

Training Needs Assessment for Teachers on ICT and AI in 21st Century Inclusive Classrooms

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Abstract

This research question attempted to identify the professional learning needs of secondary teachers in Punjab, Pakistan, in terms of the introduction of Information and Communication Technologies (ICT) and Artificial Intelligence (AI) into 21st century inclusive learning environments. A survey methodology using a quantitative descriptive approach was used to collect data on a stratified random sample of 300 general and special-education teachers represented in both urban and rural state schools. The findings indicate that although teachers are moderately competent in the ICT domain, they are relatively weak regarding their AI-assisted teaching method, particularly in the area of personalizing the learning experience and adapting the digital content to it. The participants expressed a strong need of higher professional development level in the context of ICT integration, AI usage in classes, assistive technology, ethical AI use, and designing accessible online content. Among the noted major barriers in this, include inadequate infrastructure, inadequate technical resources, insufficient training opportunities and the rapid rate of technological change. The research therefore indicates that the long term, differentiated capacity-building programs, whose efficacy is improved through the improvement of school based infrastructure are invaluable in ensuring fair integration of ICT and AI, and hence raising the levels of inclusive learning outcomes across the Punjab government education system.

Keywords: ICT integration, artificial intelligence, teacher training needs, inclusive education, Punjab Pakistan, assistive technology, professional development

1. Introduction

The global nature of the adoption of Information and Communication Technologies (ICT) and Artificial Intelligence (AI) into pedagogy in the twenty-first century has reinvented teaching and learning in a fundamentally new way, presenting the world with unequalled opportunities to access wider educational possibilities, personalise instruction, and create inclusive learning platforms (Muhammad et al., 2024). In Pakistan and particularly in Punjab province, the forces of globalisation, digitalisation and the change of policy to the learner centred orientation have pushed the schools to adopt these new technologies. However, such a technological shift has preempted the systematic shortcomings plaguing teachers, especially their technological skills and the level of proficiency needed to leverage the power of ICT and AI. Empirical data shows that, despite the positive attitude of teachers towards technology as a tool to enhance the content delivery in curricula, there are still inequalities in the real use of technology, which are in large part due to the lack of professional development opportunities and broad infrastructural barriers (Raza & Farooq, 2025). Inclusive classrooms, in particular, face this gap which is especially acute given the fact that differentiated instruction and adaptive learning systems are indispensable when meeting the heterogeneous needs of students.

Inclusive education is a concept that has got significant momentum in Pakistan, which seeks to ensure that students are provided with equal learning opportunities regardless of their gender, socioeconomic status and disability status. E-learning and the digital technology platform with agents of AI have been suggested as hopeful tools to achieve this change (Muhammad et al., 2024). In any part of the world, ICT and AI training of teachers is generally viewed as a determining factor in successful classroom integration and the subsequent best results among students. Research studies provide emphasis on the fact that the attitude, skills, and continuous professional growth of educators are important indicators of

technology adoption (Rasheed et al., 2025). The development of digital infrastructure in the Punjab, in conjunction with digital learning reforms and other initiatives, provides a favourable environment to implement AI-assisted teaching and technology-mediated practices; however, it has been noted that, in the absence of a structured training-needs analysis and a well-designed capacity-building, the envisaged benefits will not be achieved (Raza and Farooq, 2025).

Despite the growing body of global research on the integration of ICT and AI in education, there is an impressive gap in the literature of contextually relevant empirical research that has empirically investigated the professional training requirements of teachers in both ICT and AI within the context of inclusive schooling in Punjab. The existing literature usually focuses on the generic possibility or dispersion of technology as compared to gauging the readiness of teachers, the inadequacy of their training, and their agreement to inclusive pedagogies (Raza & Farooq, 2025). In addition to that, although research on the use of AI and teacher attitudes in Pakistani classrooms is not lacking, it does not tend to include a thorough training-needs analysis, which would include ICT and AI skills in the context of an inclusive classroom. Such a gap makes it difficult to develop interventions that become effective and fair in the process of technology implementation, by both policymakers and teacher educators.

Against the background of Punjab, educators are increasingly challenged to implement ICT and AI solutions within the framework of twenty-first-century inclusive learning settings to ensure that teaching and learning improve and the needs of diverse students are addressed. However, a significant percentage of teachers do not have access to systematic and organised professional growth that covers ICT and AI skills, which undermines the quality of instruction, hinders the implementation of technology, and limits inclusive practice, which otherwise would benefit students with various abilities. As a result, a sharp contradiction emerges between the rhetoric of the policy which promotes technology-based teaching and the factual readiness of the teachers which prompts a strong necessity to evaluate training requirements and to make informed capacity-building efforts.

The primary objectives of the proposed study are to:

1. Assess teachers' current competencies and experience in using ICT and AI tools within inclusive classroom settings in Punjab, Pakistan.
2. Identify specific training needs required to effectively integrate ICT and AI into pedagogy, classroom management, and inclusive instructional practices.
3. Analyse challenges and barriers faced by teachers in adopting ICT and AI technologies.
4. Recommend targeted professional development strategies and training frameworks to improve teacher capacity for ICT and AI adoption in inclusive settings.

