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Teachers' preparedness, attitudes, and perceived impact of technology use in lesson delivery in selected Zimbabwean schools

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Abstract

This study investigated teachers' preparedness, attitudes, and the perceived impact of technology use in lesson delivery in selected Zimbabwean secondary schools. Guided by the Technology Acceptance Model (TAM) and the Technological Pedagogical Content Knowledge (TPCK) Framework, it examined how teacher readiness, institutional support, and infrastructure affect ICT integration. Quantitative data from 59 teachers were analysed using SPSS version 30. Results indicated that teachers generally had positive attitudes and moderate ICT competence, recognising technology's benefits for student engagement and performance. However, inadequate infrastructure and limited support constrained effective use. The study recommends continuous training, improved resources, and supportive policies for sustainable ICT-driven education.

Keywords Technology integration · Teacher preparedness · ICT in education · Digital pedagogy · Zimbabwean secondary schools

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1 Introduction

In recent years, the rapid advancement and declining cost of digital technologies have created new opportunities to enhance teaching and learning in Zimbabwean schools (UNICEF, 2023). The integration of instructional technologies such as computers, mobile devices, digital resources, and internet-based platforms has the potential to enrich lesson delivery, enhance teaching practices, and improve student performance (Sabri et al., 2024). For this potential to be realized, teachers must be prepared, possess positive attitudes toward the technology, and recognize its utility in their instructional practice. Without such alignment, even well-resourced schools might not be able to successfully realize significant technology integration (Williams et al., 2023).

Across the world, studies emphasise that despite the significant investments by most countries in learning technologies, teacher preparedness and attitudes are the primary drivers of successful integration. For example, a systematic review of Technology Acceptance Model (TAM) research found about 2,700 TAM-relevant publications up to mid-2022, signalling a dramatic increase in studies triggered by the Coronavirus Disease 2019 (COVID-19) pandemic (Rosli et al., 2022). Furthermore, these findings suggest that psychological factors such as perceived ease of use and perceived usefulness continue to play an important role in the adoption of technology within education (Perienen & AI Sultan, 2020). A study done on teachers' attitudes toward information and communication technology (ICT) integration in South Africa found that professional development improved teacher's attitudes and intentions, but the actual implementation of technology in classrooms remained slow due to infrastructural and systemic constraints (Moosa & Ramnarain, 2023). A systematic review of online teacher education technologies in Africa (2014–2024) found that although countries such as Kenya, South Africa, and a few others are leading in innovation, many regions continue to face challenges such as inadequate infrastructure, poor internet connectivity, and limited teacher training (Oubibi et al., 2024).

A study in South Africa's rural schools found that ruralness, internet connectivity challenges, absence of equipment, and poor teacher training greatly hindered ICT integration (Ahiaku et al., 2025). Another research study conducted in Nigeria examined teachers' attitudes toward the integration of ICT and found a weak but positive relationship between these attitudes and students' performance, highlighting the importance teacher attitude while also suggesting the influence of other factors such as resource availability (Adam & Too, 2024). Generally, teacher preparedness and attitudes are widely recognized as crucial factors influencing the integration of ICT in education. However, rural and resource-poor environments face multifaceted challenges that limit effective ICT adoption. Studies indicate that these challenges include unreliable electricity supply, limited internet connectivity, insufficient hardware, lack of comprehensive teacher training, and inadequate policy support (Ahiaku et al., 2025; Mkhonto & Mubangizi, 2024; Shambare & Jita, 2025).

A study conducted in Zimbabwe on teachers' readiness to use technology in teaching found that the use of technology depends on several factors, including professional development, institutional support for devices and internet connectivity, and national policy initiatives (Magwa et al., 2025). For instance, a countrywide study showed that Zimbabwean secondary school teachers have an intermediate level of

digital competence, scoring 3 out of 5 on the Digital Competence Framework (DCF) scale, suggesting that while teachers have some skills, there are still notable gaps in capacity (Dabengwa et al., 2024). Moreover, research of urban primary school English teachers in the Bulawayo region found that, although teachers were positive about using ICT, many lacked sufficient preparation, and schools had inadequate ICT tools and technical support (Chimhenga, 2025). Policy-level reviews also show misalignment between Zimbabwe's "Education 5.0" digital ambitions and the reality of teacher education and school infrastructure (Mweha, 2025). At the teacher-education level, the absence of a context-relevant model for ICT integration has been identified as a barrier (Dzinoreva et al., 2023). Additionally, investigations into ICT use by school heads found lack of competency and weak institutional support as major inhibitors (Admire & Patience, 2024).

Building on this background, the present study focuses on three related concepts in some selected schools in Zimbabwe: (1) teachers' willingness to use technology in teaching; (2) their attitudes towards technology use; and (3) their perceptions of technology's impact on teaching and learning. By investigating these constructs and how they relate to one another, the study seeks to investigate teachers' preparedness, attitudes, and perceptions regarding the integration of technology in classroom instruction in rural secondary schools in Zimbabwe. The study therefore seeks to address or fill this existing gap in the literature. The specific objectives of the research study are to:

1. Determine the level to which teachers use technology in teaching among Secondary Schools in Chipinge District.
2. Assess teachers' preparedness and attitude towards integrating technology in teaching.
3. Identify the challenges that affect the effective integration of technology in rural secondary schools.
4. Investigate the perceptions of the impact of technology use on students' learning outcomes and engagement.

1.1 Literature review

This study is guided by two theoretical models: the Technology Acceptance Model (TAM) and the Technological Pedagogical Content Knowledge (TPCK) model. Together, they offer a good foundation for understanding educators adopt technology and how they effectively integrate it into teaching practices.

