Transforming Learning through ICT: A Case Study on Academic Performance in Peshawar, Pakistan

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ABSTRACT

The existing research study investigates the relationship between Information and Communication Technology (ICT) usage and academic performance among secondary-level students in Federal Government Boys and Girls Schools, Peshawar, Pakistan. The researchers have employed quantitative, cross-sectional correlational design with a stratified random sampling technique comprising of sample 100 students (50 boys and 50 girls, aged 13–16). The research operationalized ICT usage across three dimensions covering availability, accessibility, and user-ability measured through a validated 15 item Likert scale instrument ($\alpha = 0.87$), alongside Grade Point Average (GPA) obtained from school records. Data analysis in SPSS 26 involved descriptive statistics, independent samples t-tests, chi-square tests, Pearson correlations, multiple regression, and one-way ANOVA. Results revealed moderate to high ICT availability and user-ability, slightly lower accessibility, and no significant gender differences in ICT usage or GPA which indicate progress toward digital equity. All ICT dimensions correlated positively with academic performance while user-ability emerging as the strongest predictor. However, availability; accessibility did not significantly predict GPA when controlling for other variables. Chi-square and ANOVA analyses confirmed that higher ICT usage levels were associated with significantly better academic performance. The findings substantiate the Digital Divide Theory and Technology Acceptance Model within the Pakistani secondary education context, underscoring that resource provision alone is insufficient without parallel investments in digital skill development. Policy recommendations include enhancing digital literacy programs, ensuring equitable ICT infrastructure, integrating ICT into curricula, and strengthening teacher professional development. This study contributes context-specific, gender-balanced evidence to the discourse on ICT in education while offering actionable insights for bridging digital gaps and optimizing technology's role in improving learning outcomes in resource-constrained settings.

Keywords: Information and Communication Technology, academic performance, secondary education, digital divide, Technology Acceptance Model, gender equity, Pakistan

INTRODUCTION

In the last two decades, Information and Communication Technology (ICT) has emerged as a pivotal force shaping education systems worldwide. The integration of ICT in classrooms has transformed traditional pedagogical approaches by facilitating interactive, learner-centered, and personalized instruction (UNESCO, 2021). Globally, education stakeholders recognize ICT not merely as a tool but as a strategic enabler to improve academic outcomes, promote digital literacy, and prepare students for the demands of the 21st century (Selwyn, 2019). In developing countries like Pakistan, ICT adoption in public education is perceived as both a challenge and an opportunity, reflecting infrastructural constraints alongside potential for educational equity (Aziz et al., 2022). Although Pakistan's government has made concerted efforts to introduce digital classrooms, computer labs, and e-learning platforms across various provinces, the empirical evidence on the effectiveness of these interventions at the secondary school level remains fragmented and regionally skewed (Khan & Ahmed, 2020; Nazir & Khalid, 2023).

Specifically, in the province of Khyber Pakhtunkhwa (KP), and the city of Peshawar in particular, research on ICT's role in influencing academic performance is sparse. FG (Federal Government) schools in Peshawar represent a unique educational ecosystem, where socio-economic diversity, gender parity initiatives, and governmental digital policies converge (Government of Pakistan, 2022). Understanding how students in these schools utilize ICT resources, and the extent to which these resources contribute to academic achievement, is critical for policy formulation and pedagogical innovation. Prior studies in Pakistan have often concentrated on urban centers like Karachi and Lahore or higher education institutions, leaving a knowledge gap concerning secondary public education in less researched regions (Sherwani et al., 2023; Ahmad & Sheikh, 2022). Moreover, gender-disaggregated data regarding ICT usage and academic outcomes in KP's secondary schools are limited, despite growing emphasis on gender equity in digital access (UNICEF Pakistan, 2021).

This study aims to fill this void by systematically investigating the impact of ICT on students' academic performance in FG Boys and Girls Schools in Peshawar, employing a rigorous quantitative methodology that ensures equal gender representation. The research focuses on three dimensions of ICT usage: availability (physical access to resources), accessibility (ease and frequency of use), and user-ability (students' digital competence and confidence), and their predictive relationships with academic achievement measured via Grade Point Average (GPA). The study's findings will provide nuanced insights into the specific facets of ICT that matter most for enhancing educational outcomes in this socio-culturally complex setting.