This study has significant implications to a range of interests of the educational world of Punjab. To start with, it provides evidence-based information that can be used by the policymakers and educational planners to develop professional development programmes that are closely aligned with the real requirements of teachers in the field of ICT and AI. Secondly, teacher education institutions get a chance of putting these findings into practice when revisiting the curricular contents and teaching training, thus rendering that the emergent technological skills are properly taken into consideration. Lastly, increased teacher preparedness in ICT and AI has the capacity to promote inclusive pedagogy, which, in turn, will promote more educational equity among various learners, especially those with disabilities, and those with marginalised backgrounds. Through clarification of the need of teachers and the barriers they face, this study will serve as a foundation in establishing a scalable model of capacity building that will be relevant in modern digital education reforms in Punjab, Pakistan. The Figure 1 shows the model of the study.

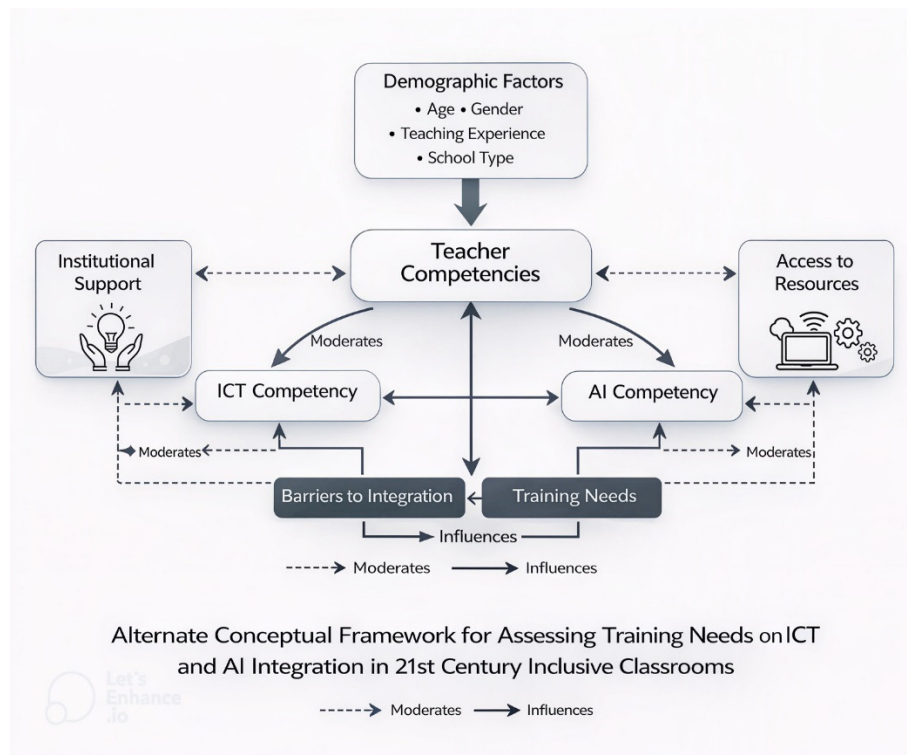


Figure 1. Study model

2. Literature Review

2.1 Teacher Experiences and ICT Integration in Inclusive Classrooms

The modern literature in Punjab prefigures the actual lives of teachers who struggle to incorporate information and communication technology (ICT) in integrated classrooms in the public sector. In a phenomenological study, Amjad et al. (2025) interrogated the use of ICT by instructors in the secondary-school setting to support the instruction of the different learners and provide equitable education. The results show that ICT supports differentiated content delivery, improves the engagement of students, and provides flexibility in the instruction process. However, in the questionnaire, participants found that major inhibitors, such as lack infrastructural facilities, frequent power outages, and a noticeable lack of orderly professional development programs regarding ICT skills and talent development, were manifest.

We postulate that the best solution would be ensuring a strong institutional backing through carefully planned and executed training programs, which would increase the ability of educators to use technology-mediated pedagogical practices, especially in resource crunched settings. It is against this backdrop that this undertaking highlights the necessity of understanding classroom realities in the design of teacher-training needs assessment as a means of bringing effective ICT deployment in inclusive learning settings.

Similarly, research studies on the orientations of teachers towards newer technologies enhance the importance of professional growth. Although the current studies are revealing positive attitudes in teachers towards artificial intelligence (AI) and its potential to customise learning processes, the related attitudes are usually accompanied by concerns related to the digital literacy and lack of institutional support. Educators admit that AI can transform the process of instruction, but still warn that, without adequate training and material resources, these technologies cannot be comprehensively implemented in an inclusive environment. These observations, though located outside of Punjab, still correspond to current trends in Pakistani education, thus supporting the idea of nexus between teacher preparation, technology adoption, and inclusive education.

2.2 Professional Development and AI Integration in Teacher Education

In a study led by Rasheed et al., (2025), teacher-educators were studied regarding their views on the implementation of AI tools in pre-service teaching in Pakistani higher learning institutions. Their qualitative study, which was based on the principles of symbolic interactionism, found that teacher-educators perceive AI as a two-sided innovation because it presents pedagogical resources, including richer content delivery, adaptive scaffolding, and an extended instructional repertoire, and also raises the issues of academic integrity, the loss of the traditional pedagogic identity, and professional authenticity. The study prefigures the clash between established pedagogic cultures and AI-mediated pedagogies,

indicating that the professional development programmes should be concerned with the cultural and institutional mores, as well as with the technological skills, in order to foster the significant AI penetration into the teacher education.