1.1.1 Technology acceptance model (TAM)

The questionnaire was developed based on the TAM (Davis, 1989) and related literature on technology integration in education, which emphasizes three core constructs: perceived usefulness (the extent to which technology can improve job performance), perceived ease of use (how simple and effortless it is to use), and behavioural intention (the willingness or plan to use technology in lesson delivery). While the instrument was informed by TAM constructs, the items were contextualized to reflect the

realities of rural public secondary schools in Zimbabwe. Several external variables were also considered to contextualize TAM for this setting, including teacher preparedness and attitudes toward technology, challenges in technology integration, and perceived impact on students. These factors are highly relevant in rural schools, where limited ICT infrastructure, training opportunities, and resource availability can influence teachers' perceptions of technology. In line with TAM, such external variables affect perceived usefulness and perceived ease of use, which in turn shape teachers' behavioural intentions and actual technology use. Content validity was ensured through expert review by two specialists in educational technology and research methodology, and the internal consistency reliability of the constructs was assessed using Cronbach's alpha, with all scales demonstrating acceptable reliability coefficients above the recommended threshold of 0.7 (Nunnally, 1978). Recent research studies continue to support the validity of the TAM in educational contexts, including teachers' acceptance digital tool. For example, a 2024–25 study by Galimova et al. (2024) verified that TAM variables are strong predictors of teachers' adoption of artificial intelligence (AI)-based teaching tools across many countries. In this research study, considering teachers in rural secondary schools in Zimbabwe, the TAM helps explain how teachers' preparedness through training and facilities, affects their perceived ease of use and usefulness of technology, which further impact their attitudes and intention to integrate technology into their teaching practices.

1.1.2 Technological pedagogical content knowledge (TPCK) framework

While the TAM explains why technology is adopted, TPCK framework explains how technology is integrated into instruction. TPCK argues that effective technology-enhanced instruction arises from the dynamic interaction among three areas of knowledge: Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK). Overlapping with them are Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and Pedagogical Content Knowledge (PCK), leading to the integrated TPCK teacher's ability to apply technology in ways that are pedagogically appropriate for specific content. Recent studies (Armouti et al., 2023; Chimhenga, 2025; Ahmad et al., 2023) continue to examine TPCK in both in-service and pre-service teacher training, showing that professional development and context-based training enhance teachers' integration of PTCK. In this research study, TPCK serves as a framework for examining teachers' pedagogical preparedness and their practical use of technology in instruction. It extends TAM by focusing on integration instead of adoption alone.

1.1.3 Technology use in lesson delivery

Globally, the role of education technology has grown from simple digital accessibility to facilitating blended and student-centred teaching approaches, formative assessment, and adaptive learning paths (Rincon-Flores et al., 2024; Brown et al., 2008). However, unbalanced evidence remains of its use across settings, particularly between countries and urban-rural divides (Ronconi et al., 2022). Cross-country summaries indicate that technology has the potential to improve the quality of teach-

ing if it is integrated with pedagogy, curriculum, and teacher ability (Azevedo et al., 2021; Escueta et al., 2017), but "tech-first" approaches without complementary system supports risk aggravating existing inequalities (Tamim et al., 2011). In low- and middle-income environments, teachers rely more on mobile phones, offline materials, and low-bandwidth technologies in instruction where there is not complete internet access (Hawkins et al., 2022). Systematic reviews of rural education suggest that many promising digital interventions fall short of classroom use because they were designed for better-resourced environments and consequently require local adaptation (Ronconi et al., 2022).

1.1.4 Teachers' preparedness and attitudes toward technology use

Teacher preparedness for technology integration can be understood as the extent to which teachers receive professional development to effectively leverage technology in teaching, access to necessary infrastructure such as devices, connectivity, and software, and the digital competence to integrate these tools into pedagogy. In Sub-Saharan Africa, teacher preparedness is usually hindered by inadequate infrastructure, unreliable internet access, and weak institutional support, particularly in rural schools (Ayega, 2020). Findings from Zimbabwe corroborate this trend: Chimhenga (2025) reported that urban primary school educators in Bulawayo found it hard to apply blended learning because of limited devices and little technical support, whereas Mhishi et al. (2023) found that rural day schools were behind boarding schools in adopting e-learning despite the availability of basic technological resources. A recent review of Zimbabwean digital learning initiatives reaffirmed that infrastructure, connectivity, and digital skill disparities continue to exist, undermining teachers' efforts to leverage technology for instructional improvement (Mweha, 2025). Age and experience are important. Matongo (2022) found that younger, more digitally teachers tend to have more positive attitudes toward ITC integrations, while older teachers are often more traditional in approach due to a lack of appropriate training.

1.1.5 Challenges in technology integration

Recent systematic reviews and empirical studies identify ongoing barriers to effective technology integration, many of which are especially pertinent in rural areas: intermittently accessible electricity, unreliable or absent internet connection, lack of digital devices, insufficient resources, limited technical support, misalignment between digital tools and national curriculum, and overcrowded classrooms that complicate device management (Tondeur et al., 2023; Atabek, 2020). Where such structural constraints are present, teaching often reverts to traditional teaching practices or is dominated using technology for administrative rather than instructional purposes. Zimbabwe-focused research points out similar challenges in rural regions: although initiatives such as community ICT centres, solar-powered computer labs, and NGO-supported digital literacy programs are emerging, systemic concerns like inconsistent policy implementation, inadequate school electrification, and limited teacher training continue to be limiting factors for long-term integration (Matongo, 2022; Mweha, 2025). These challenges not only limit the teaching capabilities of technology but

also shape teachers' attitudes toward its value in instructional delivery, indicating the need for context-dependent approaches such as Bring Your Own Device (BYOD) programs, school-based professional development, and low-bandwidth learning solutions (Dhliwayo & Jita, 2023; Amarteifio, 2018).

1.1.6 Perceived impact of technology on students

Perceived impacts of technology on students refers to teachers' beliefs about how the use of computer-based tools and platforms impacts teaching practices (e.g., improved efficiency, increased student engagement or more personalized instruction) and student performance (e.g., enhanced learning outcomes, motivation or self-regulation). Global evidence suggests that technology can promote higher levels of participation and positive learning outcomes when it supports interactive and formative pedagogies. However, the extent of these benefits largely depends on teacher preparedness, curriculum alignment, and institutional support (Akhter, 2025). The COVID-19 pandemic further demonstrated the possibilities of technology in ensuring continuity of learning but also exposed disparities in access that further entrenched educational inequalities. In Zimbabwe, teachers who employed mobile and blended teaching methods during periods of crisis reported perceived advantages such as maintained learning continuity, greater learner engagement, and broader access to complementary content (Magwa et al., 2025).

