

From Potential to Practice: Challenges of Integrating Artificial Intelligence Technologies in School Classrooms

Norah Almusharraf¹ and Muhammad Imran^{1,2}

¹Prince Sultan University, Riyadh, Saudi Arabia

²Khazar University, Baku, Azerbaijan

nmusharraf@psu.edu.sa

Abstract: This study investigates the integration of Artificial Intelligence Technologies (AIT) into classroom teaching, focusing on three factors: teachers' access to AIT tools, the frequency of their use, and the key challenges and barriers to integrating AIT for e-learning. A quantitative, survey-based approach was employed to address the study's research questions. A 25-item questionnaire was administered to 90 elementary and secondary school teachers, and the data were analysed descriptively and correlationally using SPSS (version 23). The findings reveal that teachers have limited access to various AIT applications, receive inadequate training, and face infrastructural challenges. More than half of the teachers (54%) reported using the Internet to prepare lessons and carry out other teaching activities. Despite recognizing AIT's potential to enhance teaching effectiveness, educators reported attitudinal and systemic barriers to its integration. This study offers original evidence on AIT integration in elementary and secondary classrooms in Pakistan, a context that remains underrepresented in the literature, by examining teachers' actual access, usage patterns, and the systemic barriers they face, and by situating these findings within established technology-adoption frameworks to offer policy-relevant insights.

Keywords: Artificial Intelligence Technologies (AIT); Technology Adoption Barriers; Classroom Technology; Teacher Technical Knowledge; E-learning

1. Introduction

In this technologically advanced era, the integration of Artificial Intelligence Technologies (AIT) in education has emerged as a transformative force, reshaping traditional pedagogical paradigms and redefining the dynamics of teaching and learning (Marengo & Pange, 2024; Bashir et al., 2025; Imran et al., 2024a, 2024b; Maqbool et al., 2024). AIT integration can improve learners' outcomes while also helping to minimize technology access and equity gaps that are necessary to address for success in the 21st century (Berisha Qehaja, 2025; Akinoso, 2023). While developed nations have embraced AI as a cornerstone of modern education, developing countries such as Pakistan face distinct challenges in harnessing its potential (Shoukat, 2024), including inadequate technological infrastructure, overcrowded classrooms, and constrained annual education budgets (Mannuru et al., 2023; Alam et al., 2023). As the application of AIT in teaching and learning expands worldwide, the need to investigate the challenges faced by students and teachers, the adequacy of study materials, and the pedagogical techniques required to build effective, AIT-integrated learning environments has grown correspondingly (Hamzah et al., 2024; Gull et al., 2020).

This research critically examines AIT integration in elementary and secondary school classroom practices for e-learning, exploring how technology can be strategically incorporated into teaching methodologies to bridge educational disparities, enhance student engagement, and foster 21st-century skills. By examining the infrastructural, attitudinal, and policy-related barriers to AIT adoption, this study aims to propose context-sensitive solutions that align with global trends and address the specific needs of the Pakistani educational landscape. In doing so, it aims to contribute to the ongoing discourse on educational innovation by offering a grounded perspective on how AIT can catalyse equitable and sustainable educational reform in resource-constrained settings. This study further assesses teachers' technical knowledge (TK), that is, their ability to apply information and communication technology tools to classroom activities and everyday professional tasks after developing a working understanding of AIT tools.

Specifically, this study addresses the following research questions: (1) To what extent do teachers have access to AIT tools, and what is their level of technical knowledge in using them? (2) How frequently do teachers integrate AIT tools into classroom activities? (3) What key challenges and barriers hinder the integration of AIT in Pakistani school classrooms?

2. Literature Review

A growing body of research demonstrates that the integration of AIT into educational systems has significantly transformed teaching methodologies worldwide (Tam et al., 2017; Gull et al., 2020; Huang et al., 2024; Maqbool et al., 2024; Asad et al., 2021). Over the past five years in particular, institutions have seen a marked increase in

research examining the role of AIT in classrooms, particularly in developing countries such as Pakistan (Butt et al., 2020). For instance, Aldhafeeri and Alotaibi (2023) proposed a new educational model, Digital Education Shifting (DES), to support quality digital learning in K-12 education. Related evidence indicates that AIT can increase student engagement, encourage collaborative learning, and provide access to extensive resources, thereby improving educational outcomes (Zaremozhzabieh et al., 2024).