Objectives

The existing research study seeks to achieve the following research objectives:

- To examine the relationship between ICT usage dimensions (availability, accessibility, user-ability) and academic performance among secondary-level students in FG Boys and Girls Schools, Peshawar.

- To analyze gender differences in ICT usage patterns and their association with academic achievement.

- To determine the predictive power of ICT usage components on students' academic performance.

- To identify key ICT usage factors that can be targeted in interventions aimed at improving educational outcomes in Peshawar's public secondary schools.

Research Questions

In line with the research objectives, the study addresses the following research questions:

- What is the nature and strength of the relationship between ICT usage (availability, accessibility, user-ability) and academic performance among secondary-level students in FG Schools, Peshawar?

- Are there significant gender differences in ICT usage and academic performance among these students?

- To what extent do ICT usage dimensions predict academic performance when controlling for demographic factors?

- Which ICT usage dimension(s) serve as the strongest predictors of academic achievement in this context?

Hypotheses

Based on existing literature, hypotheses of the existing research study are as follows:

H1: There is a positive and significant correlation between ICT usage dimensions (availability, accessibility, user-ability) and academic performance.

H2: ICT usage dimensions significantly predict academic performance beyond demographic variables.

H3: There are no significant gender differences in the relationship between ICT usage and academic performance.

H4: Among ICT usage dimensions, user-ability will exhibit the strongest predictive power for academic performance.

Significance of the Study

This research holds significant implications for educational policy, curriculum development, and teacher training in Pakistan, particularly within Khyber Pakhtunkhwa province. By focusing on FG schools in Peshawar, the study contributes data driven evidence on ICT's role in enhancing secondary education outcomes in a context characterized by diverse socio-economic backgrounds and ongoing digital inclusion efforts. The balanced gender representation enables a nuanced analysis of equity issues, addressing a critical gap in the national education discourse. Furthermore, the study's findings can inform government initiatives aimed at scaling up ICT infrastructure and digital literacy programs, supporting Pakistan's broader digital transformation goals as outlined in the National Education Policy (2022). Lastly, the empirical modeling of ICT usage components offers practical insights for school administrators and educators to optimize resource allocation and instructional design, thereby fostering a more effective integration of technology in teaching and learning processes.

Research Gap

While numerous studies have highlighted the importance of ICT in education globally, empirical research focusing on Pakistan's public secondary schools, especially within KP province, remains limited. Most existing research concentrates on higher education or urban metropolitan areas, neglecting regional disparities and socio-cultural factors influencing ICT adoption and academic performance at the secondary level (Raza et al., 2021; Malik & Rehman, 2020). Additionally, prior studies have tended to treat ICT usage as a unidimensional construct, failing to disentangle the distinct contributions of availability, accessibility, and user-ability. This oversight limits the precision of policy recommendations and intervention strategies. Gender-disaggregated analyses are sparse, despite evidence suggesting gendered patterns in digital literacy and access (UNICEF Pakistan, 2021). This study addresses these gaps by employing a multidimensional approach to ICT usage and a gender balanced sample, thereby providing comprehensive, context-specific insights that advance the understanding of how ICT influences academic outcomes in Pakistan's public secondary education system.

LITERATURE REVIEW

Global Perspectives on ICT and Academic Performance

The transformative potential of Information and Communication Technology (ICT) in education has been extensively documented across diverse international contexts. Meta-analytical reviews emphasize that the integration of ICT can enhance student learning outcomes, engagement, and motivation when accompanied by appropriate pedagogical practices (Tamim et al., 2019). However, findings from the Organisation for Economic Co-operation and Development (OECD, 2020) caution that mere access to technology does not automatically translate into improved academic achievement. Instead, the effectiveness of ICT hinges on quality of integration, teacher competencies, and the socio-economic context of learners. For instance, Bulman and Fairlie (2020) found that digital learning interventions produced significant academic gains in math and reading when technology was embedded into structured curricular activities. Conversely, superficial or unstructured ICT use may yield negligible or negative effects (Hattie & Timperley, 2022).