Nevertheless, notable gaps remain in the literature, specifically in the Zimbabwean context. Few studies have examined the three constructs (preparedness, attitude, perceived impact) within the same sample of teachers simultaneously. Even fewer have focused specifically on lesson delivery as opposed to broader administrative or remote learning environments. Moreover, limited attention has been given to variations across school type (e.g., rural versus urban), subject area, or teacher demographics. This study seeks to address these gaps by investigating teachers in selected Zimbabwe schools, focusing on lesson delivery and investigating the interrelationship among preparedness, attitudes, and perceived impact. The findings are expected to provide evidence-based insights that can guide government and educational policymakers in designing targeted professional development programmes, infrastructure investments, and support mechanisms aimed at strengthening technology integration in schools.

1.1.7 Conceptual framework

This study is guided by a conceptual framework that integrates the TAM and the TPCK framework to explain teachers' integration of technology in lesson delivery in rural secondary schools in Zimbabwe. The central outcome of the framework is technology use in lesson delivery, defined as the extent to which teachers incorporate digital tools and resources into teaching practices. Drawing from TPCK, effective technology use requires the integration of technological knowledge with pedagogical and content knowledge, enabling teachers to apply technology in ways that are instructionally meaningful and contextually appropriate. Guided by TAM, the framework posits that teachers' preparedness influences their perceptions of the usefulness

and ease of use of technology, which in turn shape their attitudes toward technology integration and their likelihood of using technology in classroom instruction. Teachers perceived impact of technology on teaching and learning is expected to further reinforce positive attitudes and actual technology use. The framework further recognises the influence of contextual challenges, particularly in rural school settings. Factors such as inadequate infrastructure, unreliable electricity, limited internet connectivity, insufficient technical support, and policy constraints are considered moderating variables that may limit the extent to which preparedness, attitudes, and perceived impact translate into effective technology integration. Overall, the conceptual framework provides a coherent theoretical basis for examining technology integration among rural secondary school teachers in Zimbabwe.

2 Methods and materials

2.1 Research design and instrument development

The study used a cross-sectional survey design to examine teachers' readiness, attitudes, and perceived impacts of using technology in classroom teaching at two selected rural secondary schools in Chipinge District, Zimbabwe. A stratified random sampling technique was applied to select the schools, and all teachers from the selected schools were invited to participate to ensure broad and unbiased representation, as the total teacher population was small and manageable. Data were collected using a standardized questionnaire that was developed and adapted from previously validated tools measuring teachers' preparedness and attitudes toward technology integration, including constructs from the TAM (Davis, 1989). The final instrument contained 20 items organized into four thematic areas (excluding demographic information): (1) technology use in lesson delivery (5 items); (2) teachers' preparedness and attitudes (5 items); (3) challenges in technology integration (5 items); and (4) perceived technology impact on students (5 items). All responses were rated on a five-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5).

To ensure validity, the questionnaire was reviewed by three educational technology experts from local universities. A pilot study was then conducted with 10 teachers from another secondary school in the same district to check the clarity and reliability of the items. A Cronbach's alpha value greater than 0.6 was considered acceptable, indicating that the items were reliable in measuring their respective constructs (Jarupunphol et al., 2024).

2.2 Population and sampling strategies

The target population comprised all teachers from rural public secondary schools in Chipinge District, Zimbabwe. The study focused specifically on rural public schools because these institutions typically experience limited ICT infrastructure, constrained financial resources, and reduced access to professional development opportunities compared to urban schools. As such, they provide a relevant context for examining technology integration and related constructs in under-resourced educational

settings. At the time of the study, there were 56 rural public secondary schools in Chipinge District. Using a stratified random sampling method, two rural secondary schools were randomly selected for inclusion. The selected schools were comparable in terms of socio-economic context, infrastructure, and curriculum delivery, ensuring contextual consistency. The total teaching staff in these schools consisted of 66 teachers (46 from one school and 20 from the other school). However, six teachers from the first school were assigned to examination monitoring duties, and one teacher from the second school was on official leave during the study period, leaving 59 teachers who participated in the research, representing approximately 89% of the total teacher population across the two schools. This high coverage rate is adequate for statistical analysis and ensures that the sample closely reflects the teacher population within the selected schools. A census sampling approach was employed within the selected schools, meaning that all available teachers were included in the study. This approach was considered appropriate given the small and manageable population size, which allowed for a comprehensive understanding of technology adoption in the two schools (Berndt, 2020). Although the study was conducted in only two rural public secondary schools, the use of a census within each selected school enhances internal representativeness and reduces sampling bias. The participating teachers represented a diverse range of subject areas, including Sciences, Humanities, Commercial Studies, and Computer Science.

2.3 Data analysis

After the data were entered into an Excel spreadsheet, they were imported into the Statistical Package for the Social Sciences (SPSS) version 30.0 for analysis. Descriptive statistics, such as frequencies and percentages, were used to summarize the characteristics of the study participants. Cronbach's alpha analysis was conducted to assess the reliability of items within each construct, as well as the overall reliability for all items. A normality test was performed on the mean scores for each construct to determine whether parametric or non-parametric tests would be appropriate for further analyses. The mean and standard deviation for each item within each construct were calculated to examine whether participants agreed with the statements. The criterion mean (CM) was calculated to interpret responses on the Likert scale as follows: $CM = (5+4+3+2+1)/5 = 3$. A mean score below 3 was considered indicative of disagreement, while a mean score above 3 indicated agreement with the statement (Oduro-Ofori et al., 2023). A one-sample Wilcoxon signed rank test was used to determine whether responses differed significantly from a neutral value of 3. Graphical representations were also generated to illustrate the distribution of responses.

Correlation analysis was conducted to examine relationships between the mean scores of two constructs. Correlation coefficients were interpreted based on absolute values, with 0.1–<0.3 indicating a weak correlation, 0.3–<0.6 indicating a moderate correlation, and 0.6 or above indicating a strong correlation (Jarupunphol et al., 2024). Additionally, the Kruskal–Wallis H test was performed to assess any significant differences across age groups and highest levels of education in relation to technology use in lesson delivery, teachers' preparedness and attitudes, challenges

in technology integration, and perceived technology impact on students. Statistical significance was set at p-value < 0.05.