Similarly, Meace-Williams (2024) and Wilson (2023) argue that effective AIT integration cannot occur without a corresponding shift in pedagogy: teachers can no longer treat digital tools merely as peripheral aids but must come to view them as instruments capable of transforming teaching practice. These studies further emphasize the importance of sustained professional development programs, given the central role that teachers' AIT-related skills play in successful integration.

To support e-learning trends, Maqbool et al. (2024) and Gull et al. (2020) investigated emerging trends in e-learning, with particular attention to teachers' perceptions of technology for collaborative learning without physical boundaries; they found that fuzzy-interface systems could enhance e-learning both within and outside the formal classroom while also promoting collaboration. AIT also offers advantages for accommodating diverse learning styles: technology can enable personalized learning experiences tailored to individual students' needs (Van Deursen et al., 2020). More broadly, it is widely recognized that education is shifting from traditional chalk-and-talk instruction toward interactive, technology-enabled learning models. In a systematic review, Hsu, Ching, and Grabowski (2013) emphasize that technology-integrated learning environments become more interactive, participatory, and student-centred, qualities that are necessary for developing critical thinking and problem-solving skills.

The above-discussed literature demonstrates broad, cross-national interest in AIT integration; however, much of it remains descriptive, cataloging adoption trends or barriers without engaging critically with the theoretical mechanisms that explain why some teachers adopt AIT while others do not. Established technology-adoption frameworks offer a useful lens for interpreting these patterns. The Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) emphasize perceived usefulness, perceived ease of use, and facilitating conditions as key predictors of technology adoption, while the Technological Pedagogical Content Knowledge (TPACK) framework highlights the interaction between teachers' technological, pedagogical, and content knowledge as a precondition for meaningful integration. Few studies (Barakabitze et al., 2019; Alam et al., 2023; Maqbool et al., 2024), however, have applied these frameworks to elementary and secondary school contexts in developing countries, and fewer still have examined Pakistan specifically, where the infrastructural constraints and teacher-training gaps documented by Butt et al. (2020) and Shoukat (2024) may interact with facilitating conditions differently than in the higher-education or developed-country settings that dominate the existing literature. This gap motivates the present study, which draws on TAM, UTAUT, and TPACK to examine teachers' access to AIT tools, their technical knowledge, and the structural and attitudinal barriers that shape AIT integration in Pakistani elementary and secondary classrooms.

3. Methods

This study employed a quantitative, questionnaire-based approach to examine the integration of AIT in classroom teaching at primary and elementary school levels.

3.1 Participants and Sampling

A stratified random sampling technique was used to select participants from **18 primary and elementary schools** from both rural and urban locations. Of the 100 teachers initially selected, 110 questionnaires were distributed. Ninety-six questionnaires were returned (87.3% response rate), and 90 were retained for analysis after six incomplete responses were excluded (81.8% usable response rate). Figure 1 presents the participant recruitment flowchart.

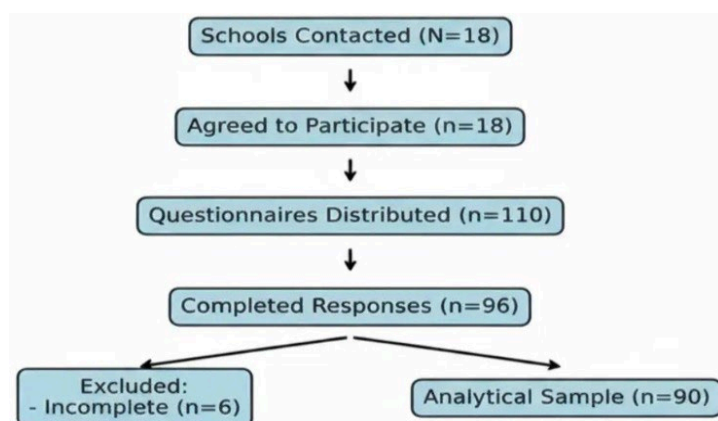


Figure 1: Participants' Recruitment Flowchart

Questionnaires were distributed without discrimination based on gender, qualification, teaching experience, or subject specialization. Nonetheless, as reported in Section 4.1, the achieved sample was heavily skewed toward male respondents (91.11%); this imbalance was not by design and is addressed as a limitation of the study in Section 5.3.