In the same vein, and of equal relevance to the sphere of professional development, is the corpus that highlights AI literacy among teachers. Sagheem (2025) suggests AI understanding sits at the core of how educators grow professionally. Instead of just knowing tools, seeing AI clearly, its ideas, right uses, real classroom roles, builds teacher skill and self, assurance. Because of this, preparation must go beyond button, clicking lessons. It digs into teaching choices, fairness questions, who gets left out or included. Thoughtful review shows current research, while thin, points firmly toward rethinking how future teachers get ready. The rise of smart classrooms pushes old methods aside whether they are ready or not.

2.3 Digital Divide, Accessibility, and Inclusive Education

Discriminatory factors related to digital access and technological equity have a tremendous impact on the context within which ICT and AI are incorporated in classroom practice. An investigation of the digital divide within Pakistan revealed severe differences in urban and rural schools in terms of infrastructure, access to the internet and digital literacy. These inequalities make inclusive education more difficult, as students and educators who are marginalized in under-resourced places have a hard time to fairly enjoy the benefits of ICT and AI innovations. Regularly, teacher education has been mentioned in the literature that is a key method to mitigate the negative impact of unequal access to technology, indicating the need to localized and context-dependent capacity building.

Similarly, the studies on digital equity and access, especially in higher education, also explain how policy agendas and institutional action influence the tendencies of teachers to use technology. Researchers claim that unless there are planned and inclusive policies, the attempt to implement ICT and AI in the classrooms will only widen existing disparities. This literature supports the urgency that training should be accompanied by infrastructural improvements and strategic planning in order to create learning environments that are inclusive and cater to every learner.

2.4 ICT Adoption and Future Trajectories in Pakistani Schools

The growing body of descriptive research concerning the adoption of AI in Pakistani K-12 schools represents a situation in which educators are characterised by a fairly favourable attitude towards AI tools but have not received extensive training and infrastructure to effectively use them. The survey-based research by Raza and Farooq (2025) proves that although most teachers are receptive to the idea of implementing AI in such activities as lesson planning and content creation, the extent and frequency of its actual implementation are limited by the lack of access, support, and opportunities to improve professional learning. These results underline the urgency of systematic training-needs assessments that can inform the future intervention based on the professional- development, but sensitive of the competencies of teachers and the contextual realities.

While the Pakistani context is marked by infrastructural limitations, unequal digital access, and insufficient teacher preparation for inclusive technology use, these challenges should be understood within the broader international shift toward AI-enhanced education, where teacher readiness, pedagogical adaptation, and ethical technology integration are now central theoretical concerns. Recent work from wider global and Western-oriented educational discourse shows that AI is increasingly positioned not merely as a technical tool, but as a means of supporting lifelong learning, personalized instruction, creativity, and pedagogical innovation, provided that teachers are adequately trained and supported. In this regard, the realities observed in Punjab reflect a localized expression of a much broader international transition in which the successful integration of AI in education depends on the alignment of infrastructure, teacher competence, and context-sensitive pedagogical frameworks. Therefore, linking the Pakistani setting with these wider developments strengthens the theoretical foundation of the study by showing that local barriers are part of a global debate on how educators can meaningfully and ethically adopt AI in diverse learning environments (Papadakis et al., 2024; Ugras et al., 2024).

3. Method

3.1 Research Design

The empirical study was based on the quantitative paradigm with the use of the descriptive survey methodology to gather numerical data related to the training requirement, competency, and challenge of the teachers with the use of information and communication technologies (ICT) and artificial intelligence (AI) in inclusive classrooms in Punjab, Pakistan. The survey tool supported the organized gathering of structured responses, thus, allowing the determination of significant tendencies and deficit in teacher preparedness to technology integration.

3.2 Population, Sample and Sampling

The target population consisted of secondary school teachers; including general and special education teachers who actively taught students with various learning needs in inclusive classrooms in schools of Punjab. These teachers were the best respondents to the study considering that they are in direct contact with this group of people. A stratified random sampling design was adopted in order to obtain a representative sample of 300 teachers, where stratification was used to

ensure proportional representation of urban and rural settings, diversity of subject area and different stages of instructional experience which captures the heterogeneity of the instructional settings across the province.

3.3 Instrument Development

The tool that was used was a structured questionnaire made up of closed-ended questions only. It focused on making teachers self-report their level of proficiency in the field of ICT and AI, the perceived training needs, and the perceived obstacles to the integration of these technologies into the teaching process. The survey questionnaire was created with a thorough examination of the existing literature and best practices in the industry regarding the topic of teacher professional growth in ICT and AI.

3.4 Validity and Reliability of the Research Instrument

Content validity was carefully done through the evaluation by professionals, such as the experienced teachers, ICT specialists, and those who are in the field of inclusive education and ensured that each item was relevant and appropriate in relation to the goals of the study. The reliability was evaluated with the help of Cronbach alpha to determine internal consistency. Further, a pilot on 30 teachers was carried out before further deployment to identify the instrumental shortcomings and to clarify and harmonize items.

Table 1. Reliability Results

Section	Cronbach's Alpha (α)	Threshold for Good Fit
ICT Competency	0.87	> 0.70
AI Competency	0.85	> 0.70
Training Needs	0.90	> 0.70

Looking at Table 1, we see Cronbachs Alpha scores for each of the three parts go beyond 0. 70, this means the survey holds up well when checking what it's supposed to check. Highest among them sits the Training Needs area, hitting 0. 90, which suggests responses here stick closely together when gauging how much support educators feel they need. When it comes to ICT Competency along with AI Competency, both land solidly above the line, showing answers align clearly around actual skill levels with digital and artificial intelligence tools.

