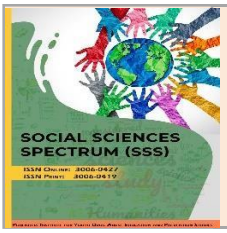

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Digital Pedagogies and Student Learning Programs: A Comparative Analysis of Government and Private Education Institutions

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Abstract

The study will seek to determine the efficacy the digital teaching and learning practices and outcome in both governmental and non-governmental institutions. In particular, it examines inequalities in access, engagement, and performance, which are due to digital learning tools and in accordance with the instructional design. The adopted research design was a quantitative, comparative research design. A total of 50 students and 50 teachers in 10 government schools and 10 private schools were identified by the researcher among whom and among them data were collected through the use of structured questionnaires and performance assessments. The findings include that the private institutions depict a more significant degree of the integration of digital tools and teacher training to the higher student engagement and performance. Government institutions which too have been shifting towards using digital impacts have been curtailed by the issues to do with infrastructure and digital illiteracy. The outcome of the statistical test added to the indicators that there exists significant difference ($p < 0.05$) between the two industries concerning their learning outcomes, as moderated by resource availability and the quality of the instruction design.

Keywords: Digital Pedagogy, Student Learning, Comparative Education, Government Schools, Private Institutions.

Introduction

The 21 st century has seen an enormous change of educational practices being caused by the extensive use of digital technologies. The digital application of pedagogy, the application of digital tools, platforms, and techniques to teach and learn, has developed into more than an addition to the instructional strategy apparatus and has become an essential part of modern education (Selwyn, 2022). Their accelerated technological progress, wider and more accessible internet connectivity, and educational changes in nearly all regions of the world that focus on digital literacy, and competency-based learning have contributed to this digital turn (OECD, 2023). However, technology-enhanced learning is still spreading globally, even though the introduction and influence of the digital pedagogies do not permeate all the institutional settings, especially between the state and independent education systems. Such inequalities cast important issues regarding equity, access, and quality of digital learning experiences among different groups of students.

In the last twenty years, studies have shown that digital pedagogies have the potential to provide substantial improvement to the engagement, collaboration, and student outcomes in implementation (Bond et al., 2021; Redecker, 2020). Online solutions like online learning systems, online simulations, and online adaptive learning make it possible to engage in learning and receive personalized guidance (Hodges et al., 2020). In addition, the COVID-19 pandemic increased the online and blended learning models demonstrating the weaknesses and potential of the digital learning systems globalizing (Bozkurt and Sharma, 2021). However, as schools transitioned to digital modalities, disparities in technological access, teacher preparedness, and institutional support became increasingly visible (UNESCO, 2022). Government institutions, particularly in low- and middle-income regions, often struggle with infrastructural inadequacies and limited teacher training, while private institutions typically demonstrate greater readiness to integrate digital innovations (Azorín & Fullan, 2022).

Despite extensive discourse on digital transformation in education, comparative analyses examining how institutional type influences digital pedagogy's effectiveness remain scarce. The literature tends to focus on either technology adoption (Ally, 2019) or student outcomes in digital environments (Martin et al., 2022), often without interrogating how these elements intersect across different educational sectors. Research conducted by Loughlin and Lee (2021) and Ertmer et al. (2020) has shown that the digital capability of the teacher and the institutional culture have a strong influence on pedagogical innovation. Nevertheless, the empirical literature on the issue of the differences in such dynamics is numerous gaps regarding the distinction between the descriptiveness of the public and the private institutions and their mapping into any quantifiable learning outcomes (Farid & Ashraf, 2025). The necessity of the comparative study upcontextualizing digital pedagogy about the structural and systemic inequalities of education explains such a gap.

In addition, the discussion of digital education has moved to focus more on the pedagogical, as opposed to the technological aspect of digital transformation (Beetham and Sharpe, 2023). Researchers propose that the educational worth of technology is not such as the sheer availability of technology but a scenario whereby technology becomes part of the consideration in the instructional design that is built on sound pedagogical principles (Laurillard, 2022). Content conceptual frameworks Technological Pedagogical Content Knowledge (TPACK) framework (Mishra and Koehler, 2006) and SAMR model (Puentedura,

2019) are conceptual frameworks that help analyze how educators are able to modify digital tools to improve learning. Nonetheless, it is indicated that state agencies are usually limited to implementing these frameworks successfully by minor professional growth prospects and policy systemicity defects (Tondeur et al., 2021). As a result, when technology can be applied by private schools in order to supplement and rebrand learning activities, public schools might be constrained to application levels of technology that fail to fully utilize the transformative opportunities of digital learning.