3.2 Instrument Development and Validation

The questionnaire consisted of 25 items organized into three sections: (a) teachers' access to Artificial Intelligence Technologies (AIT) tools and technical knowledge, (b) the frequency of AIT use in classroom activities, and (c) perceived barriers to AIT integration. Responses were measured on a five-point Likert scale ranging from 1 (Never/Strongly Disagree) to 5 (All the Time/Strongly Agree). The questionnaire was developed following an extensive review of the literature and adapted from previous studies on artificial intelligence technologies, educational technology integration, and teachers' technology adoption. The questionnaire was self-developed based on an extensive review of the literature on AIT integration, teacher technology adoption, and digital competence. To establish content validity, the instrument was reviewed by two experts in educational technology and teacher education, who evaluated the relevance, clarity, and comprehensiveness of the items. Their recommendations were incorporated into the final questionnaire before administration. The instrument was also pilot-tested with 10 teachers who were not included in the main study to ensure the clarity, readability, and feasibility of the questionnaire.

3.3 Data Analysis

Data were analysed descriptively using SPSS (version 23), including frequency counts, percentages, means, and standard deviations. Spearman's rank-order correlation was used to examine the strength and direction of association between the five AIT adoption activities reported in Table 2.

3.4 Ethical Considerations

This study was conducted in accordance with the ethical research standards of Prince Sultan University, which granted approval prior to data collection. Participation was voluntary, and all participants provided informed consent after being briefed on the purpose of the study, their right to withdraw at any time without penalty, and the measures taken to protect the anonymity and confidentiality of their responses. No personally identifiable information was collected, and no minors, patients, or animals were involved in this study.

4. Findings and Discussion

Data collected from the 90 respondents were analysed descriptively, using frequencies, percentages, means, and standard deviations, and correlationally, using Spearman's rank-order correlation to examine relationships among AIT adoption activities.

4.1 Descriptive Statistics

The demographic profile of respondents is an important consideration in interpreting the findings of this study. Of the 90 teachers surveyed, 82 (91.11%) were male, and 8 (8.89%) were female. Regarding teaching experience,

43 teachers (48%) reported 6–10 years, 25 (28%) reported more than 10 years, 12 (13%) reported less than 1 year, and 10 (11%) reported 1–5 years. Regarding school location, most teachers (55; 61.11%) were based in urban areas, compared with 35 (38.89%) in rural areas. Most respondents (61; 67.78%) taught at the elementary level, while 29 (32.22%) taught at the secondary level. Regarding highest qualification, 61 teachers (68%) held a bachelor's degree, 10 (11%) held a master's degree, and 19 (21%) held an M.Phil.

4.2 Teachers' Access to AIT Tools and Technical Knowledge (TK)

Table 1 presents the availability of AIT tools and teachers' self-reported level of knowledge in using them. Most teachers reported access to a smartphone with an internet connection (97.78%) and the ability to open email messages (97.78%), while 72.22% reported having a PC or laptop at home. Only 28.33% of teachers reported being able to use an AI tool such as ChatGPT for lesson planning, despite 95.55% reporting that they could search for a topic using ChatGPT, DeepSeek, or other AI chatbots — a gap suggesting that many teachers are comfortable with general-purpose AI search but have not yet adopted AI tools specifically for instructional planning. Similarly, while 75.55% of teachers could install apps from the Play Store and 64.44% could upload files to the internet, only 41.11% reported being able to create a presentation using MS PowerPoint, indicating a specific gap in presentation-software skills relative to more general digital literacy.

Table 1: Accessibility of Participants to AIT Tools and Technical Knowledge

No.	Item	Frequency	Percentage (%)
1	I have a smartphone with an internet connection.	88	97.78
2	I have a PC/laptop at home.	65	72.22
3	I can open my email messages.	88	97.78
4	I can use an AI tool (e.g., ChatGPT) for lesson planning.	25	28.33
5	I can install apps from the Play Store on my phone or computer.	68	75.55
6	I can search for a topic using ChatGPT, DeepSeek, or other AI chatbots.	86	95.55
7	I can write a suitable prompt to create images using AI tools.	50	56.66
8	I can upload files to the internet.	58	64.44
9	I can create a presentation using MS PowerPoint.	37	41.11
10	I can compose a letter using a word processor.	58	64.44