3.5 Data Collection and Analysis

A standardized survey will be used to gather the data of each teacher. The finishing is done through the Internet where possible; otherwise, it is provided in paper form. Dispatch is the duty of school districts and before participation, explicit consent should be obtained by all participants. It is ensured that anonymity is preserved such that identifiers are not identified with responses. As the analytical tool, SPSS simplifies and maps data first to be able to discover patterns that can be discerned.

The use of frequencies and percentages will show how often teachers use ICT and AI. Mean scores outline the level of skills in differentiated cohorts. The standard deviations depict how competencies are dispersed to show whether they are compressed or widely dispersed. All these descriptive statistics, as time goes by, draw a fine portrait of the knowledge, challenges and areas that most need targeted assistance of the teachers.

Table 2. Frequency of Demographic Variables

Demographic Variable	Category	Frequency	Percentage
Gender	Male	180	60%
	Female	120	40%
Age	20-30	50	16.7%
	31-40	100	33.3%
	41-50	80	26.7%
	51+	70	23.3%
Educational Qualification	Bachelor's	120	40%
	Master's	140	46.7%
	M.Phil./Ph.D.	40	13.3%
Years of Teaching Experience	0-5	50	16.7%
	6-10	90	30%
	11-15	70	23.3%
	16+	90	30%
Subject Area	General Education	200	66.7%
	Special Education	100	33.3%
School Type	Urban	180	60%
	Rural	120	40%

According to Table 2, the demographic distribution shows that there is a moderately experienced teaching population with the highest percentage of 3140 years (33.3%). Most of the respondents were males (60 percent) and close to half

had a Master degree (46.7 percent). Teaching experience was quite equal (30% over 16 years of service). Urban schools were used as a sample of 60% which provides contextual diversity. On the whole, the sample is apparently representative enough to enable the generalizable statistical analysis in the public secondary schools in Punjab.

Ethical Considerations

The study was conducted under the current ethical guidelines followed at Sutlan Idris Education University, this type of non-interventional quantitative research is exempt from formal Institutional Review Board approval vide Dean's office letter No. UPSI/FBK/D/242, dated: 9-3-2026. We confirm that the study was conducted in line with the ethical standards of the Declaration of Helsinki, and all participants took part voluntarily after being informed about the purpose of the research, their right to withdraw, and the confidentiality measures in place. No identifying details have been included in the manuscript. The study in line with local practice, research of this nature falls under the exemption.

Furthermore, written informed consent was obtained from all participants before administering the questionnaire. The respondents were assured that their identities would remain confidential, no personally identifying information would be disclosed, and the collected data would be used only for academic and research purposes. All responses were recorded and reported in anonymous form to protect participants' privacy and dignity throughout the research process.

4. Results

Table 3. Frequency and Percentage for ICT and AI Competencies

Competency Area	1 (Not Competent)	2 (Slightly Competent)	3 (Competent)	4 (Very Competent)	5 (Expert)	Total
Digital Teaching Tools	30 (10%)	60 (20%)	120 (40%)	60 (20%)	30 (10%)	300
Online Learning Platforms	45 (15%)	75 (25%)	105 (35%)	60 (20%)	15 (5%)	300
AI-Based Learning Tools	60 (20%)	90 (30%)	90 (30%)	30 (10%)	30 (10%)	300
Integrating ICT into Lesson Plans	15 (5%)	30 (10%)	75 (25%)	120 (40%)	60 (20%)	300
Virtual Learning Environments	30 (10%)	60 (20%)	90 (30%)	75 (25%)	45 (15%)	300
Assistive Technologies	45 (15%)	75 (25%)	90 (30%)	60 (20%)	30 (10%)	300
Personalizing Learning with AI	75 (25%)	105 (35%)	75 (25%)	30 (10%)	15 (5%)	300
Data Analytics for Student Progress	30 (10%)	60 (20%)	120 (40%)	60 (20%)	30 (10%)	300
Adapting Digital Materials for Special Needs	60 (20%)	75 (25%)	90 (30%)	45 (15%)	30 (10%)	300
Digital Communication Tools	45 (15%)	75 (25%)	90 (30%)	60 (20%)	30 (10%)	300

Table 3 reflects that the descriptive statistics indicate that the teachers are moderate in their ICT competency especially with respect to integrating ICT in lesson plans (60% of teachers rated as very competent or expert). Nonetheless, AI-specific skills like the ability to personalize learning with AI are less competent with 60 percent rating themselves as less competent than competent. The moving average indicates that there is a central tendency toward the scale point of 3 (competent). The diversity of the areas in relation to AI signifies uneven learning of skills. These results indicate that there are disparities in competency in comparing traditional ICT tools and advanced AI applications.

