



Inclusive Education, Digital Divides, and Learning Outcomes among Marginalized Secondary Students in Pakistan: Access, Engagement, and Equity Gaps in Hybrid Learning Environments

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ABSTRACT

Background: Hybrid learning has expanded educational opportunities but has also exposed digital inequalities that limit equitable participation. In Pakistan, disparities in internet access, device ownership, and digital skills may hinder learning among marginalized secondary school students.

Objective: To examine the relationship between digital access, learning engagement, inclusion, and academic outcomes among marginalized secondary school students in Pakistan, while exploring teachers' and parents' perspectives on educational equity.

Methods: A mixed-methods cross-sectional study was conducted among 648 students, 98 teachers, and 84 parents from public, private, and low-fee private schools across rural, peri-urban, and urban Pakistan. Participants were recruited through stratified convenience sampling. Data were collected using structured questionnaires and focus group discussions. Quantitative data were analyzed using descriptive statistics, reliability analysis, ANOVA, hierarchical regression, and structural equation modeling, while qualitative data underwent thematic analysis.

Results: Significant socioeconomic and geographic disparities in digital access were identified. Overall, 17.9% of students lacked digital devices and 65.0% reported limited internet connectivity. Private-school students demonstrated significantly greater learning engagement than public and low-fee private school students ($p<0.001$). Learning engagement ($\beta=0.36$), device access ($\beta=0.31$), internet quality ($\beta=0.28$), parental education ($\beta=0.17$), and teacher digital training ($\beta=0.14$) significantly predicted academic outcomes ($p<0.001$). Digital access also improved educational inclusion and engagement, leading to better academic performance.

Conclusion: Digital inequality remains a major barrier to inclusive education in Pakistan. Expanding digital infrastructure, affordable internet access, and teacher digital capacity is essential to improve educational equity and learning outcomes.

INTRODUCTION

Education is widely recognized as a fundamental human right and a critical driver of social, economic, and national development (Ainscow, 2020; Alenezi et al., 2023; Anthony Jnr & Noel, 2021). Quality education promotes individual empowerment, reduces poverty, enhances employment opportunities, and contributes to sustainable development (Arkorful et al., 2020; Ben Youssef et al., 2022; Buhl-Wiggers et al., 2023). However, despite significant global progress in expanding educational access, substantial inequalities persist in learning opportunities and outcomes, particularly among marginalized populations. These disparities are often shaped by socioeconomic status, gender, geographic location, disability, and access to educational resources (Cerf, 2023). In recent years, the rapid integration of digital technologies into education has created new opportunities for learning while simultaneously exposing and, in some cases, widening existing educational inequalities (Chankseliani & McCowan, 2021). The concept of inclusive education emphasizes the right of all learners, regardless of their social, economic, physical, or cognitive characteristics, to participate fully in quality educational environments (Chankseliani et al., 2021; de Souza Rodrigues et al., 2021). Inclusive education seeks to remove barriers to participation and ensure that students from diverse backgrounds have equitable opportunities to learn and succeed (Edeji, 2024). Achieving educational inclusion has become a central objective of Sustainable Development Goal 4 (SDG 4), which aims to ensure inclusive and equitable quality education for all (Feraco et al., 2023; Francisco et

al., 2020). However, the increasing reliance on digital learning technologies has introduced new challenges related to educational equity, particularly in low- and middle-income countries where access to digital infrastructure remains uneven (Golden et al., 2023). The expansion of online and hybrid learning models has transformed educational systems worldwide (Halai & Durrani, 2021). Hybrid learning combines face-to-face instruction with digital learning activities, allowing students to access educational content through multiple modalities (Jamil & Muschert, 2024). Although hybrid learning offers flexibility and opportunities for personalized learning, its effectiveness depends heavily on students' access to digital devices, internet connectivity, and supportive learning environments

HIGHLIGHTS	
Research insights	Digital inequality remains a major barrier to inclusive education in Pakistan, with significant disparities in access, engagement, and academic outcomes.
Practical insights	Expanding digital infrastructure, affordable internet access, and teacher digital capacity is essential to improve educational equity and learning outcomes overall.
Industry insights	Teacher digital training significantly predicted academic outcomes, highlighting the importance of digital capacity for improving educational equity and learning outcomes.