Table 2 reports the frequency of use of specific AI-powered tools and digital platforms for instructional preparation, captured on a five-point Likert scale (Never, Rarely, Sometimes, Often, All the time). The most prevalent activity was "Use of ChatGPT to prepare lessons" (Activity 1), with the largest share of respondents (54.44%) reporting "Sometimes" and a mean frequency of $M = 2.77$ ($SD = 0.86$). A similar pattern of moderate, occasional use emerged for "Use of AI applications to prepare a presentation for lessons" (Activity 3), with 60.00% responding "Sometimes" and a nearly identical mean of $M = 2.78$ ($SD = 0.92$). Together, these results suggest that ChatGPT and comparable AI presentation tools are becoming embedded, though not yet dominant, components of lesson planning for a substantial share of teachers, with moderate variability in usage intensity across the sample. "Download/upload/browse material from a learning platform" (Activity 4) recorded the highest mean ($M = 3.00$, $SD = 1.10$), while "Look for online professional development opportunities" (Activity 5) recorded the lowest ($M = 2.60$, $SD = 0.97$), indicating that teachers engage somewhat more consistently with retrieving instructional material than with pursuing their own professional development online.

Table 2: Frequency and Percentage of AIT Integration in Classroom Activities

No.	Activity	Never	Rarely	Sometimes	Often	All the time	Mean	S.D.
1	Use of ChatGPT to prepare lessons	7 (7.77%)	22 (24.44%)	49 (54.44%)	9 (10.00%)	3 (3.33%)	2.77	0.86
2	Use of AI chatbots to collect resources for lessons	15 (16.66%)	10 (11.11%)	44 (48.88%)	14 (15.55%)	7 (7.77%)	2.89	1.21
3	Use of AI applications to prepare a presentation for lessons	14 (15.55%)	9 (10.00%)	54 (60.00%)	9 (10.00%)	4 (4.44%)	2.78	0.92
4	Download/upload/browse material from a learning platform	9 (10.00%)	14 (15.55%)	43 (47.77%)	17 (18.89%)	7 (7.77%)	3.00	1.10
5	Look for online professional development opportunities	12 (13.33%)	25 (27.77%)	35 (38.88%)	14 (15.55%)	4 (4.44%)	2.60	0.97

Figure 2 shows the Spearman's rank correlation coefficients between the five AIT adoption activities. Each coefficient measures the strength and direction of a monotonic relationship between activity pairs, with values close to +1 indicating a very strong positive relationship; diagonal values equal 1.00 by definition, reflecting the perfect self-correlation of each activity. All off-diagonal coefficients exceed 0.86, reflecting consistently strong positive associations among the AIT adoption activities in this sample.