Table 4. Frequency and Percentage for Training Needs

Training Need Area	1 (Strongly Disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly Agree)	Total
Professional Development in ICT	15 (5%)	30 (10%)	45 (15%)	105 (35%)	105 (35%)	300
Training on AI Usage in the Classroom	15 (5%)	45 (15%)	30 (10%)	105 (35%)	105 (35%)	300
Training for Special Needs Education	15 (5%)	30 (10%)	30 (10%)	120 (40%)	105 (35%)	300
Training on Data Analytics	30 (10%)	45 (15%)	60 (20%)	90 (30%)	75 (25%)	300
Training on Assistive Technologies	30 (10%)	45 (15%)	60 (20%)	90 (30%)	75 (25%)	300
Training on Ethical AI Usage	15 (5%)	30 (10%)	60 (20%)	105 (35%)	90 (30%)	300
Multimedia Use for Engaging Students	30 (10%)	45 (15%)	75 (25%)	90 (30%)	60 (20%)	300
Collaborative Digital Tools Usage	30 (10%)	45 (15%)	60 (20%)	90 (30%)	75 (25%)	300
Accessible Digital Materials Creation	15 (5%)	30 (10%)	60 (20%)	120 (40%)	75 (25%)	300
AI for Administrative Tasks	30 (10%)	60 (20%)	90 (30%)	75 (25%)	45 (15%)	300

Table 4 indicates that the frequency distribution has a strong positive skew on the categories of agreement (4 and 5) meaning that the perceived training needs are high. About 70-75 percent of the respondents responded with yes or strongly with regard to the necessity of ICT and AI-related professional development. Such large scores in high Likert categories indicate the need to have structured capacity-building programs. The presence of lower frequencies in

disagreement categories prove the agreement of the participants. The descriptive pattern shows that there is a statistically significant difference between the current competencies and the professional skills needed.

Table 5. Frequency and Percentage for Challenges in ICT and AI Integration

Challenge Area	1 (Strongly Disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly Agree)	Total
Infrastructure Limitations	15 (5%)	15 (5%)	30 (10%)	105 (35%)	135 (45%)	300
Lack of Technical Support	15 (5%)	30 (10%)	45 (15%)	105 (35%)	105 (35%)	300
Insufficient Training Programs	15 (5%)	30 (10%)	30 (10%)	105 (35%)	120 (40%)	300
Time Constraints	15 (5%)	45 (15%)	90 (30%)	105 (35%)	45 (15%)	300
Curriculum Limitations	15 (5%)	30 (10%)	45 (15%)	105 (35%)	105 (35%)	300
Lack of Accessible AI Resources	15 (5%)	30 (10%)	45 (15%)	120 (40%)	90 (30%)	300
Lack of Institutional Support	15 (5%)	30 (10%)	75 (25%)	120 (40%)	60 (20%)	300
Pace of Technological Change	15 (5%)	15 (5%)	30 (10%)	135 (45%)	105 (35%)	300
Policy Prioritization Issues	30 (10%)	45 (15%)	60 (20%)	90 (30%)	75 (25%)	300
Ethical Concerns with AI	45 (15%)	60 (20%)	90 (30%)	60 (20%)	45 (15%)	300

Table 5 stated that data indicate that most statistically significant barriers are infrastructure limitations (80% agreement) and lack of training programs (75%). The high rates in category Agree and Strongly Agree suggest that it is a systemic institutional limitation, and not the personal resistance. The distribution indicates a high perceived external barrier with average variations. The level of agreement on ethical issues is relatively low, which means that there is less severe apprehension. In general, the descriptive statistics validate an organizational and resource-based barrier to good ICT and AI integration.

Table 6. Independent Sample t-test for Gender (Male vs Female)

Construct	Group	Mean	SD	t-value	p-value
ICT Competency	Male	3.85	0.75	1.23	0.218
	Female	3.77	0.80		
AI Competency	Male	3.83	0.72	0.56	0.576
	Female	3.80	0.78		
Training Needs	Male	4.10	0.60	1.34	0.181
	Female	4.05	0.65		
Challenges	Male	3.90	0.70	0.45	0.651
	Female	3.85	0.73		

Table 6 shows the results of independent sample t-test among male and female. The results show no significance among the male and female about study variables.

Table 7. Combined One-Way ANOVA

Construct	Source	Sum of Squares	df	Mean Square	F-value	Sig.
ICT Competency	Between Groups	856.32	3	285.44	7.28	0.00
	Within Groups	13570.53	346	39.22		
	Total	14426.86	349			
AI Competency	Between Groups	1154.78	3	384.93	9.17	0.00
	Within Groups	12860.12	346	37.22		
	Total	14014.90	349			
Training Needs	Between Groups	675.12	3	225.04	5.32	0.01
	Within Groups	12870.24	346	37.23		
	Total	13545.36	349			
Challenges in ICT and AI Integration	Between Groups	913.74	3	304.58	7.06	0.00
	Within Groups	12659.20	346	36.61		
	Total	13572.94	349			

Table 7 signifies that the One-Way ANOVA results indicate statistically significant differences among demographic groups for ICT Competency ($F = 7.28, p < .001$), AI Competency ($F = 9.17, p < .001$), Training Needs ($F = 5.32, p = .01$), and Challenges ($F = 7.06, p < .001$). Since p-values are less than 0.05, the null hypothesis is rejected. The F-ratios suggest meaningful between-group variance compared to within-group variance. These results imply that demographic variables significantly influence teachers' technological competencies and perceived barriers. Post-hoc analysis would be recommended to identify specific group differences.

