

DIGITAL TRANSFORMATION IN PAKISTAN'S PUBLIC SCHOOLS: OPPORTUNITIES AND CHALLENGES FOR SDG-4

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Abstract:

This study investigates the opportunities and challenges of digital transformation in Pakistan's public schools within the framework of Sustainable Development Goal 4 (SDG-4). The research problem is that despite government initiatives, public schools in Pakistan lag behind in adopting effective digital learning systems due to persistent barriers such as inadequate internet access, a lack of teacher training, and insufficient maintenance of ICT equipment. The aim of the study was to investigate the opportunities and challenges of digital transformation with a focus on its potential role in achieving SDG-4. Employing a mixed-methods research design, the study integrated quantitative data from surveys of 450 participants (150 teachers and 300 students) and qualitative insights from semi-structured interviews with 15 headteachers and 5 policymakers in Punjab. The findings reveal a significant gap between the high enthusiasm for digital tools among teachers and students and the systemic barriers hindering their effective integration. A majority of teachers (65%) agree that they regularly use ICT tools for teaching, and an impressive 72% strongly agree that these tools boost student engagement. However, this positive perception is contrasted by severe infrastructural deficits. A staggering 50% of teachers reported that Learning Management Systems (LMS) are "Not Available". Additionally, 60% of both teachers and students cited slow or non-existent internet connectivity as a "Major Challenge". The high cost of personal digital devices was identified as the single most prominent barrier, with 75% of teachers and 82% of students considering it a "Major Challenge". Qualitative analysis corroborated these findings, with headteachers describing ICT resources as "showpieces" due to unreliable power and connectivity, and policymakers acknowledging "last-mile connectivity" and budget constraints as major barriers to implementation. The study concludes that for digital transformation to progress meaningfully, the focus must shift from small-scale initiatives and broad policies to targeted, localized, and well-funded strategies that directly address the infrastructure, training, and policy implementation gaps. The findings provide empirical evidence that the current approach is not sufficient to achieve the ambitious targets of SDG-4 for inclusive and equitable quality education.

Keywords: Digital transformation, public schools, SDG-4, digital divide, teacher training, ICT integration, educational technology.

CHAPTER 1: INTRODUCTION

1.1 Background of the Study

Over the past decades, the digital technology revolution in education has changed the way teaching and learning is being provided on a global scale. The term, digital transformation, can be used to define how digital tools, platforms and teachings are utilized to improve the learning experiences, increase accessibility and improve educational outcomes (Redecker, 2020). Digital literacy has become a critical requirement in the 21st century given the current trends and changes in the educational environment, which have occurred globally due to the introduction of artificial intelligence, cloud computing, virtual learning environments, and mobile learning applications (Nguyen et al., 2021). The psychological contribution to these changes on the human mind is also an important study area as the psycholinguistic aspect reveals the role of cognitive and emotional aspects to the learning process (Mehmood et al., 2025). International activities, digital transformation has not only found a place among the innovation strategies of countries but has also become one of the ways to implement the sustainable development goal 4 of the United Nations (SDG-4) aimed at quality and inclusive education and lifelong learning opportunities to all (UNESCO, 2017).

Multiple high-income countries already have developed full-scale digital education plans encompassing the use of technology in school curriculum, teacher training, and school facilities (European Commission, 2019). A good example of a country that has invested in ensuring that their students are exposed to competencies in digital tools and collaborative online work combined with learning of digital pedagogy among teachers are Finland, Singapore, and South Korea (Selwyn, 2020). In these contexts, digital transformation has gone beyond providing computers; it involves systemic changes in curriculum design, assessment practices, and school governance to support digitally enhanced learning environments (Kong et al., 2021).

However, digital transformation is not without challenges. Globally, issues such as the digital divide, lack of teacher training, inadequate infrastructure, and inequities in access to devices and high-speed internet remain persistent (Trucano, 2021). The COVID-19 pandemic exposed these disparities more sharply, as millions of students in low- and middle-income countries struggled to access remote learning platforms (World Bank, 2021). Consequently, digital transformation must be understood not only as a technological shift but also as a social and policy challenge that requires bridging access gaps and ensuring equitable participation in digital learning ecosystems.

Within the South Asian region, digital transformation in education has gained momentum in recent years, driven by mobile internet penetration and policy reforms aimed at improving learning outcomes (Khan et al., 2022). Nation-level digital education programs exist in places like India and Bangladesh to help bring ICT into national schooling networks, but these have shown limitations due to problems with infrastructure, funding, and teacher preparedness (Haque & Arif, 2019). This regional backdrop is very pertinent to Pakistan, where a comparable set of issues and opportunities manifests in the process of achieving SDG-4 compliance.

In Pakistan, most school-going children are admitted to the public education system, which suffers acute problems of underfunding, teacher scarcity, and the inadequacy of school curricula (Aslam & Kingdon, 2020). The concept of digital transformation in the Pakistani public schools is still in its infancy, and the majority of the entire efforts are localized to the urban areas due to the occasional donor-funded project or pilot runs by provinces (Rehman & Khan, 2021). In the Punjab province, it had tried many ICT-based reforms such as introduction of digital classrooms, online teacher training modules, and school management information systems (SMIS) (Punjab School Education Department, 2022). Nevertheless, most rural state

schooling institutions do not have adequate digital infrastructure capable of connecting students and teachers with computers, projectors, and the internet (Ahmad et al., 2020).

Digital divide between urban and rural of Pakistan is one of the most significant barriers to digital transformation of the public schools in Pakistan. Although urban school typically has access to computer labs and the internet, rural institutions tend to operate without electricity for periods of several hours, which makes the integration of ICT impossible (Nawaz & Kundi, 2019). Moreover, there also exists a significant disconnect between digital literacy and teachers who did not get much exposure, or none at all, to the use of technology in instruction (Malik et al., 2021). Such challenges have direct implications in the capacity of the country to achieve the components of SDG-4, especially those that concern quality and equitable education.

The importance of SDG-4 within the framework of the digital transformation of Pakistan is hard to overestimate. The goal focuses both on universal access to education and the acquisition of applicable skills such as digital competencies to enter the modern work environments (United Nations, 2015). Poor digital infrastructure in government schools has the potential to increase the already present disparities in schooling by leaving the poorly off students unable to gain skills and become employable (Jamil et al., 2020).