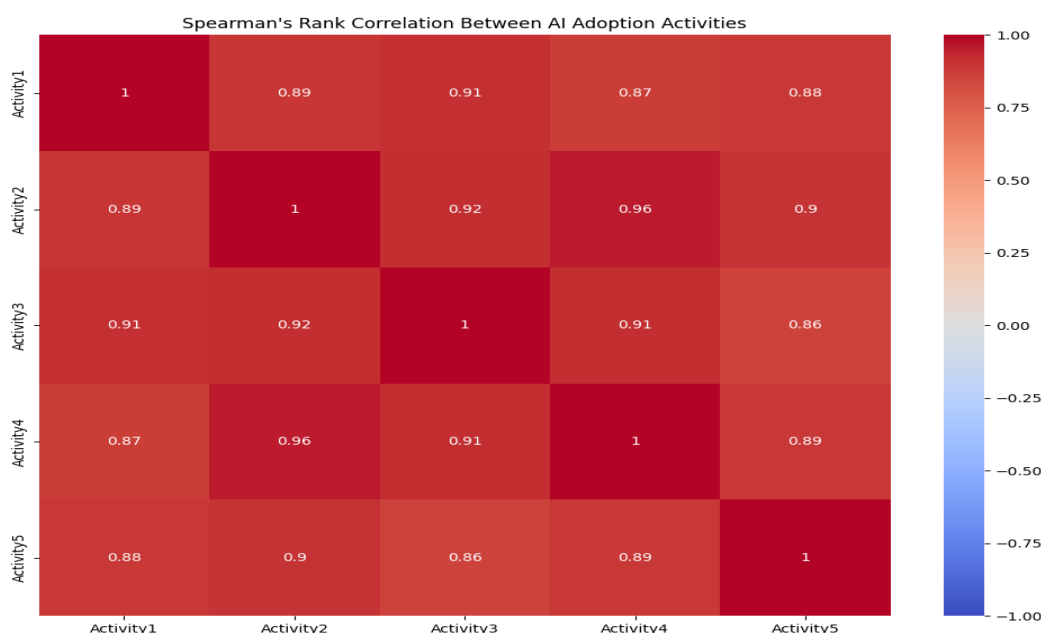


Figure 2: Spearman Correlation Between AIT Adoption Activities

The strongest relationship was between Activity 2 (use of AI chatbots to collect lesson resources) and Activity 4 (downloading/uploading/browsing material from a learning platform), at 0.96. In practical terms, this suggests that these two behaviours are not adopted independently: a teacher who regularly turns to an AI chatbot for resources is, in this sample, almost certain to also be a regular user of online learning platforms, which is consistent with both behaviours drawing on the same underlying digital-resource-seeking habit rather than on distinct skill sets. Activity 3 (AI-assisted presentation preparation) maintained consistently high correlations with all other activities (0.86–0.92), suggesting it functions as a central, integrative behaviour within teachers' broader pattern of AIT use. The lowest observed correlation, between Activity 3 and Activity 5 at 0.86, is still a strong positive association, indicating that even the least closely related activities in this dataset tend to co-occur. Because all five activities are drawn from the same respondents and rated on the same underlying construct of AIT engagement, these uniformly high correlations should be interpreted with some caution: they may partly reflect a general disposition toward AIT use (or toward more positive self-report) rather than five fully independent behaviours, a possibility we return to in the Limitations (Section 5.3).

Beyond adoption patterns, the analysis identifies several barriers that impede AIT integration in schools (Table 3). Organisational constraints were the most strongly endorsed barriers: pressure to prepare students for examinations ($M = 2.94$, $SD = 1.05$) and inflexible school schedules ($M = 2.85$, $SD = 0.93$) left teachers little room to experiment with AIT tools during instructional time. Infrastructural barriers were also prominent, particularly a lack of internet-connected computers ($M = 2.69$, $SD = 0.91$), while the sheer shortage of computers was rated as a comparatively more moderate concern ($M = 2.32$, $SD = 0.79$). Teachers were similarly dissatisfied with technical support ($M = 2.33$, $SD = 1.02$) and, to an even greater extent, with pedagogical support for AIT integration ($M = 2.14$, $SD = 0.91$), suggesting that the absence of in-school pedagogical guidance is felt more acutely than the absence of technical troubleshooting. Attitudinal barriers were comparatively less pronounced: teachers' own attitudes toward AIT ($M = 2.02$, $SD = 0.92$) and their perception that AIT offers limited benefit ($M = 2.42$, $SD = 1.28$) were rated lower than the structural barriers above, suggesting that teachers are not, in the main, resistant to AIT on personal or attitudinal grounds; rather, structural and organisational constraints appear to be the primary obstacle to integration in this sample.

Table 3: Perceived Barriers to AIT Integration

Barrier	Mean	S.D.
Insufficient number of computers	2.32	0.79
Lack of internet-connected computers	2.69	0.91
Inadequate technical support	2.33	1.02
Inadequate pedagogical support	2.14	0.91
Inflexible school schedules	2.85	0.93
Pressure to prepare students for examinations	2.94	1.05
Negative teacher attitudes toward AIT	2.02	0.92
Teachers' lack of interest in AIT	2.59	1.21
Low perceived benefit of AIT in teaching	2.42	1.28
Low institutional prioritisation of AIT	2.02	0.98

5. Discussion

5.1 Interpreting the Findings

Consistent with Butt et al. (2020) and Shoukat (2024), the findings show that structural and organisational barriers — inflexible schedules, examination pressure, and inconsistent access to internet-connected computers — are rated as more significant obstacles to AIT integration than teachers' own attitudes toward the technology. This pattern aligns with the facilitating-conditions component of UTAUT, which holds that even motivated users will not adopt a technology consistently if the organisational and infrastructural conditions for doing so are absent. In our data, teachers reported comparatively low negative attitudes toward AIT ($M = 2.02$) alongside comparatively high organisational barriers ($M = 2.85$ – 2.94), indicating that the barrier to integration in this sample lies less in teacher willingness and more in facilitating conditions — a distinction with direct implications for policy, since it suggests that attitude-change campaigns alone are unlikely to be as effective as investment in infrastructure and scheduling flexibility.

The moderate-but-inconsistent usage pattern reported in Table 2 (means of 2.60–3.00 on a five-point scale, all clustering around "Sometimes") is also consistent with a TPACK-informed reading of the data: teachers appear to possess sufficient technical knowledge to use AIT tools occasionally, but the absence of dedicated pedagogical support (the lowest-rated item in Table 3, $M = 2.14$) suggests a gap in the pedagogical and technological-pedagogical knowledge components of TPACK, rather than in technical knowledge alone. This may explain why general-purpose AI search (95.55% able to use ChatGPT/DeepSeek to search a topic, Table 1) is far more

widespread than AIT use specifically for lesson planning (28.33%): teachers appear to have crossed the threshold of basic technical competence but not yet the further threshold of integrating AIT into pedagogical design.