2.4 Ethical considerations

The study adhered to established ethical standards for research involving human participants. Formal permission was obtained from the Permanent Secretary of the Ministry of Primary and Secondary Education, the Manicaland Provincial Education Director, and the Chipinge District Education Office prior to accessing the selected schools. These approvals ensured compliance with governmental and educational regulations. All participants provided informed consent after being fully briefed on the purpose, procedures, and confidentiality provisions of the study. No personal or identifying information was requested from the teachers.

3 Results

The demographic characteristics of secondary school teachers who participated in the study are presented in Table 1. The results indicate a gender imbalance in favour of male teachers, who constitute 64.4% of the sample, compared to 35.6% female teachers. We observed from the results 20 (33.9%) teachers were aged between 41 and 50 years and followed by those aged 31–40 years (30.5%), below 31 years (20.3%), and above 50 years (15.3%). Nearly half of the teachers (49.2%) held a diploma, 20.3% had a bachelor's degree, and 30.5% possess a master's degree or higher, suggesting a well-qualified teaching workforce. The findings further show that a large majority

Table 1 Descriptive statistics of the study participants ($n = 59$)

Variable	Frequency	Percentage (%)
Gender		
Male	38	64.4
Female	21	35.6
Age group (years)		
Below 31	12	20.3
31–40	18	30.5
41–50	20	33.9
Above 50	9	15.3
Highest level of education		
Diploma	29	49.2
Bachelor's degree	12	20.3
Master's degree or higher	18	30.5
Have you received formal training in ICT integration for teaching?		
Yes	48	81.4
No	11	18.6
How would you rate your ICT skills?		
Poor	-	-
Fair	16	27.1
Good	22	37.3
Excellent	21	35.6

Table 2 Reliability Analysis of Teachers' Responses

Section	Number of items	Cronbach's Alpha
A. Technology use in lesson delivery	5	0.644
B. Teacher preparedness and attitudes	5	0.729
C. Challenges in technology integration	5	0.844
D. Perceived impact on students	5	0.787
OVERAL	20	0.875

Table 3 Results of Normality Tests (Kolmogorov–Smirnov and Shapiro–Wilk)

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
A. Mean response of items assessing the technology use in lesson delivery	0.176	59	<0.001	0.951	59	0.020
B. Mean response of items assessing teacher preparedness and attitudes	0.169	59	<0.001	0.886	59	<0.001
C. Mean response of items assessing the challenges in technology integration	0.180	59	<0.001	0.890	59	<0.001
D. Mean response of items assessing perceived impact on students	0.168	59	<0.001	0.888	59	<0.001

of teachers (81.4%) had received formal training in Information and Communication Technology (ICT) integration for teaching, while 18.6% had not. In terms of ICT competence, 37.3% rated their skills as good, 35.6% as excellent, and 27.1% as fair, with none reporting poor skills. Overall, the results suggest that most teachers are formally trained and have moderate to high ICT proficiency, which may enhance the effective use of technology in teaching and learning.

The reliability analysis of teachers' responses was conducted, and the results are presented in Table 2. The Cronbach's alpha values for the individual sections ranged from 0.644 to 0.844. All sections met the minimum acceptable threshold of $\alpha > 0.6$ as recommended by previous studies (Lizelwati et al., 2025; Zakariya, 2022), indicating adequate internal consistency and reliability measurement of the constructs measured. The overall Cronbach's alpha value for all 20 items was high ($\alpha = 0.875$), demonstrating that the questionnaire was generally consistent and dependable for assessing teachers' perceptions and experiences related to technology integration.

The results of the normality assessment are presented in Table 3, with emphasis placed on the Shapiro–Wilk test, which was deemed appropriate given the relatively small sample size in this study ($n = 59$). The analysis revealed that the mean response data for all constructs deviated significantly from normality, as indicated by p-values less than 0.05. Consequently, the assumption of normality was not satisfied across any of the constructs. Considering these findings, non-parametric statistical tests were subsequently employed to ensure the validity and robustness of the inferential analysis.

The findings presented in Table 4 (Panel A) indicate that the mean values for all items exceeded the neutral midpoint of 3, suggesting that most respondents expressed agreement with the statements related to technology use in lesson delivery. To determine whether these mean scores were statistically different from the neutral value, the

Table 4 Summary of Teachers' Mean Scores Responses on Technology Integration and Related Factors with One-Sample Wilcoxon signed rank Test Results

	Mean (SD)	One-Sample Wilcoxon signed rank test	*p*-value
A. Technology use in lesson delivery			
I regularly incorporate digital tools (computers, projectors, software) in my lessons.	3.85 (0.997)	0.256	<0.001
I use the internet to access teaching resources for my lessons.	4.25 (0.733)	0.269	<0.001
I integrate multimedia (videos, animations) to enhance lesson delivery.	3.81 (0.919)	0.275	<0.001
I encourage students to use technology during lessons for learning activities.	4.20 (0.943)	0.262	<0.001
I adapt my teaching methods to effectively use available technology.	4.44 (0.595)	0.318	<0.001
B. Teacher preparedness and attitudes			
I feel confident in using technology to improve my teaching effectiveness.	4.36 (0.609)	0.297	<0.001
I have received sufficient training to use technology in my classroom effectively.	4.08 (0.934)	0.260	<0.001
I believe technology integration positively impacts student learning.	4.24 (0.703)	0.259	<0.001
I am motivated to learn new technologies to enhance my teaching.	4.47 (0.653)	0.349	<0.001
I am comfortable troubleshooting basic technical problems during lessons.	4.03 (1.098)	0.250	<0.001
C. Challenges in technology integration			
Technical problems (e.g., power outages, device failures) frequently disrupt my use of technology.	4.20 (0.664)	0.298	<0.001
Lack of adequate ICT infrastructure limits my ability to integrate technology.	4.41 (0.722)	0.320	<0.001
Insufficient time to prepare technology-based lessons is a barrier.	4.22 (0.892)	0.284	<0.001
Students' limited access to devices affects the effectiveness of technology use.	4.32 (0.776)	0.284	<0.001
Lack of ongoing technical support hinders my technology use.	4.32 (0.06)	0.272	<0.001
D. Perceived impact on students			
Technology use increases student engagement during lessons.	4.29 (0.789)	0.257	<0.001
Students understand concepts better when technology is used.	4.44 (0.650)	0.330	<0.001
Technology helps cater to different learning styles in my classroom.	4.39 (0.720)	0.310	<0.001
Technology integration improves students' academic performance.	4.51 (0.626)	0.360	<0.001
Technology use increases student engagement during lessons.	4.44 (0.749)	0.315	<0.001