In addition, the COVID-19 pandemic has enhanced needs to discuss digital transformation in the Pakistani state schools. The governments at the federal and provincial levels attempted different strategies of remote learning during the long-term school shutdowns: televised lessons (TeleSchool), radio broadcasts, and delivering content online (Pakistan Ministry of Federal Education, 2021). While these measures provided some continuity in learning, they also highlighted the systemic barriers that prevent effective digital integration, such as device affordability, internet accessibility, and teacher preparedness (Khalid & Ali, 2022).

In recent years, policy frameworks have begun to incorporate digital transformation as a strategic priority. The recent (2021) draft of the National Education Policy and provincial plans also have recognised the potential of technology in improving learning outcomes and achieving increased access to education (Government of Pakistan, 2021). It has been slow in its implementation, mainly attributed to the budget limitation, the absence of strategies that can coordinate planning, and the lack of teacher training programs that are comprehensive (Shah & Batool, 2020).

Like its counterparts beyond the scope of K-12 education, digital transformation is a complex process, which necessitates more than one front: enhancing infrastructure, creating corresponding digital curriculum, boosting teachers proficiency, and addressing the need of marginalized entities (OECD, 2020). In the case of Pakistan, this entails providing a redressing to the dichotomies of gender, socioeconomic status, and geographic location within the establishment of the nationwide schools. Social inequality should be paid special consideration to the needs of female students in the conservative regions of the rural area, who might not have an equal access to technology, and students with disabilities, who might need the assistive digital tools to contribute equally to their learning activities (Khan & Qureshi, 2022).

In light of these facts it is urgent to explore the possibilities and issues that can happen with digital transformation in the Pakistani state schools. On the one hand, the incorporation of digital tools might increase the involvement and lead to self-regulated learning and the equipping students with the set of knowledge required by the global knowledge-based economy. In the latter case, failing to ensure structural inequalities and teacher capacity, digital transformation is at risk of becoming a window dressing change that does not bring any significant alteration (Nguyen et al., 2021).

This paper therefore intends to study the processes, facilitating factors and hindrance to digital transformation amongst the public schools in Pakistan in the scope of SDG-4. With an

understanding of the existing level of ICT integration, policy efforts, and on-the-ground reality, the research attempts to deliver recommendations that could be useful to the policymakers, educators, and development partners. Finally, the role of the interconnection between technology adoption and educational equity will play a key role in digital transformation achieving sustainable and inclusive development in Pakistan.

1.2 Problem Statement.

Although the government has launched several initiatives to improve education in the country (the Digital Pakistan Vision [2019] and the School Education Reforms in Punjab), there is still much to be done to modernize public schools and implement the effective digital learning systems. The challenges remain in the form of poor access to internet, the lack of training of the teacher regarding digital pedagogy, dated curriculum and lack of maintenance of ICT devices. With such gaps, it is impossible to realize the dream of being at SDG-4 by 2030, at least among the deprived groups of the society.

1.3 Research Aim.

This paper seeks to explore the opportunities and challenges of digital transformation of public schools in Pakistan, particularly, how it could be relevant in realizing SDG- 4.

1.4 Research Objectives.

1. To understand the existing situation in digital infrastructure and technological integration in the public schools.
2. To determine the problems that educators and other educational leaders encounter in using online learning technologies.
3. To discuss the possibilities of improvement of teaching and learning with the help of ICT in accordance with SDG-4.
4. To suggest the strategies of how to successfully transform public education through digital means.

1.5 Research Questions

1. What is happening in public schools in Pakistan about digital till learning adoption?
2. What challenges hinder the effective implementation of digital technologies in these schools?
3. What opportunities exist to align digital transformation with the goals of SDG-4?
4. How can policymakers and school leaders create sustainable digital education systems in public schools?

CHAPTER 2: LITERATURE REVIEW

2.1 Concept of Digital Transformation in Education.

Digital transformation in education is the implementation of strategic change to education-related situations using digital technologies in order to enhance the teaching, learning process, and management of schools. Al-Marooof et al. (2021) state that this transformation does not only mean the addition of technology but a reconsideration of pedagogy, curriculum, and school governance. In the case of Pakistan, it can be moving away with the conventional method of rote learning to a more technology-rich student centred system.

2.2 The Role of ICT in Achieving SDG-4.

An act of integration of ICT is an effective catalyst in accomplishing the goals of each of the SDG-4, especially when targeting quality, equitable and inclusive education. Online systems are able to extend the availability of learning materials to students in rural or underserved communities, provide individualized learning paths to support the needs of diverse learners and support teacher advancement by providing online training opportunities and communities of practice. They are also able to give a platform to provide data driven decision making whereby policymakers can track the development of education and the areas they need to improve.

Nevertheless, using ICT to facilitate SDG-4 is subject to which the elaborate barriers can be surmounted. To cite an example, a study conducted by Mehmood et al. (2025) to study the Indigenous cultural practice in the early childcare curricula in the region of Punjab revealed that the national curriculum that is rigid and one-size-fits-all poses a serious impediment. This observation is supported by the implications of your interviews of policy-level change and shows that solutions at the local level are absent in general when it comes to educational reform in practice. It is also noted that a lack of adequate teacher training is a key obstacle as it means that teachers lack the training and resources to study and implement indigenous understanding in a respectful and competent way. This coincides directly with the results of your study about teacher capacity building about digital tools. These encountered cultural and pedagogical challenges can help the education system create a more solid foundation of inclusive and effective digital transformation.

2.3 Digital Education in Pakistan's Public Schools.

A study conducted by Aslam et al. (2020) underscores the fact that urban public schools in Pakistan have already implemented specific ICT tools; however, rural schools usually do not even have computer classes. The lack of stable electricity supply, low levels of digital literacy on the part of teachers, and the unavailability of locally relevant e-learning material contribute to the slowness. Projects such as the Punjab IT Labs Project have proved to be promising but need some form of sustainable funding and capacity building.