The global COVID-19 pandemic has accelerated ICT adoption in education, catalyzing research on digital equity and the digital divide. Studies reveal that disparities in access, skills, and infrastructure can exacerbate educational inequalities (Van Dijk, 2020). The distinction between first-level digital divide (access) and second-level divide (skills and usage) has become critical in understanding how ICT influences academic outcomes (Van Deursen & Helsper, 2020). These insights underscore the importance of a multifaceted approach to ICT research, addressing availability, accessibility, and user-ability dimensions central to the current study.

ICT in Education: The Pakistan Context

Pakistan's educational landscape presents unique challenges and opportunities for ICT integration. Despite governmental efforts, including the Digital Pakistan initiative and establishment of smart classrooms, disparities in ICT infrastructure and digital literacy remain pronounced, particularly between urban and rural areas and across gender lines (Khan et al., 2021). Empirical studies at the secondary education level reveal mixed findings regarding the impact of ICT on academic performance.

Ahmad and Sheikh (2022), in a quantitative study involving university students in Punjab, reported significant positive correlations between ICT availability, accessibility, user-ability, and academic success.

Similarly, Sherwani et al. (2023) observed that Karachi public schools with better ICT resources exhibited higher student achievement in science and mathematics. However, the generalizability of these findings to KP and Peshawar remains limited due to socio-cultural and infrastructural differences. Gender disparities in ICT use and educational outcomes have been highlighted in Pakistan's context. UNICEF Pakistan (2021) reported that girls face more significant barriers in accessing technology, which affects their academic performance. Nonetheless, progressive policies in federal schools, such as those in Peshawar, have sought to bridge these gaps by ensuring equal resource allocation and promoting digital literacy among female students (Government of Pakistan, 2022).

Theoretical Frameworks Informing ICT Research

This study draws upon the Digital Divide Theory and the Technology Acceptance Model (TAM) to frame the investigation of ICT's role in academic performance. The Digital Divide Theory (Van Dijk, 2020) conceptualizes disparities in ICT use as a multi-layered phenomenon encompassing physical access, skills, and usage patterns, corresponding to the study's focus on availability, accessibility, and user-ability.

The TAM (Davis, 1989; Venkatesh & Bala, 2020) postulates that perceived usefulness and ease of use influence technology adoption, which in turn affects outcomes such as academic achievement. User-ability reflects this ease of use and confidence dimension, posited to mediate the relationship between ICT resources and student performance. Integrating these theories facilitates a comprehensive understanding of both structural and behavioral factors shaping ICT's educational impact.

Empirical Evidence from Khyber Pakhtunkhwa and Peshawar

Research focusing explicitly on KP province and Peshawar's public schools is sparse but growing. Gulzar (2020) employed a mixed-methods approach in Peshawar secondary schools and found that while ICT resources were available, lack of teacher training and limited student competencies hampered effective use. Quantitative investigations remain rare. A recent study by Raza et al. (2021) in KP public secondary schools showed that ICT availability and usage positively correlated with student academic achievement, but the predictive strength was moderated by gender and socio-economic status. Malik and Rehman (2020) emphasized the need for focused interventions on user training to leverage ICT's potential fully. These studies highlight the critical importance of disentangling the separate effects of availability, accessibility, and user-ability, which this study addresses with a balanced gender sample in Peshawar's FG schools.

Research Gap

The extant literature underscores the nuanced and context-dependent nature of ICT's impact on academic performance. Globally and nationally, studies confirm positive associations but also reveal significant mediators such as pedagogical integration and user competence. Pakistan's secondary education sector, especially in KP and Peshawar, lacks rigorous quantitative research examining multi-dimensional ICT usage and its gendered effects.

This study fills this void by operationalizing ICT as three distinct constructs, employing advanced statistical modeling to test their predictive power on academic outcomes. The focus on gender parity and the use of official GPA data further strengthen the study's contribution to both theory and practice.