researchers performed a one-sample Wilcoxon signed rank test. The results revealed that all items measuring technology use in lesson delivery were significantly different from the test value of 3 (p-value < 0.05) (see Table 4, Panel A). This finding confirmed that respondents' perceptions were significantly inclined toward agreement regarding the use of technology in teaching. Further analysis of individual items provided deeper insights into the pattern of responses. Specifically, about 69.49% of participants agreed with the statement, "I regularly incorporate digital tools (computers, projectors, software) in my lessons." Similarly, 83.05% agreed with "I use the internet to access teaching resources for my lessons," while 69.49% indicated agreement with "I integrate multimedia (videos, animations) to enhance lesson delivery." Moreover, 84.75% of respondents agreed with the statement "I encourage students to use technology during lessons for learning activities," and a noTable 94.91% agreed that "I adapt my teaching methods to effectively use available technology" (see Fig. 1). Collectively, these results demonstrate a strong positive inclination toward the integration of technology in instructional practices.

A comparable pattern of agreement was observed for the items measuring the construct "Teacher Preparedness and Attitudes," as presented in Table 4 (Panel B). Overall, the results reflect highly positive attitudes across all items, with most teachers indicating agreement or strong agreement with the statements. Specifically, 55.93% of respondents strongly agreed and 35.59% agreed that they are motivated to learn new technologies, demonstrating a strong commitment to continuous professional development. Likewise, 42.37% strongly agreed and 50.85% agreed that they feel confident using technology to enhance teaching effectiveness. Most teachers expressed strong agreement regarding having received sufficient training (79.66%) and feeling comfortable troubleshooting technical issues (76.27%) (Fig. 2). This implies that the level of professional development and technical exposure among

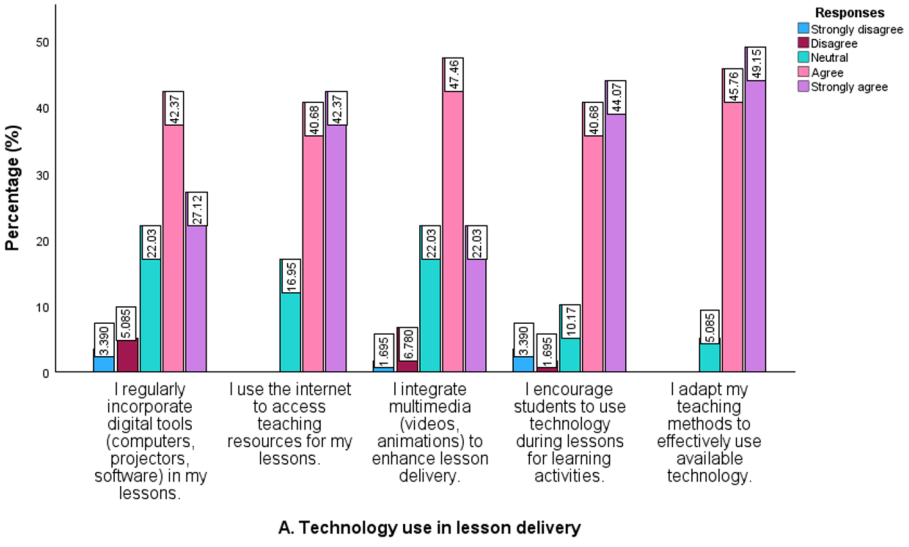

Fig. 1 Teachers' responses regarding the use of technology in lesson delivery

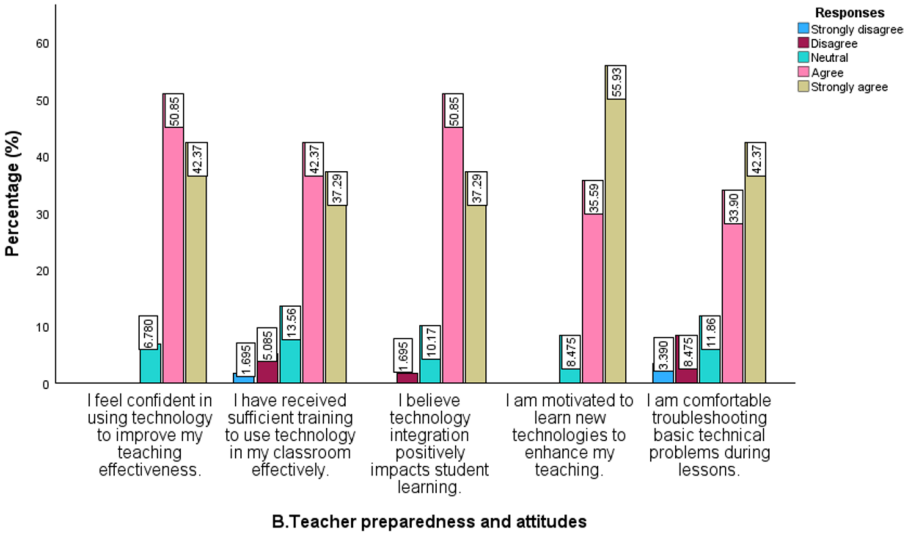

Fig. 2 Teachers' responses regarding preparedness and attitudes toward technology integration

teachers is relatively high, enabling them to integrate technology into their lessons with minimal difficulty. It also indicates that training initiatives and capacity-building efforts have been effective in equipping teachers with the necessary skills for technology-supported instruction. Only a small proportion of respondents disagreed or remained neutral across all items, indicating that teachers generally exhibit a high level of preparedness and a positive disposition toward technology integration.