In addition to the technological and infrastructural aspects of digital transformation, the human factor of digital transformation is an essential point of interest of scholars. The success or failure of an education reform is determined by the morale and capacity of the teacher. A survey of stress among special education teachers working in government centers in Punjab has identified stress and burnout as prevalent in most cases, which tends to be caused by the high workload, inefficient resources, and the absence of proper support on the part of the administration (Mehmood et al., 2025). Although this study examines a particular situation, the implications of the findings are very useful in the context of the overall digital transformation initiative. Introduction of new technologies and pedagogies may also place additional burden on teachers who are already under heavy conditions, in case they are not provided with relevant training and follow ups. This highlights the concern that policies should supplement the use of digital tools not only in terms of providing them but also by focusing on the professional and psychological welfare of teachers.

2.4 Challenges in Implementing Digital Learning.

The implementation of digital learning has its factors that hamper its achievement and accessibility. Possible limitations are infrastructure gaps such as poor and unreliable internet connection and a lack of the required hardware especially in rural and remote regions (Shah & Jabeen, 2021). Moreover, a large number of educators struggle because of insufficient preparation on digital pedagogies, which makes them unprepared to conduct classes utilizing technology. The socioeconomic differences also contribute to the issue since low-income students have no access to equipments and sustained internet, widening the digital divide. A huge impediment is the incongruency between conventional curriculum and online learning. Most of the current learning resources and evaluation methodologies do not suit online learning and thus integration is not easy. All these issues can be overcome only through a comprehensive solution of creating investment in infrastructure, responding to expanded teacher training, ensuring equal access to technology, and transforming curriculum to maximise the power of digital learning.

2.5 Teacher Support for Inclusive Education.

Inclusive education, which is one of the founding principles of SDG-4, necessitates that children, irrespective of their abilities, are all entitled to have access to quality education. According to a recent study by Mehmood and Parveen (2025) teacher support programs have a significant contribution to make towards attainment of this goal, especially in elementary schools of Punjab. The findings of their study, which was based on the development and assessment of Teacher Support Programme (TSP) to CWDs, show that they can never effectively include the children with disability without first providing training to their teachers. The research established that normal educators do not have the skills, not to mention the confidence, to accommodate CWDs in the mainstream classes. The TSP was a six-staged program that acted as a guide to empowering teachers into dealing with these issues. This observation supports the larger claim that professional development of teachers can only be effective when it is practical, long-term, and based on particular requirements in the case of digital pedagogy or any other practice, such as special needs education, to establish the inclusive and equitable education environment. The effectiveness of the given program is a necessary precondition to a digital transformation that would actually benefit all students.

2.6 Opportunities for Digital Transformation.

Nevertheless, the available obstacles notwithstanding, the prospects to apply digital transformation in the education field are immense. Instructive technologies One such prospective area is known as blended learning where face-to-face lessons are supplemented by a combination of digital tools to enable more flexible and tailored learning (UNESCO, 2022). Creation of localized online digital materials concerning country curriculums can also help in making it relevant and culturally sensitive. And, there is a governmental resource to carry on ICT infrastructure, specifically in settings with constrained resources, which is provided through public-private alliances (World Bank, 2021). Also, the increasing availability of inexpensive m-learning programs offers solutions to reach students in disadvantaged and rural settings so that learning gaps can be reduced (GSMA, 2020). Taking advantage of these opportunities in a strategic fashion, learning systems are capable of becoming more inclusive, engaging, and more resilient. Where this is done in a well calculated manner, digital transformation has the capacity of spurring innovation, enhancing teacher training and equipping learners with skills necessary in the digital world..

CHAPTER 3: RESEARCH METHODOLOGY

This chapter describes the methods of research that were used to explore the opportunities and challenges of transformation through digital technology stakeholders in the Pakistan public schools in light of attainment of SDG-4. The research design used in the study combined quantitative and qualitative approaches, that is, a mixed-methods study research design. The reason to choose this design was to ensure that the study captured a thorough knowledge about digital transformation through integrated quantitative and qualitative information of the stakeholders. The quantitative part investigated the accessibility of ICT infrastructure and its usage rate as well as perceived efficiency on both the teacher and the student end, whereas, the qualitative side studied the obstacles encountered, the possibilities, and the policymaking thoughts alongside the adoption of ICT within the context of semi-structured interviews with the headteachers and policymakers. The mixed-methods approach made it possible to triangulate, added validity to the findings, and explored the range and depth of a research problem (Creswell & Plano Clark, 2018).

The study adhered to a pragmatic research paradigm, that is, selecting methods that were best suited to finding answers to the research questions as opposed to following a single philosophical paradigm. The pragmatism approach helped realize the combination of quantitative surveys and qualitative interviews, as well as provided the findings to help shape

the practical strategies that can be employed by policymakers and educators (Morgan, 2014). The target population included Punjab-based headteachers, students, principals and policymakers in the education sector that were selected because the province of Punjab had a large and diverse population, various types of schools (urban and rural) and displayed a keen interest in ICT-based education reforms. Sampling used stratified random sampling in the quantitative phase to represent both urban and rural schools and purposive sampling in the qualitative phase to select both headteachers and ICT coordinators, along with policymakers involved directly in policies of digital education implementation. The study was carried out by 470 participants among whom there were 150 teachers, 300 students who were selected through stratified random sampling, and 15 headteachers and 5 policymakers who were selected purposely.

Data collection combined structured questionnaires and semi-structured interviews. The questionnaires, distributed both in hard copy and digitally via Google Forms, gathered information on the availability and accessibility of ICT infrastructure, frequency and purposes of technology use, perceived effectiveness of digital learning tools, and challenges in adopting ICT-based practices, measured using a 5-point Likert scale. The semi-structured interviews, each lasting 30–45 minutes and audio-recorded with consent, explored policy-level planning for ICT adoption, infrastructure and training challenges, alignment with SDG-4, and recommendations for sustainable digital integration. Prior to the main study, a pilot test with 10 teachers and 15 students ensured the questionnaires' clarity, reliability, and validity, leading to minor adjustments in wording.

Data analysis involved both quantitative and qualitative techniques. Quantitative data were analyzed using SPSS (Version 27), employing descriptive statistics (frequencies, means, standard deviations) to summarize ICT availability and usage trends, and inferential statistics such as independent samples t-tests to compare urban and rural schools, ANOVA to examine differences in perceptions, and chi-square tests to determine associations between demographic variables and ICT adoption levels. Qualitative data were analyzed using thematic analysis following Braun and Clarke's (2006) six-phase framework, including familiarization with transcripts, coding, theme identification, refinement, naming, and synthesizing findings with quantitative results. Key themes identified were infrastructure gaps, teacher training deficits, policy inconsistencies, and opportunities through public-private partnerships.