METHODOLOGY

The existing research study adopted a quantitative, cross-sectional correlational design to examine the relationship between Information and Communication Technology (ICT) usage and academic performance among secondary-level students in Federal Government (FG) Boys and Girls Schools, Peshawar. A stratified random sampling approach was used to ensure equal representation of genders, yielding a sample of 100 students (50 boys and 50 girls) aged 13–16 years. Data were collected through a structured self-administered questionnaire comprising a validated ICT Usage Scale measuring availability, accessibility, and user-ability across 15 items on a 5-point Likert scale (Cronbach's alpha = 0.87) and standardized Grade Point Average (GPA) scores obtained from school records.

Ethical approval and administrative permissions were secured, with informed consent obtained from students and parents. Data collection occurred during school hours under researcher supervision to ensure completeness and reliability. Analyses were conducted in SPSS (Version 26), with descriptive statistics summarizing ICT use and performance, and inferential tests including independent samples *t*-tests, chi-square tests, Pearson correlations, multiple regression, and one-way ANOVA used to test hypotheses. Model assumptions were verified, statistical significance was set at $p < 0.05$.

RESULTS AND DISCUSSION

Descriptive Statistics

Table 4.1 results present the means and standard deviations for the three dimensions of ICT usage availability, accessibility, and user-ability as well as for students' academic performance measured by Grade Point Average (GPA).

Table 4.1: Descriptive Statistics for ICT Usage Dimensions and Academic Performance (N = 100)

Variable	Mean	SD	Min	Max
ICT Availability	3.65	0.58	2.10	4.90
ICT Accessibility	3.42	0.62	1.90	4.80
ICT User-Ability	3.71	0.55	2.40	4.80
Academic Performance (GPA)	3.25	0.45	2.20	4.00

Scale for ICT variables: 1 = Strongly Disagree, 5 = Strongly Agree; GPA scaled 0–4.

The data indicate moderate to high perceived availability and user-ability of ICT resources, with slightly lower accessibility scores. The mean GPA of 3.25 suggests an overall satisfactory academic performance in the sample.

Gender Differences in ICT Usage and Academic Performance

An independent samples t-test was conducted to compare ICT usage dimensions and GPA between male and female students. Results of Table 4.2 indicate no statistically significant gender differences in ICT availability, accessibility, user-ability, or GPA.

Table 4.2: Independent Samples t-Test Comparing Boys and Girls on ICT Usage and Academic Performance

Variable	Gender	M	SD	t	df	p
ICT Availability	Boys	3.61	0.59	0.54	98	0.59

	Girls	3.69	0.57			
ICT Accessibility	Boys	3.39	0.63	0.42	98	0.68
	Girls	3.45	0.61			
ICT User-Ability	Boys	3.69	0.57	0.34	98	0.73
	Girls	3.73	0.53			
Academic Performance (GPA)	Boys	3.19	0.47	1.08	98	0.28
	Girls	3.31	0.43			

These findings support Hypothesis 3, indicating equitable ICT access and academic performance across genders in the sample.

Association Between ICT Usage Levels and Academic Performance Categories

To investigate the relationship between categorical ICT usage levels and academic performance categories, a chi-square test of independence was performed (Table 3).

Table 4.3: Chi-Square Test of Association Between ICT Usage Level and Academic Performance Category

ICT Usage Level	Low Performance	Medium Performance	High Performance	Total
Low	12	6	2	20
Medium	7	18	10	35
High	1	8	36	45

$\chi^2(4) = 12.46$, $p = 0.014$*
*Significant at $p < .05$

This significant association suggests that higher ICT usage correlates with better academic performance, supporting Hypothesis 1.

Correlational Analysis

Pearson correlation coefficients Table 4.4 results demonstrate significant positive relationships between ICT dimensions and academic performance.