(Korpershoek et al., 2020). The COVID-19 pandemic accelerated the adoption of hybrid and remote learning approaches, forcing educational institutions to rely extensively on digital technologies



(Krishnaswami et al., 2022; Langthaler & Bazafkan, 2020). While these changes enabled learning continuity during school closures, they also highlighted significant disparities in technological access and digital readiness among students and schools (Lythreatis et al., 2022).

One of the most critical challenges associated with hybrid learning is the digital divide (Mishra et al., 2023). The digital divide refers to inequalities in access to information and communication technologies, including digital devices, internet connectivity, digital skills, and opportunities to use technology effectively (Olanrewaju et al., 2021; Pregowska et al., 2021). Students from low-income households, rural communities, and marginalized social groups are often disproportionately affected by digital exclusion. Research has demonstrated that limited access to digital technologies can reduce participation in online learning, negatively affect academic performance, and contribute to widening educational achievement gaps (Raes et al., 2020). Consequently, understanding how digital inequalities influence learning experiences has become increasingly important for policymakers and educators (Singh et al., 2022).

Pakistan faces significant challenges related to educational access, quality, and equity (Tonegawa, 2022). Although school enrollment rates have improved over the past two decades, substantial disparities remain across regions, socioeconomic groups, and gender categories (Tonegawa, 2022). Rural communities frequently experience shortages of educational infrastructure, qualified teachers, and technological resources (Cerf, 2023). Moreover, many households lack reliable internet access and digital devices, limiting students' ability to participate fully in digital learning initiatives (Pregowska et al., 2021). These challenges became particularly evident during the COVID-19 pandemic when many students struggled to access remote education due to technological and economic constraints (Golden et al., 2023; Raes et al., 2020).

Marginalized students are especially vulnerable to the effects of digital inequality. Students from low-income households may face financial barriers to acquiring devices and internet services, while students living in remote areas often encounter inadequate digital infrastructure (Golden et al., 2023; Pregowska et al., 2021). Similarly, students with disabilities may experience additional accessibility challenges when educational technologies are not designed to accommodate diverse learning needs (Chankseiani et al., 2021; Francisco et al., 2020). These intersecting disadvantages can reduce educational participation and hinder learning outcomes, thereby undermining efforts to achieve inclusive education (Edeji, 2024; Feraco et al., 2023).

Learning engagement is an important factor influencing educational success in both traditional and digital learning environments (Jamil & Muschert, 2024). Engagement encompasses behavioral, emotional, and cognitive dimensions of student participation in learning activities. Students who are actively engaged in learning are more likely to demonstrate higher academic achievement, stronger motivation, and greater educational persistence (Turnbull et al., 2021). However, engagement may be adversely affected when students encounter barriers to accessing digital learning resources (Olanrewaju et al., 2021; Singh et al., 2022). Limited connectivity, inadequate devices, and insufficient digital support can reduce participation in online activities and contribute to disengagement from educational processes (Pregowska et al., 2021).

Perceived inclusion and school belonging also play crucial roles in shaping student experiences and outcomes. Students who feel accepted, valued, and supported within their educational environments are more likely to participate actively in learning and achieve positive academic outcomes (Korpershoek et al., 2020). Inclusive educational practices are particularly important within hybrid learning contexts, where digital barriers may increase the risk of exclusion for already marginalized learners (Van De Werfhorst et al., 2022). Ensuring that all students have equal opportunities to participate in learning activities is therefore essential for promoting

educational equity and social inclusion (Edeji, 2024; Feraco et al., 2023).

Teachers play a central role in determining the effectiveness of hybrid learning environments (Korpershoek et al., 2020). Digital pedagogy refers to the knowledge and skills required to integrate technology effectively into teaching and learning processes (Winter, 2021; Golden et al., 2023). Teachers with adequate digital training are better equipped to design engaging learning experiences, facilitate online participation, and support diverse learner needs (Winter, 2021). However, many educators in developing countries have received limited preparation for digital instruction, potentially affecting the quality and inclusiveness of hybrid education (Golden et al., 2023).

Despite growing international interest in digital education and educational equity, limited empirical research has examined the relationships among digital access, learning engagement, inclusion, and academic outcomes within the Pakistani context. Existing studies have primarily focused on technological infrastructure or educational attainment separately, with relatively few investigations adopting a comprehensive approach that incorporates multiple stakeholders, including students, parents, and teachers. Furthermore, there remains a need for evidence regarding how digital inequalities affect marginalized student populations in hybrid learning environments.