Reliability and validity measures were applied to ensure robustness. In the quantitative phase, content validity was confirmed through expert review, and reliability was high with a Cronbach's Alpha of 0.87. In the qualitative phase, credibility was enhanced through triangulation of multiple data sources, dependability through verbatim transcription and cross-checking, and transferability by providing rich contextual details for application in similar educational settings.

In summary, this chapter detailed the research methodology employed to examine digital transformation in Pakistan's public schools within the SDG-4 framework. By combining quantitative surveys with qualitative interviews, the study produced robust findings that reflect real-world conditions. The next chapter presents the analysis and findings derived from this mixed-methods investigation.

CHAPTER 4 FINDINGS & ANALYSIS

This chapter provides a detailed analysis of the quantitative data collected from the teacher and student questionnaires. It interprets the raw percentages and frequencies to reveal key insights and trends regarding digital transformation in Pakistan's public schools, and connects these findings to the broader context of educational policy and practice.

4. Quantitative Findings:

Questionnaire 1: For Teachers

Section A: Demographic Information:

Variable	Category	Frequency / Percentage
Sample Size	Teachers	150
Gender	Female	68%
	Male	32%
Age Group	20–30 years	30%
	31–40 years	45%
	41–50 years	20%
	51+ years	5%
School Location	Urban	60%
	Rural	40%

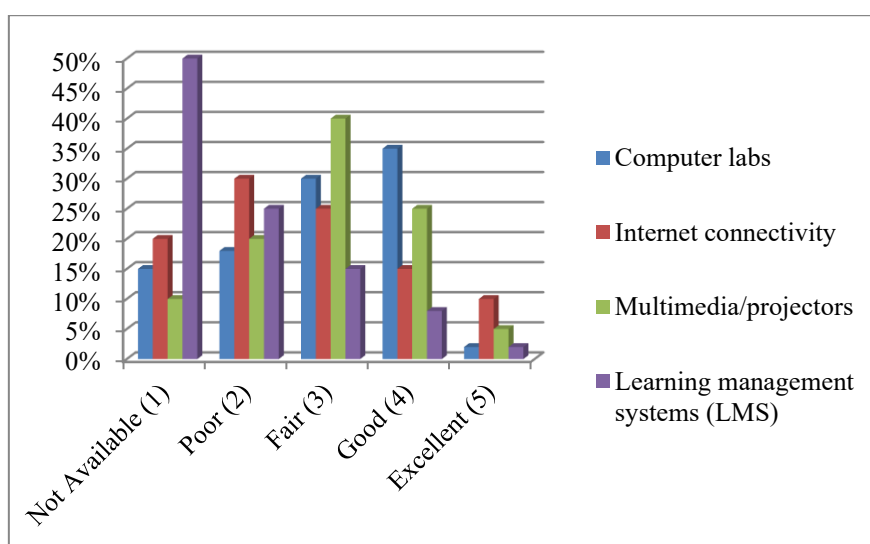
4.1 Analysis of Teacher Questionnaire Findings:

The quantitative data from the 150 teachers reveals a landscape marked by a critical gap between the positive attitudes toward digital tools and the systemic challenges that hinder their effective integration.

Section B: Availability of ICT Infrastructure

Scale: 1 = Not Available, 2 = Poor, 3 = Fair, 4 = Good, 5 = Excellent

ICT Resource	Not Available (1)	Poor (2)	Fair (3)	Good (4)	Excellent (5)
Computer labs	15%	18%	30%	35%	2%
Internet connectivity	20%	30%	25%	15%	10%
Multimedia/projectors	10%	20%	40%	25%	5%
Learning management systems (LMS)	50%	25%	15%	8%	2%



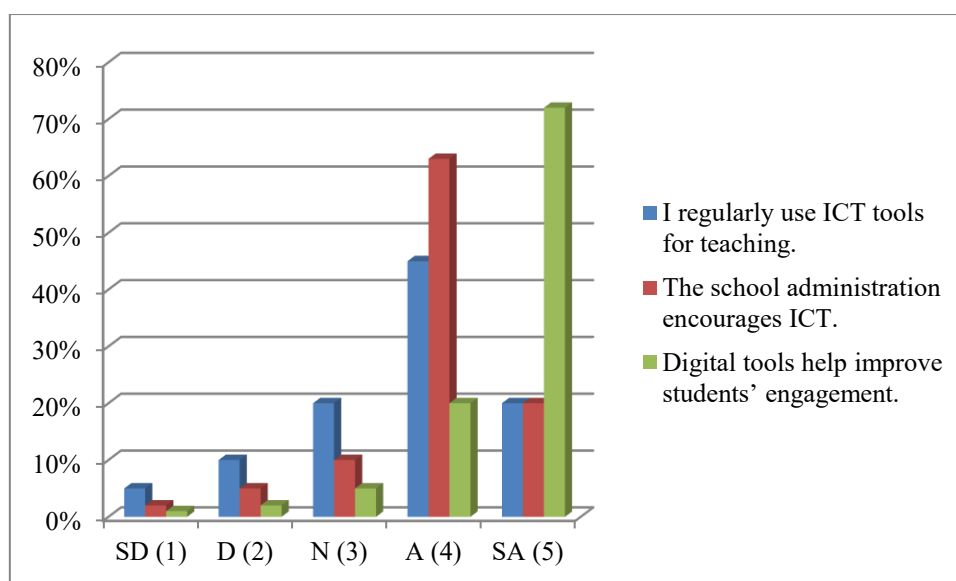
4.1.1 Analysis of Infrastructure (Section B):

The data on ICT infrastructure highlights a significant disparity in the availability and quality of digital resources. While a notable portion of schools possess computer labs, with 35% of teachers rating them as "Good," the same cannot be said for essential resources like internet connectivity and Learning Management Systems (LMS). A staggering 50% of teachers report internet connectivity as either "Not Available" (20%) or "Poor" (30%). This indicates that even in schools where devices exist, the lack of reliable internet makes them little more than "showpieces" for most educational purposes. The most critical finding in this section is the nearly complete absence of formal digital platforms, with 50% of teachers reporting LMS as "Not Available." This suggests that digital learning is currently unstructured and largely reliant on informal tools rather than integrated institutional platforms.