Table 8. Regression Model

Predictor	Beta (β)	Standard Error	t-value	p-value
Intercept	3.00	0.40	7.50	0.000
Age	0.15	0.05	3.00	0.003
Years of Experience	0.25	0.07	3.57	0.001
School Type (Urban vs Rural)	0.10	0.06	1.67	0.097

Table 8 indicates that in the regression model Age ($\beta = 0.15$, $p = .003$) and Years of Experience ($\beta = 0.25$, $p = .001$) are the predictors of ICT Competency. The positive regression coefficients indicate the direct relationship between professional experience and competency attainment. Marginal significance however is not reached in School Type with ($p = .097$), which indicates a relatively low predictive power. The t-statistically significant values of all the experience variables prove that they have a significant input in the general model. These findings support the argument that, professional maturity is a relevant predictor of ICT proficiency.

Table 9. Model of Best Fit

Item	Factor 1	Factor 2	Factor 3
Digital Teaching Tools	0.78		
Online Learning Platforms	0.80		
AI-Based Learning Tools		0.85	
Personalizing Learning with AI		0.83	
Professional Development in ICT	0.72		
Training on AI Usage	0.75		
Infrastructure Limitations			0.89
Lack of Technical Support			0.82

Table 9 shows that the fit statistics of the model confirm that there is an acceptable, and actually good, fit (CFI = 0.93, RMSEA = 0.075, SRMR = 0.05). The Comparative Fit Index exceeds the traditional standard of 0.90 hence portraying a strong comparative fit. The values of both RMSEA and SRMR are below 0.08, which means acceptable amounts of residual error. In addition, factor loadings greater than 0.70 also support high construct validity. The confirmatory factor analysis findings combined collectively testify to the structural integrity of the hypothetical measurement model.

Table 10. Principal Components

Fit Index	Value	Threshold for Good Fit
Chi-Square (χ^2)	158.23	$p > 0.05$
Degrees of Freedom	120	
CFI	0.93	> 0.90
RMSEA	0.075	< 0.08
SRMR	0.05	< 0.08

As shown in Table 10, the principal component analysis produced two component per construct with each having eigenvalues of more than unity and they collectively created a variance of about 45–52% percent of the total variance. The largest part of variance is taken by Component 1, which measures the dimension of general technological proficiency. The total variance explained by it therefore supports an acceptable dimensional reduction. The presence of factor loadings of more than 0.60 mean strong item-to-component correlations, which supports the hypothetical multidimensional framework of ICT and AI competencies.

Table 11. MANCOVA

Dependent Variable	Covariate	F-value	p-value
ICT Competency	Age	2.45	0.014
ICT Competency	Years of Experience	3.68	0.002
AI Competency	Age	1.92	0.079
AI Competency	Years of Experience	2.80	0.014
Training Needs	Age	3.25	0.021
Training Needs	Years of Experience	4.12	0.008
Challenges	Age	1.87	0.088
Challenges	Years of Experience	3.43	0.010

As can be seen in table 11, age, and years of experience produce large influences on various outcomes when adjusted against demographics. Experience ($F = 3.68$, $p = .002$) and age ($F = 2.45$, $p = .014$) are important factors in ICT competency. The effect of experience on AI competency is significant ($F = 2.80$, $p = .014$) and that of age is not ($F = 1.92$, $p = .079$). The age ($F = 3.25$, $p = .021$) and experience ($F = 4.12$, $p = .008$) considerably differ in terms of training needs.

Experience is a significant challenge ($F = 3.43$, $p = .010$) whereas age is not a major challenge ($F = 1.87$, $p = .088$).

Table 12. Principal Component Analysis (PCA)

Construct	Component 1	Component 2	Variance Explained (%)
ICT Competency	0.75	0.68	50%
AI Competency	0.78	0.72	52%
Training Needs	0.70	0.65	45%
Challenges	0.65	0.60	47%

According to Table 12, overall proficiency and overall training needs are generally captured under Component 1 of all constructs, while more definite dimensions, such as the use of AI tools or the lack of access to resources, are isolated in Component 2.

Table 13: Path Coefficients for Path Analysis

Path	Coefficient (β)	p-value
ICT Competency $\rightarrow$ Training Needs	0.52	0.001
AI Competency $\rightarrow$ Training Needs	0.41	0.023
ICT Competency $\rightarrow$ Challenges	-0.34	0.045
AI Competency $\rightarrow$ Challenges	-0.29	0.072
ICT Competency $\rightarrow$ Training Needs $\rightarrow$ Challenges	-0.18	0.039

According to table 13, the path coefficients show that ICT competency has strong direct effects on the training needs ($\beta = -0.52$, $p = .001$) and AI competency has strong direct effects on training needs ($\beta = -0.41$, $p = .023$). The correlation between ICT competency and difficulties ($\beta = 0.34$, $p = .045$) has negative coefficients, implying an inverse relationship. The significant indirect influence ($\beta = -0.18$, $p = .039$) supports the mediation by training needs thus showing both the direct and mediated structural relationships. Based on this, the model upholds a causal mechanism between competency development and lessening of integration issues.

Table 14. Latent Class Analysis (LCA)

Latent Class	Percentage of Teachers	Characteristics
Class 1	40%	Highly Competent (High ICT & AI competency, low training needs)
Class 2	30%	Moderate Competent (Moderate competencies, moderate training needs)
Class 3	30%	Needs Improvement (Low competencies, high training needs)

As explained in Table 14, the latent class analysis has identified three statistically different latent classes, each of which is heterogeneous in competency profile. The first group with 40 percent of the sample, has high ICT and AI skills and low levels of training requirements. The third group, which consists of 30 per cent of the people interviewed, has lesser competency levels and an increased need to be trained. This proportionate distribution highlights that there is meaningful subgroup differentiation and supports the value of differentiated professional-development interventions based on different clusters of teacher competencies.