Table 4.4: Pearson Correlations Among ICT Dimensions and GPA

Variable	1	2	3	4
1. ICT Availability	—	0.42**	0.55**	0.48**
2. ICT Accessibility	0.42**	—	0.46**	0.39**
3. ICT User-Ability	0.55**	0.46**	—	0.53**
4. Academic Performance (GPA)	0.48**	0.39**	0.53**	—

Note. p $< .01$

These results of the table 4.4 confirm Hypothesis 1, indicating that all ICT components are significantly positively correlated with academic achievement, with user-ability showing the strongest association.

Multiple Regression Analysis

A multiple linear regression was conducted to assess the predictive power of ICT availability, accessibility, and user-ability on academic performance while controlling for gender.

Table 4.5: Regression Model Summary Predicting Academic Performance

Model	R	R²	Adjusted R²	Std. Error	F	p
1	0.62	0.38	0.36	0.36	19.45	<0.001

Table 4.6: Regression Coefficients for Predictors of Academic Performance

Predictor	B	SE B	β	t	p
ICT Availability	0.15	0.07	0.22	2.15	0.034*
ICT Accessibility	0.09	0.06	0.15	1.62	0.108
ICT User-Ability	0.27	0.08	0.35	3.42	0.001**
Gender (Control)	0.05	0.04	0.07	1.25	0.213

*Significant at $p < .05$, **$p < .01$

The model explains 38% of the variance in GPA. ICT user-ability emerged as the strongest significant predictor, followed by availability. Accessibility and gender were not significant predictors when controlling for other variables. This supports Hypotheses 1, 2, and 4.

Analysis of Variance (ANOVA)

A one-way ANOVA tested differences in GPA among students categorized by ICT usage levels (Low, Medium, High).

Table 4.7: One-Way ANOVA for GPA by ICT Usage Level

Source	SS	df	MS	F	p
Between Groups	3.82	2	1.91	15.76	<0.001
Within Groups	11.88	97	0.12		
Total	15.70	99			

Post hoc Tukey tests indicated that students in the high ICT usage group had significantly higher GPAs than those in medium and low groups ($p < .01$). These findings reinforce the critical role of active ICT engagement in enhancing academic outcomes.

RESULTS AND DISCUSSION

The present study explored the multifaceted relationship between Information and Communication Technology (ICT) usage and academic performance among secondary-level students in Federal Government Boys and Girls Schools in Peshawar. Drawing on a gender-balanced sample and rigorous quantitative analyses, the findings elucidate the nuanced ways in which ICT availability, accessibility, and user-ability impact students' academic achievement, thereby advancing the empirical literature in an under-researched regional context.

Consistent with Hypothesis 1, all three ICT dimensions demonstrated significant positive correlations with academic performance, corroborating global meta-analyses indicating that ICT integration enhances

learning outcomes when coupled with effective usage (Tamim et al., 2019; Bulman & Fairlie, 2020). Particularly, the strong predictive role of ICT user-ability aligns with the Technology Acceptance Model (Davis, 1989; Venkatesh & Bala, 2020), which emphasizes user competence and confidence as pivotal for technology adoption and consequential benefits. This finding suggests that beyond mere physical access, students' digital skills critically determine the extent to which ICT translates into academic gains. These insights echo Gulzar's (2020) qualitative observations regarding competency barriers in Peshawar and extend them quantitatively by identifying user-ability as the most salient factor.

The non-significant gender differences in ICT usage and academic performance support Hypothesis 3 and signal promising progress toward digital equity in the sampled FG schools. This result contrasts with broader national patterns documented by UNICEF Pakistan (2021) but aligns with recent government initiatives to ensure equitable ICT resource distribution and capacity-building for female students (Government of Pakistan, 2022). The absence of gender disparities underscores the importance of context-sensitive policies and their potential to mitigate traditional access and skill gaps.

Regression analyses revealed that ICT availability and user-ability significantly predict academic performance, whereas accessibility did not independently contribute when controlling for other variables. This nuanced finding suggests that while frequency and ease of use are important, they are insufficient without the presence of adequate resources and the requisite skills to exploit them effectively. It also highlights potential areas for targeted intervention: expanding infrastructure must be complemented with comprehensive digital literacy programs to maximize impact.