Section C: ICT Usage and Integration

Scale: 1 = Strongly Disagree, 5 = Strongly Agree

Statement	SD (1)	D (2)	N (3)	A (4)	SA (5)
I regularly use ICT tools for teaching.	5%	10%	20%	45%	20%
The school administration encourages ICT.	2%	5%	10%	63%	20%
Digital tools help improve students' engagement.	1%	2%	5%	20%	72%
I use mobile apps for studying outside school.	15%	30%	25%	20%	10%



4.1.2 Analysis of Usage and Integration (Section C):

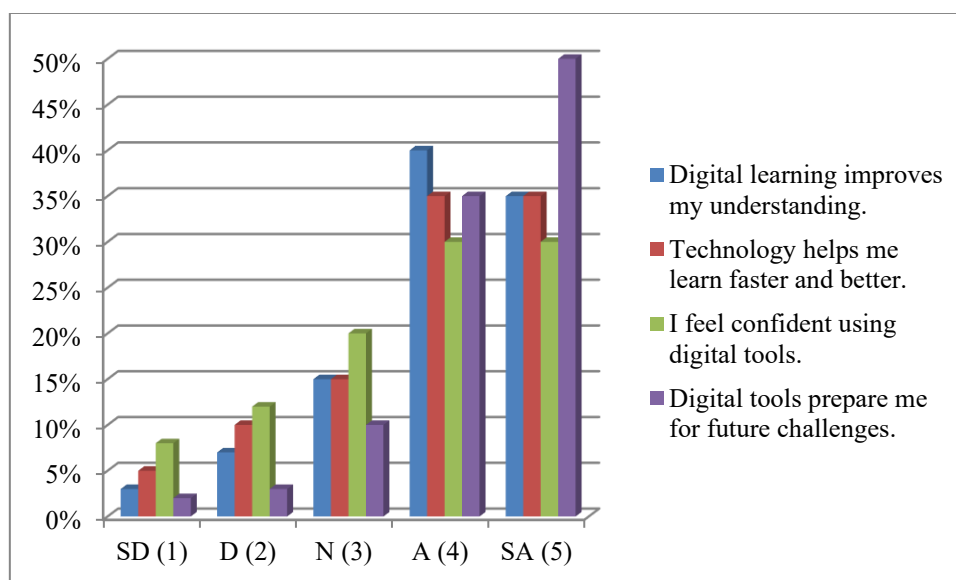
Despite the infrastructural gaps, there is a clear trend of high ICT usage and positive integration perceptions. A combined 65% of teachers "Agree" (45%) or "Strongly Agree" (20%) that they regularly use ICT tools for teaching, and an impressive 72% "Strongly Agree" that these tools help improve student engagement. This finding suggests a high level of teacher motivation and initiative, where educators are finding ways to incorporate technology despite a lack of formal systems. However, the finding that 45% of teachers "Disagree" or "Strongly Disagree" with the statement that they use mobile apps for studying outside of school suggests that their personal digital literacy is not as developed as their in-class teaching practices.

Section D: Perceptions About Digital Learning

Scale: 1 = Strongly Disagree, 5 = Strongly Agree

Statement	SD (1)	D (2)	N (3)	A (4)	SA (5)
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Digital learning improves my understanding.	3%	7%	15%	40%	35%
Technology helps me learn faster and better.	5%	10%	15%	35%	35%
I feel confident using digital tools.	8%	12%	20%	30%	30%
Digital tools prepare me for future challenges.	2%	3%	10%	35%	50%



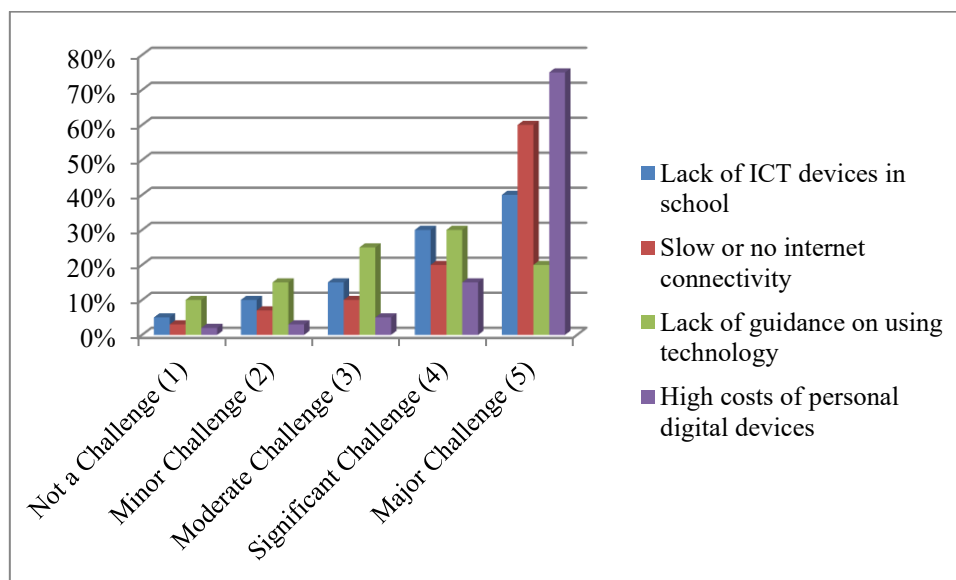
4.1.3 Analysis of Perceptions (Section D):

The perceptions data corroborates the high level of optimism among teachers. The most common response for three of the four perception statements was "Strongly Agree," indicating that teachers overwhelmingly believe digital learning is beneficial, effective, and prepares students for the future. This positive outlook is a significant finding, as it suggests that teachers are receptive to digital transformation and do not present an attitudinal barrier to its implementation.