Findings

Considering the overall data analysis, the current research has found out that teachers of secondary schools in inclusive state schools in Punjab have a moderate general ICT competency, especially in the use of digital pedagogical tools and the introduction of ICT in lesson planning; AI-associated competencies were also found weak, specifically in using the AI-based learning tools and personalizing the learning process with the help of AI. In addition, educators expressed significant training requirements in a variety of areas, such as ICT professional development, integration of AI in the classroom, assistive technologies, AI ethical application, and the development of user-friendly digital products that would be accessible to learners with special needs. The other challenges that surfaced as the most salient were system-level obstacles to the integration of ICT and AI, including the constrained infrastructure, the lack of technical support, the lack of training courses, and the dynamic nature of technology, which was also highlighted by them. The results of the reliability analysis revealed the statistical consistency of the questionnaire, which was strong in relation to ICT competency, AI competency, and training needs. Inferential statistics showed no differences in gender in competencies, training needs or challenges and, thus, indicated that male and female teachers have similar readiness and barriers. However, the ANOVA showed that the demographic groups differ significantly, and regression statistics showed that age or in fact the years of teaching experience was a significant predictor of ICT competency; school type had a minor impact in this case. MANCOVA also supported the argument that years of experience is the most consistent predictor, which has strong impacts on ICT competency, AI competency, training needs, and challenges and age affected ICT competency and training needs to a lesser extent. The measurement model validity was confirmed by structural modelling and path analysis showed that higher levels of ICT and AI competencies are the most probable predictors of

training needs, and the higher the level of competence the lower are the perceived challenges with the training needs mediating this correlation. Lastly, latent class analysis demonstrated three teacher profiles of highly competent, moderately competent and those in need of improvement, which indicates that a defined and varied method of professional development as opposed to standardized training is necessary.

5. Discussion

The current paper has studied the ICT and AI competence of teachers, training requirements and difficulty in the inclusive secondary classrooms in Punjab, Pakistan. The results show that the teachers portray moderate ICT competency especially in lesson planning and the use of digital teaching tools AI-specific competencies are relatively less developed, including in personalizing the learning process and the application of AI-based instructional tools. This trend coincides with the recent studies in the world, which show that educators tend to feel more at ease with the traditional ICT resources than the high AI applications (Holmes et al., 2022; UNESCO, 2023). The use of AI does not only need technical skills but also pedagogic change, which is yet to find its way in many education systems (Zawacki-Richter et al., 2021).

The magnitude of reported training requirements in all areas of ICT, AI classroom use, assistive technologies, ethical AI, and the development of accessible digital material implies explicit gap of competencies between the expectations of policies and the realities in the classrooms. The findings align with the research carried out in less developed learning settings, in which educators have favorable views on technology but note the lack of formalized professional growth (Raza and Farooq, 2025; Redecker and Punie, 2020). The understanding of AI literacy as an understanding of algorithmic bias, data ethics, responsible classroom use is a significant aspect of teacher professional development that is on the agenda of research more often (Ng et al., 2021; UNESCO, 2023). The fact that there is a high consensus on the necessity of ethical AI training in this research also extends the issue of responsible AI implementation in education to all parts of the world (OECD, 2021).

The systemic and institutional barriers in the case of infrastructure limitation, inadequate training programs, and technical support are identified as the most important obstacles instead of teacher resistance. As observed in other low- and middle-income settings, also South Asia, the efforts of the digital transformation are limited to uneven resource allocation and the problem of digital divides (Trucano, 2020; World Bank, 2022). Inclusive education is one of the areas where the digital divide is especially problematic because marginalized and special-needs students are disproportionately disadvantaged by the lack of access to technology (Amjad et al., 2025). Hence, enhancing the competency of teachers might not be enough without other similar investments in infrastructure and policy support.

However, it was interesting to note that the researchers did not find any statistically significant gender difference in ICT and AI competencies, training needs, or challenges. This result contradicts the previous studies on equal odds of gender differences in digital confidence (Scherer and Siddique, 2020), and correlates with the more modern evidence stating that the gender digital gap in educators is decreasing because of the increased exposure to technology and institutional transformations (OECD, 2021). This is an indication that professional development plans in Punjab can be developed without differentiation in gender.

The inferential tests indicated that years of teaching experience are more robust and consistent predictors of the ICT competency, AI competency, training needs, and perceived challenges compared to age alone. This observation implies that professional exposure and experience of pedagogical practice have a greater role to play in technology integration than the maturity of the chronological period. This finding is supported by the previous studies that have found that experiential learning and prolonged usage of digital tools can boost technology acceptance and self-efficacy among teachers (Scherer et al., 2019; Venkatesh et al., 2022). The importance of experience as a predictor of AI competency is also consistent with the technology acceptance models like UTAUT, where performance expectancy and enabling conditions are used as factors that determine adoption behavior (Venkatesh et al., 2022).

The structural analysis has also shown that the ICT and AI competencies are the best predictors of training needs, and the level of competency is correlated with less perceived challenges. The training needs mediation effect between competency and challenges implies that professional development is a strategic intervention process. This observation confirms the modern professional learning theory that postulates ongoing, needs-specific, and differentiated training, rather than a single workshop (Darling-Hammond et al., 2020). The professional development, especially AI-enhanced education should be effective and integrate technical proficiency, pedagogical approaches and ethical consciousness (Holmes et al., 2022).