The results presented in Table 4 (Panel C) reveal that the mean values for all items measuring challenges in technology integration exceeded 4, indicating strong agreement among respondents regarding the presence of these challenges. A one-sample Wilcoxon signed rank test further confirmed that these mean values were significantly different from the test value of 3 (p-value < 0.05), suggesting that the identified challenges were statistically significant and not due to random variation. As illustrated in Figs. 3 and 57.63% of teachers agreed and 32.20% strongly agreed that "technical problems such as power outages and device failures disrupt technology use." Similarly, 37.29% agreed and 52.54% strongly agreed that "a lack of adequate ICT infrastructure limits their ability to integrate technology." In addition, 45.78% agreed and 42.37% strongly agreed that "insufficient time to prepare technology-based lessons is a barrier," while 40.68% agreed and 47.46% strongly agreed that "students' limited access to devices affects the effectiveness of technology use." Finally, 45.76% agreed and 44.07% strongly agreed that "the lack of ongoing technical support hinders technology use" (Fig. 3).

The results displayed in Table 4 (Panel D) reveal that the mean values for all items under the construct "Perceived Impact of Technology on Students" were above the neutral midpoint of 3, indicating that most respondents expressed agreement with the statements. This pattern suggests that teachers generally hold positive perceptions regarding the influence of technology on students' learning outcomes. To verify the statistical significance of these perceptions, a one-sample Wilcoxon signed rank

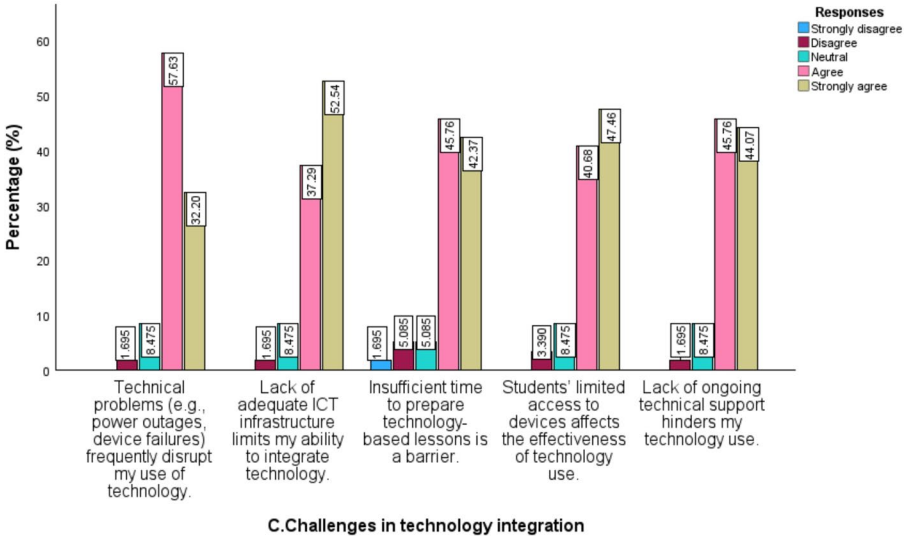

Fig. 3 Teachers' responses regarding challenges faced in integrating technology

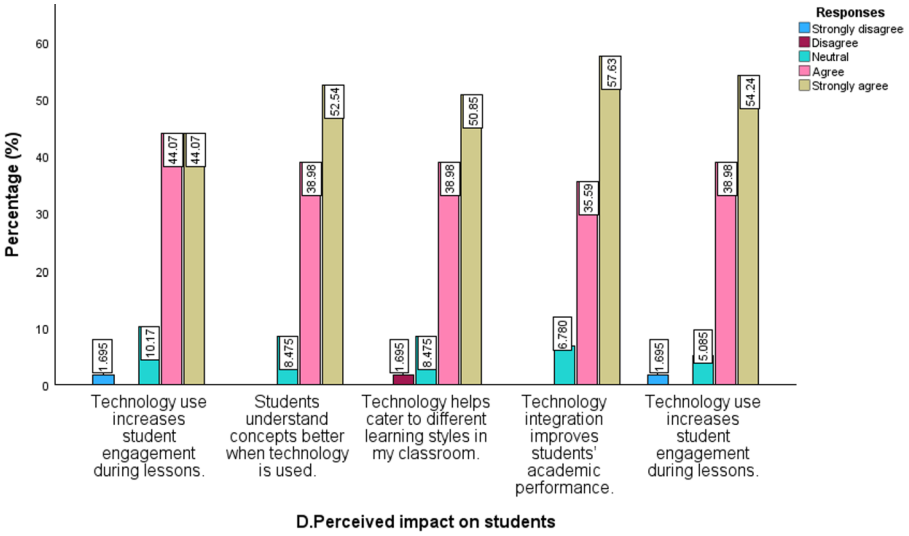

Fig. 4 Teachers' responses on the perceived impact of technology on students

test was performed using a test value of 3. The results indicated that all items were significantly different from this value (p-value < 0.05), confirming strong and consistent agreement among respondents concerning the perceived benefits of technology integration in learning. A closer examination of individual items provided further insight into teachers' views (see Fig. 4). For the statement "Technology use increases student engagement during lessons," 44.7% of teachers strongly agreed and an equal proportion (44.7%) agreed. Similarly, 52.54% strongly agreed and 38.98% agreed

with the statement "Students understand concepts better when technology is used," reflecting a strong belief that technology enhances conceptual understanding. Likewise, 50.85% strongly agreed and 38.98% agreed that "Technology helps cater to different learning styles in my classroom," suggesting that teachers perceive technology as an effective means of accommodating diverse learner needs. The statement "Technology integration improves students' academic performance" received the highest level of endorsement, with 57.63% strongly agreeing and 35.59% agreeing, highlighting teachers' conviction that technology contributes to improved academic outcomes. The repeated item "Technology use increases student engagement during lessons" yielded consistent results, with 54.24% strongly agreeing and 38.98% agreeing, further reinforcing the finding that technology substantially enhances student engagement.