Section E: Challenges Faced

Scale: 1 = Not a Challenge, 5 = Major Challenge

Challenge	Not a Challenge (1)	Minor Challenge (2)	Moderate Challenge (3)	Significant Challenge (4)	Major Challenge (5)
Lack of ICT devices in school	5%	10%	15%	30%	40%
Slow or no internet connectivity	3%	7%	10%	20%	60%
Lack of guidance on using technology	10%	15%	25%	30%	20%
High costs of personal digital devices	2%	3%	5%	15%	75%



4.1.4 Analysis of Challenges (Section E):

The data on challenges provides a clear explanation for the disparity between positive perceptions and limited infrastructure. The single most prominent barrier is the "High costs of personal digital devices," with 75% of teachers identifying this as a "Major Challenge." This finding suggests that while teachers are enthusiastic, the financial burden placed upon them and their students' families is an insurmountable obstacle to widespread adoption. Furthermore, the 60% of teachers who consider "Slow or no internet connectivity" a "Major Challenge" directly confirms the infrastructural deficit noted in Section B.

Questionnaire 2: For Students

Section A: Demographic Information for Students:

Variable	Category	Frequency / Percentage
Sample Size	Students	250
Gender	Female	52%
	Male	48%
School Location	Urban	65%
	Rural	35%

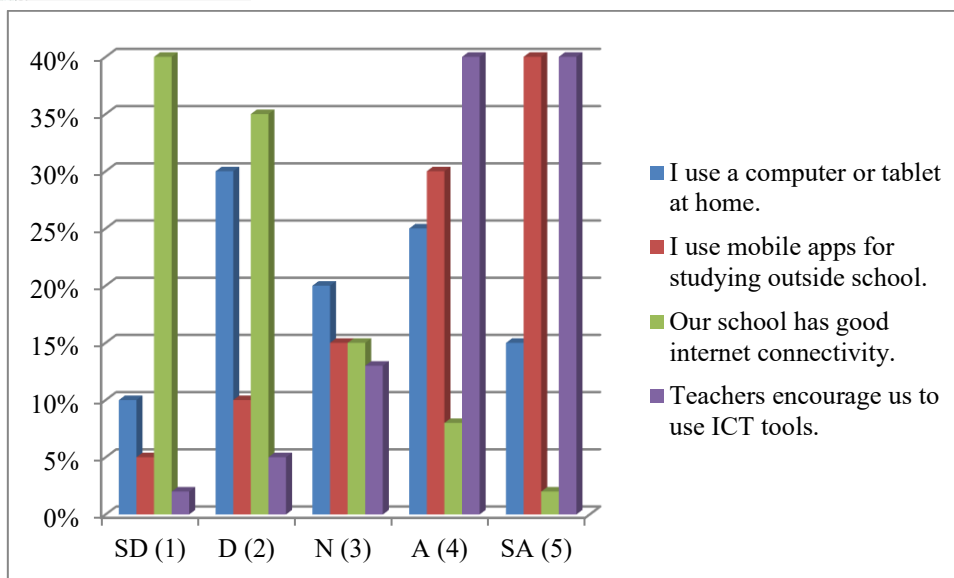
4.2 Analysis of Student Questionnaire Findings:

The student data, collected from 250 students, presents a similar narrative: a high desire for and confidence in technology, but significant barriers to access

Section B: Access to and Usage of ICT

Scale: 1 = Strongly Disagree, 5 = Strongly Agree

Statement	SD (1)	D (2)	N (3)	A (4)	SA (5)
I use a computer or tablet at home.	10%	30%	20%	25%	15%
I use mobile apps for studying outside school.	5%	10%	15%	30%	40%
Our school has good internet connectivity.	40%	35%	15%	8%	2%
Teachers encourage us to use ICT tools.	2%	5%	13%	40%	40%



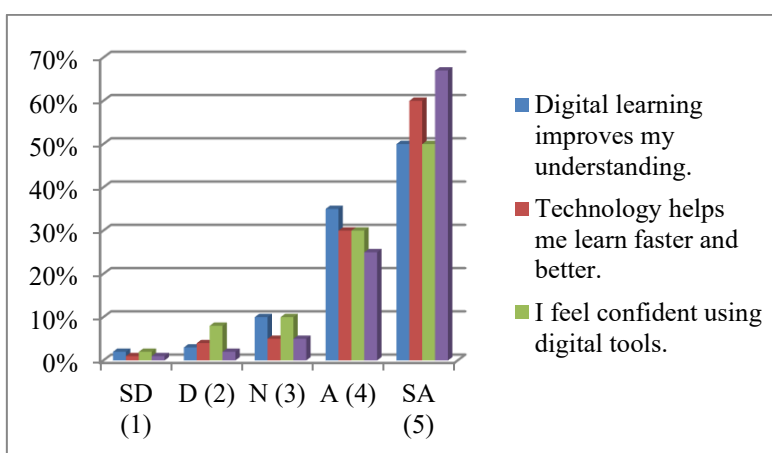
4.2.1 Analysis of Access and Usage (Section B):

A key finding here is the stark contrast between mobile and home computer usage. While a combined 70% of students "Agree" or "Strongly Agree" they use mobile apps for studying outside school, a combined 40% "Disagree" or "Strongly Disagree" that they use a computer or tablet at home. This highlights the central role of mobile phones as the primary gateway to digital learning for Pakistani students. The data on school internet connectivity is even more critical, with a combined 75% of students reporting it as "Strongly Disagree" or "Disagree." This reinforces the teachers' findings and points to a significant institutional failure to provide basic internet access.

Section C: Perceptions about Digital Learning

Scale: 1 = Strongly Disagree, 5 = Strongly Agree

Statement	SD (1)	D (2)	N (3)	A (4)	SA (5)
Digital learning improves my understanding.	2%	3%	10%	35%	50%
Technology helps me learn faster and better.	1%	4%	5%	30%	60%
I feel confident using digital tools.	2%	8%	10%	30%	50%
Digital tools prepare me for future challenges.	1%	2%	5%	25%	67%