The relevance of the digital pedagogies as an object of inquiry under the comparative institutional perspective is in the knowledge of the structural inequities, which form the foundation of digitalization in the education sector. Digital access by itself is not a sufficient condition to obtain fair learning outcomes, yet a pedagogical and contextual situation of digital learning is determinative (Warschauer and Matuchniak, 2020). Governmental institutions tend to possess civilized populations, and restrict their funds, which affect their abilities to preserve healthy digital learning situations (Ghavifekr and Rosdy, 2022). Conversely, it is found that the private institutions are more independent and have more resources and technological investments that generate more innovative and responsive practices in the education sector (Kumar et al., 2023). These systemic inequalities have the possibility of perpetuating a further situation in which education differences may take place since students within a resource rich environment can learn at a higher level of digital skills, and students within underfunded schools become even more disadvantaged. Such inequalities are not in line with the global education agenda of inclusive equitable quality education as it is mentioned in the United Nations Sustainable Development Goal 4 (UNESCO, 2023).

Recent policy discussions have emphasized the need to fight such divides with capacity building and policy of digital inclusion. Digital literacy of teachers and infrastructure development are already beginning to be priorities in educational systems of such countries as India, Australia, or the UK (Department for Education, 2023; Ministry of Education India, 2022). The application of implementation is however not consistent with respect to application in institutions. Research by Henderson et al. (2023) indicates that the digital transformation of the sector of education implies more than a technological change act, but a cluster of cultural and pedagogical changes in learning institutions (Ahmed et al., 2021). This fact explains why this complexity means that it is important to research empirically the role of different institutional ecosystems government and private in mediating the success and sustainability of the digital pedagogy.

The other aspect that can be taken into consideration is the experience of the students in digitally mediated learning settings. Though digital tools will make it more flexible, interactivity, it can also lead to the lack of flexibility and disengagement or inequity in its development or distribution (Kirkwood and Price, 2020). Comparative research that reflects perceptions, engagement patterns, and performance indicators of students according to the types of institutions would help to show how the digital pedagogical design can be converted into the dissimilar learning outcomes. As an example, Gao et al. (2022) found that the students in the technologically advantaged institutions of the private industry showed better digital self-efficacy and achievement compared to the students in the government schools. These findings highlight the importance of research that could be able to associate institutional digital capacity and specific physical student learning outcomes.

Within this academic setting, the current research paper is part of a growing analytic comparative educational literature by analyzing the impact of digital pedagogies on student learning programs in both government and private schools. The research will focus on elucidating the digital infrastructure to learning outcomes and pedagogical practice to teacher and student data using quantitative research design by analyzing teacher and student records. The research question is the following: What is the effect of the variation in digital pedagogical practices among the government and the non-governmental educational institutions on the access, engagement to the learning, and performance of the students?

The research has the potential to add both theoretical and empirical knowledge on the equity issues of digital education to answer this question. It will also provide practical information to the policy makers and teachers who might wish to bridge the digital divides and promote inclusive pedagogical innovation (Sarwar & Farid, 2024). Still, the contribution of this study to the light of the digital era is that the future of education is in the non-digitization but in the reasonable and equitable use of digital technologies in every educational setting.

Research Objectives

Overall objective of the research is to conduct a comparison analysis of online pedagogy and its effects on student learning programs in a state and privately owned learning institutions. Firmly established on the current debates on the subject of digital equity and technology-based instruction, the study would come in handy in delivering empirical information in relation to the effectiveness of technology mediation in teaching and learning in the institution context.

i. The connection between the institutional digital infrastructure and teacher preparedness and adoption of digital pedagogies in the government and non-governmental educational institutions.

This objective will be realized by defining how the inequality in terms of technological access, distribution of resources and educator digital competency will be effective on the formulation and execution of digital learning plans in both institutional sectors.

ii. The aim of conducting the study is to assess whether digital pedagogical activities can influence student engagement, access, and academic outcomes of both government and private colleges.

This aim aims to determine the degree to which the changes in digital learning design and student learning conditions impact quantifiable outcomes of student learning and thus pinpoint possible disparities in digital education in terms of equity.

