pedagogically integrated into teachers' learning practices (see Discussion).

Discussion

The significant association between digital informal learning and functional skills is consistent with Connectivism, which holds that learning occurs through networks, communities, and connections beyond formal instruction (Siemens, 2005), and with research showing that self-directed, context-embedded learning is a major source of professional capability (Marsick & Watkins, 2001; Eraut, 2004). In rural Islamic schools where formal training is scarce, peer collaboration, online communities, and self-guided exploration appear to function as an alternative pathway for developing classroom skills, in line with evidence that informal digital learning offers flexible professional development where standard training is unfeasible (Nazaretsky et al., 2022; Salehi & Salehi, 2012).

The significant contribution of digital competencies supports the view that functional skills depend on teachers' ability to combine technological, pedagogical, and content knowledge (Mishra & Koehler, 2006) and on their confidence and beliefs about using technology (Ertmer & Ottenbreit-Leftwich, 2010; Fanni et al., 2013). Functional skills are thus not a by-product of access to technology but of competence and self-efficacy (Bandura, 1997), which informal learning can build through observation, experimentation, and peer exchange.

These results can also be read through the three sub-variables of functional skills. They were analyzed here as a composite, so the following reading is interpretive rather than tested. Informal learning communities may help teachers solve instructional and technological problems (Jonassen, 2000), exposure to online resources may strengthen digital reading and the evaluation of information (Leu et al., 2004; Ng, 2012), and regular digital communication and content creation may support writing (Graham & Perin, 2007). AI tools may support the same sub-variables, for example by drafting or summarizing text (Kasneci et al., 2023), but only when teachers can judge and adapt the output, which again depends on competence rather than on use alone.

In contrast, AI usage did not significantly predict functional skills. Optimistic accounts expect AI to personalize instruction and improve efficiency (Luckin et al., 2016; Holmes et al., 2019), yet reviews note that AI applications are often introduced with limited attention to pedagogy and to the educator's role (Zawacki-Richter et al., 2019). The Technology Acceptance Model helps explain the gap: perceived usefulness and ease of use may encourage AI use (Davis, 1989), but use alone does not produce skill gains unless it is pedagogically integrated. In Islamic education, integration is further conditioned by ethical and cultural concerns over data privacy, content appropriateness, and fairness (Šabić et al., 2022; Alotaibi, 2023), which may limit how fully teachers adopt AI tools. Because the AI coefficient approached but did not reach significance ($p = .065$), this finding should be treated as inconclusive and replicated with larger and more varied samples.

Taken together, the findings refine rather than reject optimism about AI: in this context, AI usage appears to add little unless it is embedded in teachers' continuous informal learning and supported by digital competencies. This synthesis extends informal learning theory to AI-supported teacher development in faith-based, resource-constrained schools, where AI research has paid little attention, and it suggests that professional development should build on teachers' informal learning practices rather than introduce AI tools in isolation. The descriptive disparities across areas and gender (Tables 1–3) indicate where such support is most needed.

Recommendations

Professional development programs should build on teachers' informal digital learning, for example through peer networks and online communities, and strengthen digital competencies. AI-related training should be pedagogically oriented and should address data protection and cultural appropriateness within Islamic values. Targeted support should prioritize the teachers and areas showing lower engagement.

CONCLUSION

The most important finding is that AI usage alone did not significantly predict teachers' functional skills ($p = .065$), whereas digital informal learning ($p = .003$) and digital competencies ($p < .001$) did. This became evident only through the research: although AI is widely promoted as a driver of teacher capability, in this sample it was teachers' self-directed digital learning, not their use of AI tools, that was significantly associated with functional skills. Of the two focal variables, informal digital learning therefore emerges as the primary driver.

The study challenges the assumption that adopting AI tools by itself strengthens teachers' practical competencies, confirms earlier work on the value of informal learning and digital competence, and contributes a new perspective by treating AI usage and digital informal learning as distinct predictors in rural, faith-based schools of Southern Pakistan, a context rarely examined. Practically, it supports professional development that builds on informal learning and integrates AI pedagogically and ethically.

The study has limitations. Its cross-sectional design and self-reported questionnaire data limit causal inference; purposive sampling in four areas of Southern Punjab limits generalizability; functional skills were analyzed as a composite, so effects on problem solving, reading, and writing separately remain untested; the AI coefficient was marginal ($p = .065$), and the collinearity diagnostics call for cautious interpretation of the coefficients. Future research should analyze these three sub-variables separately and use longitudinal or mixed-methods designs, probability samples, and objective measures of functional skills.

ACKNOWLEDGMENTS

The authors extend their thanks to the selected Islamic secondary school teachers who were involved in this study. Their valuable ideas made the research possible and

helped point out the strengths and weaknesses of the present approaches to AI and digital learning in education.

FUNDING INFORMATION

The authors declare that no funding was received for this research.

DATA AVAILABILITY

The data supporting this study's findings will be available from Muhammad Kashif Majeed (https://scholar.google.com/citations?user=0_loxwMAAAAJ&hl=en) after an embargo from the date of publication to allow for the commercialization of the research findings.

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