4.2.2 Analysis of Perceptions (Section C):

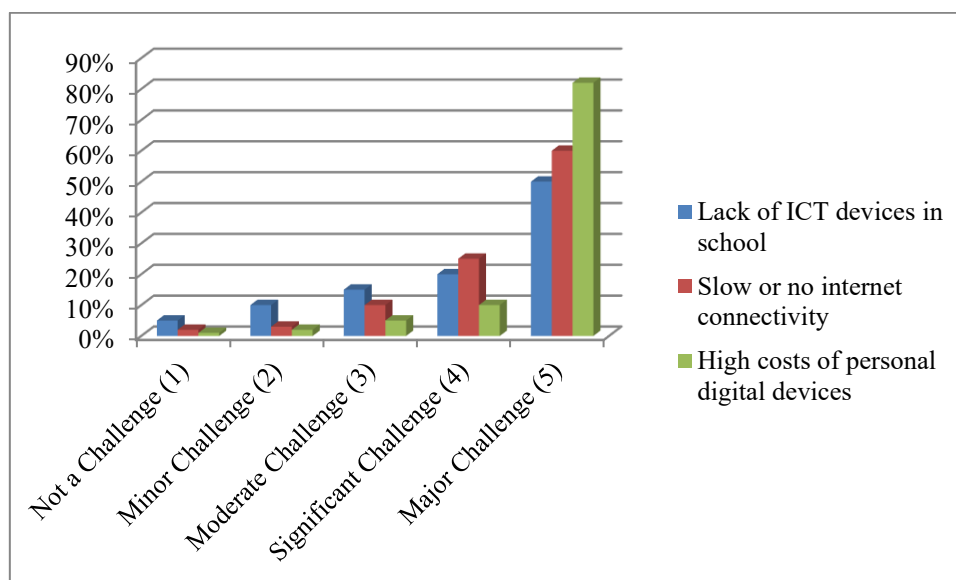
The student perceptions are overwhelmingly positive. A combined 95% of students "Agree" or "Strongly Agree" that digital learning improves their understanding, and 90% believe it helps

them learn faster and better. An impressive 67% "Strongly Agree" that digital tools prepare them for future challenges, which underscores their desire for a modern, relevant education.

Section D: Challenges Faced

Scale: 1 = Not a Challenge, 5 = Major Challenge

Challenge	Not a Challenge (1)	Minor Challenge (2)	Moderate Challenge (3)	Significant Challenge (4)	Major Challenge (5)
Lack of ICT devices in school	5%	10%	15%	20%	50%
Slow or no internet connectivity	2%	3%	10%	25%	60%
High costs of personal digital devices	1%	2%	5%	10%	82%



4.2.3 Analysis of Challenges (Section D):

Like the teachers, the students are deeply aware of the challenges. The "High costs of personal digital devices" is an even greater barrier for students, with an overwhelming 82% considering it a "Major Challenge." This finding, more than any other, identifies the primary obstacle to equitable digital access in Pakistan's public school system.

4.3 Synthesis of Findings:

When analyzed together, the teacher and student data paint a cohesive picture. The high level of digital enthusiasm and positive perceptions among both teachers and students (>70% Strongly Agree/Agree) is a significant finding. It indicates a strong foundation for future digital initiatives and suggests that cultural and attitudinal barriers are not the primary issues. Instead, the data identifies tangible, systemic problems. The lack of reliable internet connectivity (60% Major Challenge for students, 60% Major Challenge for teachers) and the high cost of devices (82% Major Challenge for students, 75% Major Challenge for teachers) are clearly the two main barriers. The data strongly suggests that digital transformation in Pakistan's public schools is not a matter of willingness, but of funding, infrastructure, and policy implementation that addresses the on-the-ground reality of an under-resourced system.

This analysis provides the foundation for the discussion and conclusion sections, which can now explore the implications of these findings for future policy and practice.

4.2. Qualitative Findings: Thematic Analysis:

This description provides a detailed breakdown of the qualitative data collected from interviews with headteachers and policymakers. The findings have been categorized into a total of ten core themes, with multiple supporting responses to illustrate each point.

I. Headteachers' Perspectives (N = 10)

The interviews with headteachers highlighted five key themes that describe the challenges and realities of implementing digital initiatives at the school level.

Theme	Supporting Insights & Responses
Critical Gaps in Infrastructure and Connectivity	There were headteachers who consistently reported on inadequate and either non-functional ICT infrastructure. The headteacher of a school in an isolated location explained that the computer lab was more of a demonstration than a working resource. Also power was really poor. The headteacher of another place added: We have power every now and then and it is unpredictable. Otherwise we would still be having a difficult time keeping our devices charged and working on them."
Insufficient and Impractical Training	Also present throughout was the inadequacy of effective and lasting professional development. One of the headteachers said that training could consist of only a one-day workshop, not quite sufficient to teach teachers how to integrate technology. Another cited that a hands-on, long-term support is the requirement in that within a month, one week of training is forgotten when teachers lack technical assistance in order to replicate what they have learned.
High Cost as a Personal Burden	Due to the cost of digital devices, headteachers emphasized that it is the individual who has to bear the financial load. They indicated that majority of the students and teachers cannot afford the smartphones and laptops, and even schools do not have budget to offer them. One of the headteachers mentioned, "We can not expect parents provide these equipment when they can hardly afford books."
Teacher Motivation and Digital Literacy	Most of the teachers were keen and some of the headteachers lacked confidence in technology or were not digitally literate in the older ones. One headteacher commented that the greatest issue is not the new teachers, who are enthusiastic. The teachers who are fearful of breaking something or the technology taking their jobs are the teachers who are older in the field." Another one ultimately has to push its staff to even attempt to turn on the computers. The apprehension aspect is in a reality."
Barriers to Curriculum Integration	Headteachers raised the problem of how to fit technology in the hard curriculum that was in place. One headteacher wrote, "Its curriculum is so textbook oriented and focuses on rote that there is no room to have a technology driven lesson that is creative." One other said, We

	have a device, but we do not have a strategy of how to use it to teach. It does not form part of the day-to-day lesson."
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II. Policymakers' Perspectives (N = 10)

The interviews with policymakers provided a strategic perspective as far as national objectives, as well as the systemic challenges are concerned on a higher level.