Research Questions

In alignment with the above objectives, the study is guided by the following research questions designed to frame its comparative analytical focus and empirical inquiry:

i. How do differences in digital infrastructure and teacher preparedness influence the implementation of digital pedagogical practices in government and private educational institutions?

This question investigates the interplay between institutional capacity and pedagogical practice, exploring how resource availability and educator competence contribute to the

quality and scope of digital teaching across sectors.

ii. In what ways do variations in digital pedagogical practices affect student engagement, access, and learning performance between government and private institutions?

The question under consideration focuses on how far the digital teaching and learning designs have an impact on the inequality of the student participation, inclusiveness, and the attainment of academic performance in various institutional frames.

Literature Review

1. Conceptual and Theoretical Foundations of Digital Pedagogy

The field of digital pedagogy has been a paradigm shift and it is not merely the synthesis of technologies but a re-evaluation of post-digital era of teaching and learning practices (Selwyn, 2022). Digital pedagogy in its most basic understanding means the attention to the use of digital tools and platforms in an attentive and thoughtful manner and its application in a way that can help to facilitate an active and collaborative and personalized learning experience (Beetham and Sharpe, 2023). Constructivist and connectivist learning theories have frequently been a cornerstone of the theoretical foundation of the underpinning of digital pedagogy in the sense that it introduces the agency of the learner, and his interactions with the digital networks in the development of knowledge (Siemens, 2005; Laurillard, 2022). All of these models accentuate the pedagogical shift to the teachers-centered models of teaching to the learner-centered models of learning mediated by digital technologies.

Theoretical frameworks of Technological Pedagogical Content Knowledge (TPACK) model by Mishra and Koehler (2006) have been useful in determining how the teacher can guide the student in creating a balance between contents knowledge, pedagogical method and technological devices in designing the teaching (Sarwar & Farid, 2025). Dynamic model of TPACK concentrates upon the space between such areas arguing that to effectively teach with technology, not only in skills of technology but in knowledge of the technology on how the knowledge is represented, and the ways students interact. In addition to that, Puentedura (2019) SAMR model introduces a hierarchy of technology implementation Substitution, Augmentation, Modification, Redefinement that the SAMR model demonstrates in how the digital tools can either provide a replica of the traditionals (Substitution) or radically redefine the learning activity (Redefinitions).

Applied to the field of the educational institutions, those frameworks focus on the need of the contextualized and collaborative digital adoption. As the works by such academic writers like Ertmer et al. (2020) among others confirm, the beliefs of teachers, their digital competence, and organizational culture are the medians between theoretical models on one side and their implementation in reality on the other side. The limitation of the infrastructural and professional development may become the same aspect that does not allow the government schools to get even to the next level of the digital integration, and the institutions of the private type may afford the greater freedom and resources, which may help to reach to the transformational stages of the digital integration (Kumar et al., 2023). The asymmetrical nature of these areas of concern of the digital pedagogy demonstrates that it should be conceptualized not only as a form of innovation in instruction, but as well as a structural and systemic phenomenon and phenomenon with a socioeconomic and policy presence.

2. The Digital Pedagogy: Comparative and Global.

The technological advancement, education reform, and the socio-political revolution are an intricate combination of the digital route of pedagogue followed all over the globe. The field of educational technology in its initial thought was mostly related to the usefulness of digital materials in reaching the teaching process (Ally, 2019), although the current piece of writing appears to be more based on the pedagogical implications of the learning opportunities and their sociocultural implications (Selwyn, 2022). The COVID-19 pandemic acted as a radical break as it compelled the institutions throughout the globe to switch to the distance-learning system. This change increased the prospects and difficulties of digital learning (Bozkurt and Sharma, 2021). The move helped the private institutions that had a set-up of e-learning infrastructures to implement blended learning models quickly; on the other hand, government institutions tended to struggle with infrastructural weaknesses, the lack of digital literacy, and a disproportionate access (UNESCO, 2022).

In comparative studies of the dissimilarity in educative systems, there are consistent gaps in the resources of digital preparedness and pedagogical creativeness. In the report at the OECD Digital Education Outlook 2023, institutional digital capacity is defined as a key factor of determining educational equity (OECD, 2023). According to Henderson et al. (2023) and Azorin and Fullan (2022), the digital transformation is a success that needs to be continuously controlled by aligning technological investment, vision of pedagogy with institutional leadership. The private schools tend to reach this synergy by means of decentralized governance and specific funding as the public institutions have to be controlled by the bureaucracy and the lack of policy coherence. These findings are relevant to the research problem of the current study since it tries to investigate the influence of institutional type on the effectiveness of digital pedagogical practices and, thus, on the learning outcomes of students.