Overall, these results demonstrate that teachers perceive technology as a powerful pedagogical tool that fosters student engagement, supports differentiated learning, strengthens conceptual understanding, and contributes to better academic performance. The consistently high mean scores (ranging from 4.29 to 4.51) and statistically significant p-values (p-value < 0.05) lend strong empirical support to this conclusion. Collectively, the findings underscore a broad consensus among teachers regarding the positive and meaningful impact of technology integration on students' learning experiences and outcomes.

The results of the Spearman's rho correlation analysis are presented in Table 5 and reveal a significant positive relationship among the key constructs of technology use in lesson delivery, teacher preparedness and attitudes, challenges in technology integration, and the perceived impact of technology on students (p-values < 0.05). All correlations were positive and statistically significant, indicating meaningful interconnections among these variables. Technology use in lesson delivery was moderately and positively correlated with both teacher preparedness and attitudes ($r = 0.501$, p-value < 0.001) and challenges in technology integration ($r = 0.520$, p-value < 0.001). This suggests that teachers who are more prepared and hold favourable attitudes toward technology tend to make greater use of it in their teaching. At the same time, those who use technology more frequently are also more likely to identify practical

Table 5 Spearman's rho Correlation Analysis Between Key Constructs of Technology Use, Teacher Preparedness, Challenges, and Perceived Student Impact

	Spearman's rho correlation	*p*-value
Technology use in lesson delivery ↔ Teacher preparedness and attitudes	0.501	<0.001
Technology use in lesson delivery ↔ Challenges in technology integration	0.520	<0.001
Technology use in lesson delivery ↔ Perceived impact on students	0.385	0.003
Teacher preparedness and attitudes ↔ Challenges in technology integration	0.346	0.007
Teacher preparedness and attitudes ↔ Perceived impact on students	0.485	<0.001
Challenges in technology integration ↔ Perceived impact on students	0.409	0.001

challenges such as inadequate infrastructure, limited technical support, or time constraints in lesson preparation.

Teacher preparedness and attitudes were weakly but positively correlated with the perceived impact of technology on students ($r = 0.485$, p-value < 0.001), while challenges in technology integration also showed a weak positive relationship with perceived student impact ($r = 0.409$, p-value $= 0.001$). These findings imply that as teachers become more engaged in technology-based teaching, they not only demonstrate higher confidence and motivation but also perceive stronger benefits for student learning. However, this engagement is accompanied by greater awareness of contextual barriers, highlighting the dual nature of technology adoption both empowering and demanding. Furthermore, the analysis revealed weak positive correlations between technology use in lesson delivery and perceived student impact ($r = 0.385$, p-value $= 0.003$), as well as between teacher preparedness and attitudes and challenges in technology integration ($r = 0.346$, p-value $= 0.007$). These relationships indicate that greater technology use modestly enhances teachers' perceptions of its benefits for students, while even well-prepared teachers with positive attitudes may still face challenges during implementation.

Overall, the results underscore that teacher preparedness, attitudes, and contextual factors collectively shape the effectiveness of technology integration and its perceived outcomes in the classroom. The interplay among these constructs highlights the need for continuous professional development and systemic support to sustain meaningful and equitable technology use in education.

The researchers used the Kruskal-Wallis H test to examine whether significant differences existed among the different age groups and highest levels of education in relation to four key areas: technology use in lesson delivery, teacher preparedness and attitudes, challenges in technology integration, and the perceived impact on students. The findings presented in Table 6 revealed a statistically significant difference among the age groups regarding technology use in lesson delivery (Kruskal–Wallis

Table 6 Kruskal-Wallis H test

		Kruskal-Wallis H value	Df	p-value
Grouping variable: Age group	Technology use in lesson delivery	9.234	3	**0.026***
	Teacher preparedness and attitudes	5.032	3	0.170
	Challenges in technology integration	0.496	3	0.920
	Perceived impact on students	2.242	3	0.524
Grouping variable: Highest level of education	Technology use in lesson delivery	0.807	2	0.668
	Teacher preparedness and attitudes	0.141	2	0.932
	Challenges in technology integration	3.657	2	0.161
	Perceived impact on students	1.706	2	0.426

*Statistically significant at a p-value less than 0.05

Table 7 Multiple comparison of age groups using Mann-Whitney U test

Age group (years)		Z-value	*p*-value
Below 31	31–40	-2.336	**0.019***
	41–50	-1.684	0.092
	Above 50	-2.002	**0.045***
31–40	41–50	-2.019	**0.043***
	Above 50	-0.479	0.632
41–50	Above 50	-1.383	0.167

H = 9.234, p-value = 0.026), indicating that teachers' use of technology in teaching varied depending on their age group. However, for the other constructs, no significant differences were observed, suggesting that teachers across age groups and education levels shared similar views or experiences in those areas.

A post-hoc multiple comparison using the Mann–Whitney U test was conducted to identify which specific age groups differed significantly in their use of technology during lesson delivery. The results, presented in Table 7, revealed several significant differences between age categories. Specifically, teachers below the age of 31 years differed significantly from those aged 31–40 years (Z-value = −2.336, p-value = 0.019) and those above 50 years (Z-value = −2.002, p-value = 0.045). Additionally, a significant difference was observed between teachers aged 31–40 years and those aged 41–50 years (Z-value = −2.019, p-value = 0.043). These findings suggest that age plays an important role in how teachers integrate technology into their lessons, with younger teachers generally demonstrating greater use and adaptability compared to some of their older counterparts.

4 Discussion

The findings of this study showed that the use of technology in lesson delivery has a positively effect on teachers' readiness and confidence to integrate ICT in their instructional practices. Teachers who regularly use digital tools in their teaching tend to develop greater confidence and stronger beliefs in the usefulness and effectiveness of technology for enhancing learning outcomes. These results are consistent with the previous findings by Peng et al. (2024) and Almusawi et al. (2021), who found that teachers' self-efficacy and familiarity with digital platforms significantly plays a crucial role in willingness to adopt and sustain ICT use. Similarly, Alisoy (2023), found that frequent use of ICT in classroom instruction not only improves the quality of teaching but also reinforces teachers' belief in the transformative potential of technology to improve education.