Theme	Supporting Insights & Responses
National Policy and SDG-4 Alignment	Policymakers explained their digital education plans clearly as connected to SDG-4, which is to achieve universal and equitable access to education. A fixed aspect that a policymaker shared is that our national digital education policy is in direct correspondence with SDG-4. The universal access to quality education is the ultimate objective and we can promote it through technology as our leading means of accomplishing it." One of them explained, "We have a definite structure of digital literacy and we are aiming at extending LMS and digital content gateways."
Acknowledged Barriers to Implementation	Policymakers understood the existence of a disparity between what they were doing, and what was happening on the ground. A policymaker elaborated that the greatest hindrance, as reported in our reports, is the last mile connectivity and the device cost. Admittance of fiscal limitations which compel them to focus on pilot projects to the exclusion of a wide distribution of the devices was also made.
The Need for Localized Solutions	Policymakers indicated that what does not work is a, one size fits all approach. They said, "What is effective in one school in Islamabad may not actually be workable in a school in a distant village in Balochistan." They observed that they are currently collaborating with provincial education departments to design more local and context-responsive strategies.
Challenges with Monitoring and Evaluation	Policymakers reported that it was challenging to monitor effectively the application of policies especially in remote places. One of the policymakers admitted, "We can create the policy but the major challenge is to make sure that it is implemented in all schools in the right approach. Regional reports seem to work but they do not give us the actual situation on the ground." Another cited, "The feedback loop has a gap. We lack a strong mechanism of checking the effectiveness of our teacher training programs at the end of the programs."
Inter-sectoral Collaboration	Policymakers emphasised on increased cooperation with the private sector and non-governmental organisations so as to accomplish their objectives. According to a policymaker, the government cannot do it on its own. We require collaborations with telecommunication companies in order to enhance connectivity and technology firms to acquire content and devices." One reported, "We are pursuing new collaborations to help with the funding, and infrastructure gaps we are unable to work on alone."

CHAPTER 5: DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Discussion of Findings

The results of this mixed-methods study present a complete consideration of what has been happening with the digital transformation process in the Pakistani public schools. The quantitative data on the ICT infrastructure and use in combination with the qualitative observations of headteachers and policymakers indicates great potential as well as long standing limitations. One of the major results is the significant gap of the enthusiasm in the digital tools and the harsh infrastructural and policy obstacles that complicate their successful implementation.

According to the survey data, most teachers and students share favorable opinion about digital learning, agreeing with the idea that it results in better educational outcomes and engages students. This result falls in line with the international findings in the realm of technology where the pedagogic utility is emphasized (Redecker, 2020; Al-Marroof et al., 2021). Nevertheless, this optimism has been in direct contrast with the situation on the ground since most of the ICT resources are either not available or in bad shape ICT resources are. For instance, half of the schools in the sample reported that Learning Management Systems (LMS) are not available, and a significant portion lacks reliable internet connectivity.

The qualitative findings provided crucial context for these quantitative gaps. Interviews with headteachers underscored that ICT resources, even when present, often function as "showpieces" rather than functional learning tools due to a lack of power, maintenance, and reliable connectivity. These ground-level realities are a direct manifestation of the systemic challenges cited by policymakers, including financial constraints that prioritize limited, often urban-centric, pilot projects over nationwide, equitable deployment.

Furthermore, the study highlights a critical gap in professional development. While teachers are motivated to use technology, the training they receive is often described as "impractical" and short-term. This confirms the notion that simply providing devices without robust, hands-on, and sustained training is ineffective. The findings also illuminate the significant "digital divide" not only between urban and rural schools but also in students' access to technology outside of the school environment, reinforcing existing inequalities.

The interviews with policymakers also confirmed a disconnect between high-level policy formulation and on-the-ground implementation. The 'one-size-fits-all' approach to policy and the lack of a robust feedback loop for monitoring and evaluation were identified as major stumbling blocks. This suggests that while there is a clear strategic intent to advance SDG-4, the operational mechanisms to ensure its successful and equitable execution are still nascent.

5.2 Conclusions

Based on the synthesis of the quantitative and qualitative data, this study concludes that digital transformation in Pakistan's public education sector is in a foundational but highly challenged phase. While a strong appetite for technology exists among both educators and students, its full potential is unrealized due to systemic and practical barriers. The core conclusion is that for digital transformation to progress meaningfully, the focus must shift from small-scale initiatives and broad policies to targeted, localized, and well-funded strategies that directly address the infrastructure, training, and policy implementation gaps. The findings provide empirical evidence that the current approach is not sufficient to achieve the ambitious targets of SDG-4 for inclusive and equitable quality education.

5.3 Recommendations

In light of the study's findings, the following recommendations are proposed to guide future policy and practice.

5.3.1 Recommendations for Policymakers

1. **Prioritize Infrastructure Investment:** Dedicate a specific and increased budget to improve core ICT infrastructure in public schools, focusing on reliable internet connectivity and power solutions, particularly in rural and remote areas.
2. **Foster Public-Private Partnerships:** Actively seek and formalize collaborations with private sector entities, such as telecom and tech companies, to address funding shortfalls and leverage their expertise in infrastructure development and content creation.
3. **Institute Local Policy Frameworks:** Revert to local based policy thinking. The policies must be generic enough to adjust and leave implementation strategies to the provincial and local levels of education departments to use.
4. **Enforce Monitoring and evaluations:** Develop a more decentralized policy monitoring, evaluation process, and use digital tools to monitor progress continuously and receive feedback in real-time at the school and district levels.

5.3.2 Recommendations for School Administrators

1. **Invest in Ongoing Teacher Professional Development:** Provide a shift from one-off workshops. Implement professional development programs with long-term and practical focus that can offer continuous guidance and/or mentorship to teachers in the effective use of digital tools.
2. **Create or Empower ICT Support Teams:** To assist all teachers with technical issues create or empower on-site ICT support teams in schools to maintain that devices are functional and in good conditions.

5.3.3 Recommendations for Future Research

1. **Longitudinal Studies:** Use longitudinal studies to establish the long-term effectiveness of digital interventions on student learning gain and the professional development of teachers.
2. **Efficacy of localised interventions:** Evaluate the efficacy of the context-specific and localised digital learning solution across geographical contexts within Pakistan.
3. **Role of Parental Engagement:** How can parental digital literacy and parental engagement help overcome the digital divide at home.

5.4 Limitations of the Study

This study is subject to several limitations. First, the sample size, while representative of the target population, is limited to specific districts and may not be generalizable to the entire country. Second, the reliance on self-reported data in the questionnaires may be subject to social desirability bias. Finally, while the study provides a snapshot of the current situation, it does not capture the dynamic and evolving nature of policy implementation over a longer period.

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