The uniformly strong Spearman correlations among the five adoption activities (all $r > 0.86$) extend, rather than merely replicate, prior descriptive findings on AIT adoption trends (Maqbool et al., 2024; Gull et al., 2020): they indicate that in this sample, AIT adoption behaviours do not develop independently but cluster together, consistent with the view that teachers develop a general disposition toward digital-resource use rather than adopting individual tools in isolation. This is a significant contribution relative to prior studies, which have typically reported adoption rates or barriers item-by-item without examining how these behaviours relate to one another.

5.2 Contribution

This study extends the existing literature in three ways. First, it provides original survey evidence from elementary and secondary school teachers, a population that remains underrepresented relative to the higher-education focus of much prior AIT research (Bashir et al., 2025; Imran et al., 2024a, 2024b). Second, by combining descriptive statistics on access, technical knowledge, and usage with a correlational analysis of how adoption behaviours relate to one another, it moves beyond a simple inventory of barriers toward an account of how these barriers and behaviours are structured. Third, by interpreting these patterns through TAM, UTAUT, and TPACK, it offers a theoretical account of why structural and pedagogical-support barriers, rather than teacher attitudes, appear to be the binding constraint on AIT integration in this context — a finding with direct implications for how limited resources should be allocated by policymakers and school administrators.

5.3 Limitations

This study has several limitations. First, the sample was drawn from the primary and elementary levels and was heavily skewed toward male teachers (91.11%), which limits the generalisability of the findings to other regions and to more gender-balanced teaching populations. Second, the study relies exclusively on self-reported, cross-sectional survey data; actual classroom observation or log data on AIT use were not collected, and no qualitative data (e.g., interviews or classroom observations) were gathered, so the findings should be read as teachers' perceptions of their access, use, and barriers rather than as directly observed behaviour. Third, because all five adoption activities in Table 2 were measured on the same self-report instrument, the uniformly high correlations between them may be partly inflated by common-method variance rather than reflecting five fully independent behaviours. Future research, discussed further in Section 6.2, should address these limitations through multi-region sampling, gender-balanced recruitment, and the incorporation of qualitative or observational data.

6. Conclusion

This study examined the current state of AIT integration in school classrooms. More than half of the teachers surveyed (54%) reported using the Internet to prepare lessons and carry out other teaching activities, yet only 28.33% reported using AI tools specifically for lesson planning, and opportunities for professional development in this area remain limited. The findings reveal moderate but inconsistent engagement with AIT tools, driven less by teachers' attitudes than by inconsistent infrastructural access, insufficient pedagogical support, and organisational constraints such as inflexible schedules and examination pressure. Addressing these gaps, particularly through infrastructure investment, continuous training, and dedicated pedagogical support, has the potential to improve teachers' capacity to integrate AIT and, in turn, to improve educational outcomes in school classrooms.

6.1 Recommendations

The findings of this study suggest that stakeholders should prioritise equitable access to AIT tools, including reliable internet-connected devices and learning platforms, across both urban and rural areas. Mandatory training programmes focused specifically on AI-tool use and broader AIT skills should be introduced, and schools should establish dedicated technical and pedagogical support teams to assist teachers in troubleshooting and integrating AIT tools into classroom activities. Given that examination pressure and inflexible scheduling were rated among the most significant barriers, school administrations should also consider building dedicated time for AIT-supported lesson preparation into teachers' schedules.

6.2 Future Implications

This research highlights several directions for future work. The study could be replicated across other regions, with a more gender-balanced sample, to compare urban–rural disparities and the effects of national policy. A longitudinal design would help assess the long-term effects of AIT integration on student engagement and performance, while a mixed-methods extension incorporating classroom observation or teacher interviews would help validate the self-reported patterns identified here. Future research should also examine the role of school administration and leadership in driving AIT adoption through blended learning models.

Acknowledgments

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Ethics Declaration

This study followed all applicable ethical principles for research with human participants; no animal subjects were involved. See Section 3.4 for full details of the ethical approval and consent procedures.

AI Declaration

No AI tool has been used to write this draft. However, we used Grammarly Premium for proofreading and language improvement in this study.

Conflict Declaration

The authors declare no conflict of interest.

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