Therefore, the present study investigates inclusive education, digital divides, and learning outcomes among marginalized secondary school students in Pakistan. Specifically, the study examines how access to digital resources, socioeconomic factors, school characteristics, and teacher digital pedagogy influence student engagement, perceptions of inclusion, and academic outcomes. By integrating quantitative and qualitative data from students, teachers, and parents, this research seeks to provide a comprehensive understanding of educational equity gaps in hybrid learning environments and to inform policies aimed at promoting inclusive and equitable education in Pakistan.

METHODOLOGY

This study employed a mixed-methods cross-sectional research design to examine inclusive education, digital divides, and learning outcomes among marginalized secondary school students in Pakistan. The study aimed to investigate how disparities in access to digital resources influence student engagement, educational inclusion, and academic outcomes within hybrid learning environments. A multi-stakeholder approach was adopted, incorporating perspectives from students, teachers, and parents to provide a comprehensive understanding of educational equity and digital participation. Quantitative survey data were complemented by qualitative insights and secondary educational statistics to strengthen the validity and contextual relevance of the findings.

The study was conducted in selected public, private, and low-fee private secondary schools located in rural, urban, and peri-urban areas across different provinces of Pakistan. Participants were recruited through collaboration with school administrations, parent-teacher associations, and district education offices. A stratified convenience sampling technique was employed to ensure representation across school types, geographical locations, socioeconomic backgrounds, and demographic groups. Stratification was based on province, school type, and locality to capture variations in educational access and digital infrastructure.

The study sample consisted of 500–700 secondary school students enrolled in grades 6–10 and 150–200 teachers and parents who were directly involved in students' educational experiences. Students with and without disabilities were included to ensure that issues related to educational inclusion and accessibility could be adequately examined. Teachers participating in the study represented a range of subject areas and levels of experience with digital teaching practices. Parents were recruited through school meetings and parent-teacher associations to provide information regarding household resources

and support for hybrid learning.

Primary data were collected using structured paper-based or tablet-assisted questionnaires specifically designed for students, teachers, and parents. Student questionnaires gathered information on demographic characteristics, including age, grade level, gender, disability status, household socioeconomic status, parental education, and place of residence. Additional sections assessed access to digital devices, internet connectivity quality, participation in online and hybrid learning activities, perceived inclusion, school belonging, and self-reported academic performance. Teacher questionnaires focused on digital pedagogy training, instructional practices, challenges encountered in hybrid learning environments, and perceptions of student engagement. Parent questionnaires examined household educational support, technology availability, internet access, and perceptions of educational equity. Independent variables included student age, grade, gender, disability status, household socioeconomic status, parental educational attainment, geographic location, device ownership, internet quality, school type, and teacher digital pedagogy training. Dependent variables included learning engagement, self-reported academic outcomes, perceived inclusion and belonging, barriers to digital participation, and attitudes toward the equity of hybrid and online learning systems. Learning engagement was assessed using validated measures of behavioral, emotional, and cognitive engagement, while inclusion and belonging were evaluated through standardized educational inclusion scales. Barriers to digital participation included limited internet access, device shortages, affordability constraints, accessibility challenges, and technological literacy limitations.

In addition to survey data, optional in-person focus group discussions were conducted with selected students, teachers, and parents to obtain deeper insights into their experiences with hybrid learning, educational inclusion, and digital access challenges. Focus groups were facilitated using semi-structured discussion guides and conducted at participating schools. Secondary data were obtained from publicly available educational databases, including Annual Status of Education Report (ASER) Pakistan, provincial education statistics, and government reports on digital learning initiatives. These secondary sources were used to triangulate findings and provide broader contextual information regarding educational inequalities and digital access patterns across Pakistan.