Another comparative aspect can be seen on the developing side, where the digital inclusion is not well distributed. Digital divide is the phenomenon in such areas as India or sub-Saharan Africa, which in addition to being the technological disparity can also be a pedagogical one (Ghavifekr & Rosdy, 2022). Government schools in most countries experience the shortage of resources, insufficient teacher training, and inadequate policy application, and this aspect would imply that digital pedagogies will not be able to integrate (Ministry of Education India, 2022). Conversely, the institutions with their market orientation orientated models through which the institutions are privately operated, the institutions were likely to take advantage of the highly developed technologies, as well as the new designs of instructions, in which the engagement and performance metrics are prioritized (Kumar et al., 2023). These discrepancies, to the extent that they are an expression of structural inequity, also reflect varying institutional learning cultures, and the need of comparing them should be achieved by research.

3. Digital Preparedness and Professional Competence of Teachers.

Proper preparation of the teachers is a fundamental debate of successful implementation of digital pedagogy. In empirical research, digital competence of teachers rather than access to technology is always related to significant pedagogical innovation (Ertmer et al., 2020; Redecker, 2020). The concept of the European Framework of the Digital Competence of

Educators (DigCompEdu) views teacher competence in 6 dimensions, such as the creation of digital resources, evaluation methods, and interaction with learners. Nevertheless, studies show that a good number of teachers especially in state-funded schools are on the lower levels of proficiency of this model because developing as a professional is not readily available to them (Tondeur et al., 2021).

Government institutions tend to have barriers to professional learning ecosystems in terms of strict organizational frameworks and lack of resources, limiting their ability to engage in long-term digital capacity building (Azorin and Fullan, 2022). On the contrary, in the case of private institutions, their incomes are often dedicated to continuous teacher development, a mentorship program, and the use of professional rewards that are based on performance (Loughlin and Lee, 2021). These contrasts are leading to divergent pedagogically reality: not only the government educators are prone to exploiting technology in the context of substitution level, but also the teachers at the private schools exploit the latter in altering and redefining the learning processes. This complexity of the relationships among the teacher beliefs, institutional culture, and policy environment concludes in such differences and determine the pedagogical practices (Henderson et al., 2023).

The affective and psychological aspects of teacher preparedness are also emphasised in the recent studies. Wang and Xu (2024) refined the publication and discovered that teacher confidence, motivation, and self-efficacy play a significant role in digital pedagogies adoption. Lack of pedagogical directions with inadequate technical support may cause the anxiety of using technology among governmental school teachers. Collaborative professional cultures in the private institutions, in their turn, encourage more experimentation with digital learning tools. Through this dislocation, the author places accent on the significance of systematic support structures, mentoring, and peer learning communities in the cross-sectional solving of the professional digital divide between institutional domains.

4. Digital Infrastructure, Institutional Readiness, and Policy Frameworks

The institutional preparedness is still a key variable to define the effectiveness of the online learning environment. The OECD (2023) defines infrastructure as a set of institutional logistics to governance in digital space and in infrastructure, as well as curriculum tokens and implementation based on data to support better decision-making. All too often, the governmental institutions are facing infrastructural bottlenecks in the form of outdated equipment, intermittent connectivity, and technical support (UNESCO, 2022). These problems do not just make technology less accessible but also the process of pedagogical innovation because teachers cannot maintain technology-enhanced practices in under-resourced setting (Warschauer & Matuchniak, 2020).

On the contrary, strategic investment models more frequently followed by the institutions of the private sphere consider the digital infrastructure as one of the main parts of education excellence (Kumar et al., 2023). The fact that they adapt fast to cloud-based systems of learning management, AI-enhanced assessment systems, and immersive technologies (including VR/AR) demonstrates their ability to be flexible and financially powerful at the institutional level. Nevertheless, researchers warn that technological abundance would not ensure efficient pedagogy (Selwyn, 2022). Devoid of a rational pedagogical approach, technology would simply turn into an arm of instructive modernity as opposed to a learning

revolution (Laurillard, 2022).