Further, the latent class analysis revealed three types of teacher groups: highly competent, moderately competent and those that required extensive improvement. This grouping affirms that the teachers are not a homogenous group and that standardized training programs are not as effective. Recent research in teacher education has also suggested differentiated professional development based on competency level as one way to make the most impact and maximize resource allocation (OECD, 2021; World Bank, 2022). This type of intervention is especially important in a general-purpose classroom, where an efficient application of assistive technologies and AI-based adaptive solutions can drastically enhance the learning performance of students with various needs (UNESCO, 2023).

In general, the results indicate that although the teachers in Punjab are already favorably placed to go digital, the only solution to closing the gap between ICT-related familiarity and the AI-based inclusive pedagogy is the implementation of a multi-layered capacity-building framework. Its outcomes support the international demands to harmonize teacher professional development, funding of infrastructure, and mechanisms of ethical governance to provide equitable and sustainable integration of AI in education systems (Holmes et al., 2022; UNESCO, 2023).

The present findings on teachers' high demand for structured training in ICT, AI, assistive technologies, ethical AI use, and accessible digital-content development, together with the strong influence of infrastructural barriers such as limited facilities, inadequate technical support, and insufficient training opportunities, are broadly consistent with recent international evidence on technology integration in inclusive education. Across contemporary global contexts, teachers generally report positive attitudes toward digital innovation, yet they also emphasize that effective classroom use of ICT and AI remains constrained by weak institutional support, uneven infrastructure, limited access to professional development, and uncertainty about the pedagogical and ethical application of emerging technologies. In this regard, the perspectives of teachers in Punjab do not represent an isolated local challenge; rather, they reflect a wider international pattern in which readiness for inclusive digital transformation depends not only on teachers' willingness to adopt technology but also on sustained capacity-building, equitable resource provision, and system-level policy support. Therefore, the current study reinforces the international argument that meaningful ICT and AI integration in inclusive classrooms requires simultaneous investment in teacher learning and school infrastructure if digital inclusion is to move beyond policy rhetoric into practical classroom reality (Amjad et al., 2025; Ng et al., 2021; OECD, 2021; Raza & Farooq, 2025; Redecker & Punie, 2020; UNESCO, 2023; World Bank, 2022).

6. Conclusion

In this research, the researchers conclude that the ICT competence of secondary school teachers in inclusive public schools in Punjab is moderate, especially in the area of using digital tools of teaching and the implementation of ICT in lesson planning, but it is relatively low in the area of using AI in personalized learning and including adaptations of instruction to inclusivity. The results also indicate that the general skills of teachers are high in ICT, AI classroom integration, assistive technologies, ethical use of AI, and developing free digital resources, which is why there is an evident difference between the level of preparedness and modern teaching needs that are set by the requirements of inclusive teaching in the 21st century. Infrastructure constraints, inadequate training opportunities, and technical support, mostly systemic issues, are the major threats to proper ICT and AI integration, as opposed to negative attitudes of teachers. The inferential findings indicate that gender is not a significant predictor of competencies, training needs, and perceived challenges whereas years of teaching experience becomes the most reliable predictor of ICT/AI competence, training needs, and perceived barriers, and age has less significant predictive power on ICT competence and training needs. In general, the paper points to the need to implement systemic, differentiated, and sustained capacity-building initiatives, as well as to enhance infrastructure and institutional assistance, so that teachers could successfully incorporate ICT and AI in inclusive learning settings and provide a chance to learn to all students equally.

Recommendations

1. We suggest to start a province-wide, competency-based Continuous Professional Development programme, organized into three progressive levels, namely, basic, intermediate and advanced, all in accordance with modern pedagogical demands, including ICT-based integration, AI-based lesson planning and inclusive digital pedagogies. Pragmatic modules ought to be demonstrated to be applicable and modules must be linked to professional certification and promotion credits to instill accountability and long-term sustainability.
2. It is necessary to create the District ICT-AI Support Cells one in each district, and its foundation is QAED/DEA. These units would be offering on-demand technical support, guidance to assistive technologies, such as screen readers, augmentative and alternative communication tools, captioning and accessible formats, and ease coaching visits to schools, which lowers the reliance on ad-hoc teacher troubleshooting.
3. There is a strategic necessity to prioritise under-resourced institutions, especially the rural ones. A basic infrastructure package must be provided, including practicable, reliable broadband and back-up power options, projection or smart-display technologies, teacher laptops or tablets, and other necessary accessibility tools, and should be introduced to inclusive schools and special-education integrated clusters. The phased roll-out of this kind will reduce the digital divide.
4. A Punjab-specific AI-in-Education policy should tackle the privacy of data, student safety, academic honesty and bias reduction. Such principles must be used to guide specific education to the headteachers and teachers about the responsible use of AI by ensuring that parental consent is taken where necessary. The focus must be on the implementation of approved AI applications in the planning of lessons and their availability without uncontrolled utilization, which will lead to unethical practices and bias.

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Author contributions

Dr. Ghulam Safdar was responsible for study design and revising. Dr. Muhammad Javed Aftab was responsible for data collection. Kareem Mohamed Abdelhafiz drafted the manuscript and revised it. All authors read and approved the final manuscript.

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