Quantitative data were analyzed using SPSS version 24 and AMOS for structural equation modeling (SEM). Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize participant characteristics and key study variables. Reliability analyses were performed to assess the internal consistency of multi-item scales. Analysis of Variance (ANOVA) and Multivariate Analysis of Variance (MANOVA) were used to compare learning outcomes and engagement levels across demographic groups and school types. Hierarchical multiple regression analyses were conducted to identify predictors of educational engagement and academic outcomes. Structural equation modeling was employed to examine the hypothesized pathways linking digital access, learning engagement, perceived inclusion, and educational outcomes. Qualitative data from focus groups were transcribed and analyzed using thematic analysis to identify recurring themes related to digital inequalities, educational inclusion, and hybrid learning experiences.

Ethical approval was obtained from the relevant Institutional Review Board before the commencement of data collection. Written informed consent was obtained from all adult participants and from parents or guardians of participating students. Student assent was also secured prior to participation. Confidentiality, anonymity, and voluntary participation were maintained throughout the study, and participants were informed of their right to withdraw from the research at any time without consequences. All procedures were conducted in accordance with ethical guidelines for educational and

social science research involving human participants.

RESULTS

A total of 648 secondary school students, 98 teachers, and 84 parents participated in the study. Students were recruited from public, private, and low-fee private schools across rural, urban, and peri-urban areas of Pakistan. The mean age of students was 14.7 ± 1.8 years, with participants representing Grades 6–10. The overall response rate was 91.4%.

Table 1: Demographic Characteristics of Student Participants (N = 648)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	332	51.2
	Female	316	48.8
Grade Level	Grade 6–7	214	33.0
	Grade 8–9	287	44.3
	Grade 10	147	22.7
Residence	Urban	286	44.1
	Peri-Urban	164	25.3
	Rural	198	30.6
School Type	Public	295	45.5
	Private	217	33.5
	Low-Fee Private	136	21.0
Disability Status	Yes	52	8.0
	No	596	92.0

Approximately 30.6% of students resided in rural areas, while 8.0% reported having a disability.

Table 2: Household Socioeconomic and Digital Access Characteristics

Variable	Category	Frequency (n)	Percentage (%)
Household SES	Low	281	43.4
	Middle	259	40.0
	High	108	16.6
Device Ownership	Personal Device	258	39.8
	Shared Device	274	42.3
	No Device	116	17.9
Internet Quality	Poor	237	36.6
	Moderate	258	39.8
	Good	153	23.6
Parental Education	Primary or Less	289	44.6
	Secondary	233	36.0
	Higher Education	126	19.4

Nearly one-fifth of students lacked access to any digital device, while only 23.6% reported having good-quality internet connectivity.

Table 3: Teacher Digital Pedagogy Training (N = 98)

Variable	Frequency (n)	Percentage (%)
Received Formal Digital Training	61	62.2
No Formal Digital Training	37	37.8
Regular Use of Online Learning Tools	69	70.4
Confidence in Hybrid Teaching	58	59.2

Although most teachers reported using digital learning tools, a substantial proportion had not received formal training in digital pedagogy.

Table 4: Learning Engagement and Academic Outcomes

Variable	Mean $\pm$ SD
Behavioral Engagement	3.42 ± 0.69
Emotional Engagement	3.27 ± 0.74
Cognitive Engagement	3.18 ± 0.71
Overall Engagement Score	3.29 ± 0.63
Self-Reported Academic Performance	3.11 ± 0.67

Scale: 1 = Very Low to 5 = Very High

Students reported moderate levels of engagement and academic performance across all domains.

Table 5: Perceived Inclusion and School Belonging

Variable	Mean ± SD
Inclusion Score	3.36 ± 0.72
School Belonging Score	3.24 ± 0.76
Perceived Equity in Hybrid Learning	2.89 ± 0.81

Students generally reported moderate levels of inclusion; however, perceptions of equity within hybrid learning environments were comparatively lower.

Table 6.: Barriers to Digital Participation

Barrier	Frequency (n)	Percentage (%)
Limited Internet Access	421	65.0
Device Sharing Within Household	364	56.2
High Data Costs	387	59.7
Electricity Interruptions	312	48.1
Lack of Digital Skills	241	37.2
Accessibility Challenges for Disabled Students	39	75.0*

*Percentage calculated among students reporting disabilities (n = 52).

Limited internet access and high connectivity costs were identified as the most common barriers to participation in hybrid learning.

Table 7: ANOVA Comparing Engagement by School Type

School Type	Mean Engagement Score ± SD
Public School	3.08 ± 0.61
Low-Fee Private School	3.24 ± 0.58
Private School	3.57 ± 0.60

$F = 18.74, p < 0.001$

Students enrolled in private schools demonstrated significantly higher engagement scores than students attending public and low-fee private schools.