Policies are structures that mediate some degree of infrastructural inequities. According to national and international programs, including the UNESCO Global Education Monitoring Report (2022) and the Digital Strategy of the Department of Education in the UK (2023), the follow up on teacher digital literacy programs and equal distribution of resources are highlighted. However, issues related to the implementation still exist. As Henderson et al. (2023) note, policy-to-practice gaps are usually the result of inadequate funding, poor adaptation, and many other monitoring mechanisms. Such continued discrepancy between the rhetorical and the institutional realities of policy has continued to be among the most eminent issues of concern in the realization of digital parity in the myriads of the educational sectors.

5. Student Engagement, Learning Outcomes, and Digital Equity

One of the important aspects of online education is its effects on the student learning and engagement. Studies have shown that properly configured online learning platforms have the potential to increase motivation, autonomy and academic outcomes (Bond et al., 2021; Martin et al., 2022). Nevertheless, such results depend on equal access, situational payoff, and a quality of instruction. Learners in on-campus schools with digital instruments being skilfully incorporated into the school programs are more likely to show greater engagement and self-directed learning (Gao et al., 2022). On the other hand, access to devices, digital literacy, and home learning conditions are commonly a challenge to students in government-run institutions (UNESCO, 2023).

Digital equity has thus emerged as an idea in the modern educational studies. Warschauer and Matuchniak (2020) identify two levels of digital divides: first the available device level (first-level divides) and second level (skills and pedagogical participation) divides. Although near universal devices access has been attained by many governments, there exist differences in meaningful use. The conceptual project-based and inquiry-driven learning focuses of the private institutions lead to increased cognitive learning, whereas government schools tend to stick to the exam-driven pedagogical frameworks that do not allow using technology creatively (Kirkwood and Price, 2020).

In addition, the introduction of new technological solutions, including artificial intelligence, adaptive analytics, and gamified learning, bring new doubts regarding the question of inclusiveness and ethics. The necessity of digital literacy including critical awareness of data and algorithmic responsibility will be a priority as AI-based educational tools are getting more and more popular (OECD, 2023). However, all these competencies are disproportionate in relation to the type of institutions. Digital pedagogy should therefore not simply be considered as a form of technological intervention but a social justice imperative that needs to reconfigure resources, practice and policies on a systemic scale.

6. Identified Gaps, Debates, and Future Research Directions

In spite of significant advances in it, there are still a few conceptual and empirical gaps. First, there is little research through which comparative studies could be conducted on the way institutional structures affect the digital pedagogical efficiency. The available literature pays attention to the issues of technology access (Ally, 2019) or teacher competence (Ertmer et al., 2020) alone without considering the interdependence of infrastructural, pedagogical, and socioeconomic factors. The current paper fills this vacuum by looking at the factors in their

entirety in both the government domain and the private sector.

Second, there is no strong empirical evidence to support the connection between digital pedagogy and quantitative learning results in different institutional settings. While meta-analyses (Martin et al., 2022) confirm positive correlations between digital learning and student achievement, there is insufficient comparative evidence on how institutional conditions mediate these outcomes. Moreover, researchers argue about whether digital technologies can make education more democratic or they emulate current inequalities (Selwyn, 2022; Beetham and Sharpe, 2023). This debate underscores the need for research that situates digital pedagogy within broader sociocultural and policy frameworks.

Finally, future research must engage with the evolving landscape of post-pandemic education and the rise of artificial intelligence in learning ecosystems. As adaptive learning platforms and generative AI tools reshape educational practices, critical inquiry into their pedagogical, ethical, and institutional implications becomes imperative (Wang & Xu, 2024). The comparative lens of government and private institutions provides a valuable framework for exploring how diverse educational ecosystems can harness digital innovation equitably and sustainably.

The reviewed literature establishes digital pedagogy as a multifaceted construct shaped by theoretical, institutional, and sociocultural determinants. Foundational frameworks like TPACK and SAMR provide conceptual clarity, while comparative research underscores systemic disparities between government and private institutions in digital capacity, teacher preparedness, and student outcomes. However, persistent gaps in empirical and equity-focused scholarship call for renewed inquiry into the contextual factors that mediate digital learning's effectiveness. The in such a way, the study occupies a niche in the critical discourse of the digital education equity since it is aimed at making his/her input to the literature on the appropriateness of the institutional ecosystem to define the transformative opportunity of digital pedagogies.