The reliability analysis confirmed that the constructs employed in the study demonstrated strong internal consistency, indicating that the instruments effectively captured teachers' perceptions, attitudes, and experiences regarding technology integration. This reliability further strengthens the validity of the study's findings. Consistent with the recommendations of Lizelwati et al. (2025) and Sulaiman et al. (2024), a Cronbach's alpha value exceeding 0.6 is considered acceptable for ensuring internal consistency in educational and behavioural research contexts.

The study also revealed that persistent challenges such as inadequate ICT infrastructure, unreliable electricity supply, high internet costs, and limited institutional support continue to hinder effective technology integration. These barriers can discourage teachers and constrain innovation in teaching practices. Consistent with earlier studies by Qazi et al. (2024), Ntorukiri et al. (2022), and Mhlanga and Ndhlovu (2023), infrastructural limitations and insufficient administrative support were identified as key barriers to technology adoption in developing contexts. The results of the present study reaffirm that without adequate facilities, proper maintenance systems, and supportive leadership, teachers' motivation to integrate ICT may not translate into sustained implementation.

Another important finding of the study was that teachers' attitudes toward technology play a central role in determining the extent to which ICT is adopted for pedagogical purposes. Teachers with positive perceptions of the usefulness and ease of use of technology are more inclined to integrate digital tools into their lessons, whereas those with negative perceptions demonstrated reluctance or resistance to adoption. This highlights the psychological and motivational dimensions of technology integration, suggesting that beliefs about technology can significantly shape instructional behaviour. These findings are consistent with those of Habibi et al. (2023) and Bai et al. (2024), who emphasized that teachers' beliefs and attitudes toward ICT are strong predictors of their behavioural intentions to use technology. The results further imply that cultivating a supportive environment that reinforces teachers' confidence and appreciation of technology's benefits is crucial for sustained ICT adoption. Therefore, nurturing positive attitudes through continuous professional development, peer collaboration, and institutional recognition is essential for fostering a culture of innovation and technological engagement among educators.

The study further revealed that the integration of technology contributes significantly to enhancing student engagement, deepening conceptual understanding, and addressing diverse learning styles. Teachers reported that technology-supported lessons tend to make learning more interactive, dynamic, and stimulating, thereby increasing student's active participation and interest in classroom activities. Interactive tools, multimedia resources, and digital platforms were particularly noted for their ability to simplify complex concepts and cater to different learning preferences. These findings are consistent with the work of Wekerle and Kollar (2022) and Biber et al. (2022), who observed that effective ICT integration not only enhances learner motivation but also facilitates differentiated instruction and improves comprehension of challenging topics. Moreover, technology allows teachers to provide real-time feedback and create more student-centred learning environments, which promote autonomy and critical thinking. Collectively, the results affirm that when applied purposefully and supported by sound pedagogical strategies, technology has a transformative impact on both teaching and learning processes.

Overall, the study highlights that successful technology integration in Zimbabwean secondary schools is largely shaped by teachers' preparedness, institutional support, and their attitudes toward ICT. Teachers who possess adequate digital competence, confidence, and supportive working environments are more inclined to adopt innovative pedagogical strategies that foster student engagement, motivation, and academic achievement. Conversely, persistent infrastructural challenges such as inadequate

facilities, unreliable internet connectivity, and insufficient maintenance systems continue to limit the effective and equitable use of ICT in teaching. Addressing these systemic barriers through targeted investment, continuous professional development, and leadership support is essential for promoting sustainable and transformative technology integration in education.

4.1 Study strengths and limitations

A key strength of this study lies in the use of a census approach within the selected schools, which resulted in a high participation rate (89%) and enhanced internal representativeness. Additionally, the focus on rural public secondary schools provides valuable contextual insights into technology adoption in under-resourced educational settings that are often underrepresented in the literature. However, the study was limited to only two rural public schools within one district, which may restrict the generalizability of the findings to other regions, particularly urban or private schools. Furthermore, conclusions regarding student learning outcomes were based solely on teachers' perceptions rather than objectively measured student performance data. As a result, the findings reflect perceived impacts of ICT integration rather than verified improvements in student achievement. Future research should incorporate objective measures of student performance and involve a larger number of schools across diverse contexts to enhance both the robustness and external validity of the findings.

5 Conclusions

This study examined teachers' preparedness, attitudes, and perceptions regarding the integration of technology in classroom instruction within rural public secondary schools in Zimbabwe. The findings indicate that teachers who are adequately prepared, confident, and skilled in using ICT are significantly more likely to integrate technology meaningfully into their instructional practices. Such teachers tend to perceive technology as useful, efficient, and capable of enhancing both teaching effectiveness and student engagement. The results further revealed that teachers' attitudes toward ICT are a critical determinant of technology adoption. Educators who hold positive perceptions and a sense of self-efficacy exhibit greater enthusiasm, creativity, and openness to innovation in their classroom practices. In addition, the study highlights the critical role of institutional and infrastructural support in shaping teachers' willingness and capacity to use technology. Schools that provide functional ICT infrastructure, reliable internet connectivity, ongoing technical support, and administrative encouragement create enabling environments that promote sustained technology integration. Persistent contextual challenges such as inadequate infrastructure, unreliable electricity supply, limited access to digital devices, and high costs of internet connectivity continue to constrain the widespread and effective adoption of ICT in rural Zimbabwean schools.

Rather than positioning these findings as globally novel, this study contributes context-specific empirical evidence from rural Zimbabwe, where structural and resource constraints significantly influence technology adoption. By situating estab-

lished constructs such as teacher preparedness, attitudes, and institutional support within this rural context, the study enriches the understanding of how these factors interact under conditions typical of many low-resource educational settings. Overall, the findings of this study affirm that successful technology integration in rural Zimbabwean secondary schools requires coordinated efforts to strengthen teacher competence, positive attitudes toward ICT, institutional support, and adequate infrastructure and institutional support. Targeted investment, continuous professional development, and supportive policy interventions will be crucial to achieving equitable and sustainable ICT adoption in these settings.

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Declarations

Competing interests The authors declare that there are no competing interests related to this study.

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