Table 8. Hierarchical Regression Predicting Academic Outcomes

Predictor Variable	β	t-value	p-value
Device Access	0.31	8.92	<0.001
Internet Quality	0.28	7.85	<0.001
Learning Engagement	0.36	10.47	<0.001
Parental Education	0.17	4.73	<0.001
Teacher Digital Training	0.14	3.91	<0.001
Disability Status	-0.11	-2.98	0.003

The model was statistically significant ($F = 57.62, p < 0.001; R^2 = 0.52$), explaining 52% of the variance in academic outcomes. Learning engagement and digital access were the strongest predictors of educational performance.

Table 9: Structural Equation Modeling Results

Path Relationship	Standardized β	p-value
Digital Access → Learning Engagement	0.61	<0.001
Digital Access → Inclusion	0.42	<0.001
Inclusion → Learning Engagement	0.31	<0.001
Learning Engagement → Academic Outcomes	0.58	<0.001
Inclusion → Academic Outcomes	0.24	0.002

Model Fit Statistics

Index	Value
χ^2/df	2.18
CFI	0.96
TLI	0.95

RMSEA	0.049
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The SEM model demonstrated excellent fit and confirmed that digital access positively influenced engagement and inclusion, which subsequently improved academic outcomes.

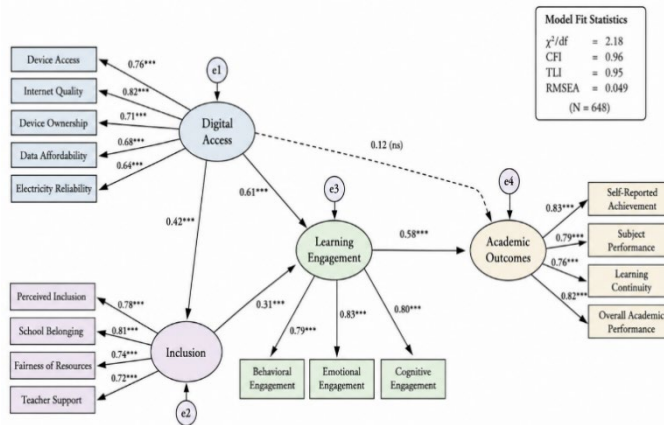


Figure 1. Structural Equation Model of Digital Access, Inclusion, Learning Engagement, and Academic Outcomes

Note. Standardized estimates are shown. ** $p < .01$, *** $p < .001$, ns = not significant.

Qualitative Findings

Thematic analysis of focus group discussions identified four major themes:

1. Persistent Digital Inequality

Students from low-income and rural households frequently reported difficulties accessing reliable internet services and digital devices, limiting their participation in online learning activities.

2. Importance of Teacher Support

Participants emphasized that teachers with stronger digital skills created more engaging and inclusive learning environments.

3. Inclusion Challenges for Marginalized Students

Students with disabilities and those from disadvantaged socioeconomic backgrounds reported greater barriers to participation and learning continuity.

4. Demand for Equitable Hybrid Learning Systems

Parents, teachers, and students expressed support for hybrid education but highlighted the need for affordable internet access, device provision, and teacher training to ensure educational equity.

Summary of Findings

The findings indicate significant digital divides within Pakistan's hybrid learning environments. Students with greater access to devices, reliable internet connectivity, and digitally trained teachers demonstrated higher levels of engagement, inclusion, and academic performance. Conversely, marginalized groups—including rural students, low-income households, and students with disabilities—experienced substantial barriers to digital participation. Structural equation modeling confirmed that digital access directly and indirectly influenced educational outcomes through improved inclusion and engagement. These findings highlight the need for targeted educational policies that address digital inequalities and promote inclusive learning opportunities for all students.

DISCUSSION

The present study examined the relationships among digital access, inclusive education, learning engagement, and academic outcomes among marginalized secondary school students in Pakistan. The findings reveal substantial disparities in access to digital resources and highlight how these inequalities influence student engagement,

perceptions of inclusion, and educational achievement in hybrid learning environments. The results further demonstrate that digital access, teacher preparedness, and socioeconomic factors play critical roles in shaping educational opportunities and outcomes. These findings contribute to the growing body of literature on digital inequality and educational equity, particularly within developing-country contexts where technological resources remain unevenly distributed (Francisco et al., 2020; Pregowska et al., 2021; Tonegawa, 2022).