The ANOVA and chi-square results further reinforce the substantive association between ICT engagement levels and academic success, demonstrating that students with higher ICT usage significantly outperform their peers. These findings validate international evidence on the educational value of active technology engagement (OECD, 2020) and call attention to the need for fostering sustained and meaningful ICT use within curricula.

From a policy perspective, the study's outcomes advocate for a holistic approach to ICT integration in Pakistan's secondary education system one that simultaneously addresses infrastructural deficits, skill development, and pedagogical alignment. Teacher training emerges as a critical lever, given its mediating role in facilitating students' user-ability and access (Sherwani et al., 2023). Furthermore, sustained monitoring of gender equity in ICT utilization remains imperative to prevent regression amidst rapid digital transformation.

The study's theoretical contributions lie in operationalizing the digital divide's multi-level dimensions within an underexplored Pakistani context and empirically validating the Technology Acceptance Model's relevance in secondary education. It bridges a critical gap in ICT research by combining gender-sensitive sampling with comprehensive, multidimensional measurement of ICT usage and objective academic performance indicators.

Limitations include the cross-sectional design, which restricts causal inference, and the reliance on self-reported ICT usage data, which may be influenced by social desirability bias despite assurances of confidentiality. Future research could incorporate longitudinal designs, qualitative methodologies, and experimental interventions to deepen understanding of ICT's causal mechanisms and optimize implementation strategies.

In conclusion, the study substantiates ICT's transformative potential in secondary education in Peshawar, contingent on equitable availability and enhanced user-ability. These findings provide actionable insights

for educational policymakers, administrators, and practitioners aiming to harness digital technologies to elevate student achievement and close educational gaps in resource-constrained settings.

CONCLUSION AND RECOMMENDATIONS

This study investigated the impact of Information and Communication Technology (ICT) usage on the academic performance of secondary-level students in Federal Government Boys and Girls Schools in Peshawar. Employing a multidimensional framework encompassing ICT availability, accessibility, and user-ability, the research demonstrated that ICT usage significantly correlates with and predicts academic achievement, with user-ability emerging as the most influential factor. The absence of significant gender differences in ICT access and academic outcomes indicates progress toward digital equity within the studied context. These findings affirm the critical role of both infrastructural provision and digital literacy in maximizing the educational benefits of ICT, substantiating theoretical models such as the Digital Divide Theory and Technology Acceptance Model within a regional Pakistani setting.

The results highlight that mere access to ICT resources is insufficient; students' competencies in utilizing technology effectively are paramount for improving academic outcomes. This nuanced understanding underscores the importance of integrated strategies that combine resource allocation with skill development and pedagogical support.

Recommendations

Based on the findings, the following recommendations are proposed for policymakers, educational administrators, and practitioners:

- Invest in comprehensive ICT training initiatives targeting students to build their digital skills and confidence, thereby increasing user-ability and translating ICT access into academic gains.

- Ensure consistent and reliable ICT infrastructure across all FG schools, maintaining gender parity in resource distribution to sustain equitable access.

- Develop targeted teacher training programs to equip educators with the pedagogical skills required to integrate ICT effectively into curricula, fostering an enabling environment for technology-enhanced learning.

- Embed ICT competencies explicitly within the secondary school curriculum, promoting active and meaningful engagement with technology as part of routine instructional practices.

- Establish ongoing mechanisms to monitor ICT usage patterns, gender equity, and academic outcomes to inform continuous improvement and policy refinement.

- Encourage longitudinal and intervention-based research to explore causal pathways and evaluate the effectiveness of specific ICT integration strategies in diverse regional contexts.

This study contributes valuable empirical evidence to the discourse on digital education in Pakistan, particularly in the underrepresented context of Peshawar's public secondary schools. By emphasizing both access and capability dimensions of ICT, it offers a holistic perspective vital for achieving sustainable educational improvements through technology. Implementation of the recommendations can

help bridge the digital divide, promote inclusive learning, and empower students to thrive in an increasingly digital world.

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