One of the most significant findings of the study was the widespread digital divide experienced by students from disadvantaged backgrounds. A considerable proportion of participants reported limited access to personal digital devices, poor internet connectivity, and difficulties participating fully in hybrid learning activities. These findings are consistent with international evidence demonstrating that digital inequalities remain a major barrier to educational participation and achievement (Olanrewaju et al., 2021; Pregowska et al., 2021; Singh et al., 2022). The COVID-19 pandemic further exposed these disparities, revealing how unequal access to technology can exacerbate existing educational inequalities and disproportionately affect students from low-income households, rural communities, and marginalized groups (Lythreathis et al., 2022; Raes et al., 2020; Van De Werfhorst et al., 2022). The high prevalence of internet connectivity challenges and device-sharing reported in this study indicates that digital exclusion remains a significant obstacle to equitable education in Pakistan.

The study found that students attending private schools reported significantly higher engagement levels compared with those enrolled in public and low-fee private schools. This finding may reflect differences in technological infrastructure, educational resources, teacher training, and institutional support across school sectors. Previous research has shown that private schools often possess greater capacity to implement digital learning initiatives due to better funding and access to educational technologies. In contrast, public schools in many developing countries frequently face resource constraints that limit their ability to support effective hybrid learning environments (Singh et al., 2022; Tonegawa, 2022). These disparities raise important concerns regarding educational equity and suggest that school type remains a significant determinant of learning opportunities (Buhl-Wiggers et al., 2023; Francisco et al., 2020).

Learning engagement emerged as one of the strongest predictors of academic outcomes. Students who reported higher levels of behavioral, emotional, and cognitive engagement also demonstrated better self-reported academic performance. This finding is consistent with extensive educational research emphasizing engagement as a key determinant of student achievement and learning success. Engaged students are more likely to participate actively in learning activities, maintain motivation, and develop positive attitudes toward education. The results suggest that interventions designed to improve engagement may contribute significantly to academic success, particularly within hybrid learning environments where maintaining student participation can be challenging (Jamil & Muschert, 2024; Korpershoek et al., 2020).

The findings also highlighted the importance of perceived inclusion and school belonging. Students who felt more included and valued within their educational environments reported higher engagement and better academic outcomes. This observation aligns with previous studies demonstrating that inclusive educational practices promote positive academic, social, and emotional outcomes for diverse student populations (Chankseliani et al., 2021; de Souza Rodrigues et al., 2021). Inclusion is particularly important for students from marginalized backgrounds because it fosters a sense of belonging, reduces social exclusion, and encourages active participation in learning processes (Edeji, 2024; Francisco et al., 2020). The relatively lower scores for

perceived equity in hybrid learning indicate that many students believe current digital education systems do not provide equal opportunities for all learners (Chankseliani & McCowan, 2021).

A particularly important finding was the significant disadvantage experienced by students with disabilities. Many participants with disabilities reported accessibility challenges that limited their participation in digital learning activities. These findings are consistent with global evidence indicating that students with disabilities often face additional barriers related to inaccessible technologies, insufficient support services, and limited inclusive educational resources (Chankseliani et al., 2021; de Souza Rodrigues et al., 2021). Although digital technologies have the potential to enhance educational accessibility, their benefits cannot be fully realized without deliberate efforts to design inclusive learning environments (Chankseliani & McCowan, 2021). Consequently, policymakers and educational institutions must prioritize accessibility considerations when developing digital education initiatives.

Teacher digital pedagogy training was another significant predictor of positive educational outcomes. Students taught by teachers with formal digital training reported higher engagement and better learning experiences. These findings support previous research suggesting that teacher competence in digital instruction significantly influences the effectiveness of technology-enhanced learning environments (Winter, 2021). Teachers who possess strong digital skills are better equipped to design interactive lessons, facilitate student participation, and adapt instructional strategies to hybrid learning contexts. The finding that a substantial proportion of teachers lacked formal digital training highlights an important area for policy intervention and professional development.

The structural equation model provided further insight into the mechanisms through which digital access influences educational outcomes. The results demonstrated that digital access directly enhanced learning engagement and perceived inclusion, which subsequently improved academic performance. These findings are consistent with the theoretical framework of digital equity, which emphasizes that meaningful access to technology involves not only the availability of devices and internet connectivity but also opportunities for effective participation and learning (Lythreathis et al., 2022; Pregowska et al., 2021). The strong pathway from digital access to engagement suggests that improving technological infrastructure may generate significant educational benefits by increasing students' ability to participate actively in learning activities.

The qualitative findings reinforced the quantitative results by highlighting students' experiences of digital exclusion, connectivity challenges, and educational inequality. Participants frequently described difficulties related to unreliable internet services, high data costs, and limited device availability. Parents expressed concerns regarding their ability to support online learning due to financial constraints, while teachers emphasized the challenges of maintaining student engagement in resource-limited settings. These findings underscore the multidimensional nature of digital inequality and suggest that addressing technological barriers alone may not be sufficient without broader efforts to address socioeconomic disparities (Pregowska et al., 2021).

The study also has important implications for educational policy and practice. The findings suggest that investments in digital infrastructure, affordable internet access, device provision programs, and teacher professional development could significantly reduce educational inequalities. Furthermore, targeted support for students with disabilities, rural learners, and low-income households is essential to ensure that hybrid learning systems promote inclusion rather than reinforce existing disparities (Francisco et al., 2020). Educational policies should adopt a digital equity perspective that recognizes technology access as a fundamental component of educational opportunity in

contemporary learning environments (Pregowska et al., 2021; Winter, 2021).

This study contributes to the literature by providing empirical evidence on the complex relationships among digital access, inclusion, engagement, and learning outcomes within Pakistan's secondary education system. Unlike many previous studies that focus solely on technological access, the present research demonstrates that educational outcomes are shaped by the interaction of digital, social, and institutional factors. The inclusion of multiple stakeholder perspectives further strengthens understanding of the challenges and opportunities associated with hybrid learning environments.

Overall, the findings indicate that digital divides remain a major challenge to inclusive education in Pakistan. While hybrid learning offers significant opportunities for expanding educational access, its benefits are unevenly distributed across socioeconomic groups, geographic regions, and student populations (Lythreath et al., 2022; Raes et al., 2020;). Addressing these inequities requires coordinated efforts to improve technological infrastructure, strengthen teacher capacity, support marginalized learners, and promote inclusive educational practices (Francisco et al., 2020). Such interventions are essential for ensuring that digital transformation contributes to greater educational equity and improved learning outcomes for all students.

CONCLUSION

This study demonstrated that digital inequalities remain a significant barrier to inclusive education and academic success among marginalized secondary school students in Pakistan. Limited access to digital devices, reliable internet, and educational resources reduced learning engagement and perceptions of inclusion, particularly among disadvantaged groups. In contrast, improved digital access, supportive home environments, and digitally trained teachers were associated with better engagement and academic outcomes. The findings emphasize the importance of expanding digital infrastructure, ensuring affordable internet and device access, and strengthening teacher digital competencies. Addressing these challenges through equitable policies is essential for promoting inclusive, high-quality hybrid education and improving learning opportunities for all students.

Ethical Considerations

The study adhered to relevant ethical principles. Informed consent was obtained from all participants, participation was voluntary, and confidentiality and anonymity were maintained throughout the study.

Data Availability

The data are available from the corresponding author upon reasonable request.

Author Contributions

Syed Muhammad Ayub Shah, Safdar Hussain, and Abubakar Tayyab: Conceptualization, methodology, data curation, formal analysis, interpretation of findings, and writing—original draft preparation, review, and editing. All authors approved the final version of the manuscript and accept responsibility for the integrity and accuracy of the work.

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Conflict of Interest

The author declares no conflict of interest.

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Artificial Intelligence (AI) Disclosure

The authors disclose that ChatGPT was used to assist with language editing, proofreading, and improving the clarity and readability of the manuscript. Gemini AI was used to assist in generating figures for the manuscript. AI tools were not used to generate, analyze, interpret, or fabricate research data or findings. The authors reviewed and verified all AI-assisted content and figures and accept full responsibility for the accuracy, originality, integrity, and final content of the manuscript.

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