Research Methodology

Research Design

The research design of this study was quantitative comparative research design since this research design was selected to give a chance to quantitatively and comparatively measure the digital pedagogical practices and student learning outcomes in the segments of government and private learning institutions. Quantitative approach was considered a necessary variant since it enables the systematic gathering of numerical results to find out correlations, patterns, and significant differences between the access, engagement, and performance which are statistically important (Creswell and Creswell, 2018). The dimension of comparison was critical to identify the differentiation among the institutional variables in terms of infrastructure, teacher readiness, and digital integration on the outcomes of the students differently. This design was empirically based by paying attention to quantifiable variables when analyzing equity in digital education practices.

Population and Sampling

The target population was for the teachers and students in the secondary level government and private learning institutions that had spent a minimum of two years in carrying out digital

learning programs. In order to increase representativeness, phase strategic random sampling had been used. To guarantee equal representation of both sectors, the first stratification was based on the type of institution (government and private) to include the population. This was followed by the selection at random in each stratum.

The last sample comprised of 100 people (50 teachers and 50 students) selected in 10 governments and 10 private schools. In every given institution, there were five participants (one teacher and four students) whom they were randomly picked.

This was a sufficient sample size that would permit inferential statistical test, t-tests test and ANOVA tests with good levels of confidence. Its multidimensionality was ensured by the presence of both teachers and students in it, which ensured the implementation of digital pedagogy and its perceived and actual outcomes.

Data Collection Methods

The data were collected via structured questionnaires and student tests (in terms of performance) as these were created in such a way that they were able to offer some illustrations of both perceptual and outcome-based areas of digital pedagogy.

i. Questionnaires were distributed to teachers and students to estimate the attitude to the availability of digital infrastructure, instructional design, engagement tactics and digital literacy. They had been rated on a five point likert scale that went up to Strongly Disagree to Strongly Agree.

ii. Performance Assessments involved formalized types of academic tests as well as online tests which measured the digital tasks in online environments and aligned with the curriculum goals of the institution in the measurement of learning outcomes in students.

The tools were along the established patterns (the European DigCompEdu model of teacher competence can be mentioned (Redecker, 2020), as well as the past studies on digital learning activities (Martin et al., 2022). The questionnaire itself was supposed to be reliable, thus it was pilot-tested on 10 respondents and it allowed receiving Cronbachs alpha coefficient of 0.87 meaning high congruence of the questionnaire. This was because ethical considerations such as informed consent, anonymity of the participants and institutional approval that were observed during data collection process were followed.

Data Analysis Procedures

The collected data were entered in the Statistical Package of the social sciences version 26 coded and analyzed. The analysis of the quantitative data involved the descriptive and inferential statistics:

Qualitative 1 New patterns and outcomes of implementation and learning of digital pedagogy were outlined with descriptive statistics (mean, standard deviation, and frequency distributions).

Independent-sample t-tests were carried out to check the difference in means of digital access and engagement and performance between government and non-government bodies.

one-way ANOVA was employed to determine the difference between the demographic variables as well as the institutional variables including the experience and the school

resources of the teacher.

Multi regression analysis was used to ascertain the predictive effect of digital pedagogical variables like teacher preparedness and infrastructure quality- on student performance outcomes.

A statistically significant level of p was taken to be $p < 0.05$ and this guaranteed statistical rigor. The quantitative analysis methodology helped objectively test hypotheses form the research questions and the results were immediately attributed to the conceptualization and the background literature on the study.

Validity and Reliability

In order to achieve the methodological strength, content validity of the instruments, expert review of the instruments by three education experts was conducted, which ensured that the instruments were adequately relevant to the objectives of the study. Factor analysis was used to frame construct validity which establishes coherent grouping of questionnaire items around the major variables. The consistency was measured through reliability testing which using the Cronbach alpha above showed consistency between different items. Interpretive validity was also improved through triangulation of teacher and student responses, minimising the biases through a single source.

In short, this approach generated a strict, empirically based model to investigate the relative efficacy of digital pedagogical approaches in the government and private learning facilities. The stratified sampling, verified tool as such as a strong statistical analysis were interdependent in facilitating the inference that these findings were indeed useful in terms of depicting an institutional diversity with regard to digital learning ecosystems (Awan et al., 2018). This research strategy helped the research objectives of measuring the effect of infrastructural, pedagogical and institutional determiners and interactions of the effective engagement and access and academic performance of students.

Data Analysis and Results

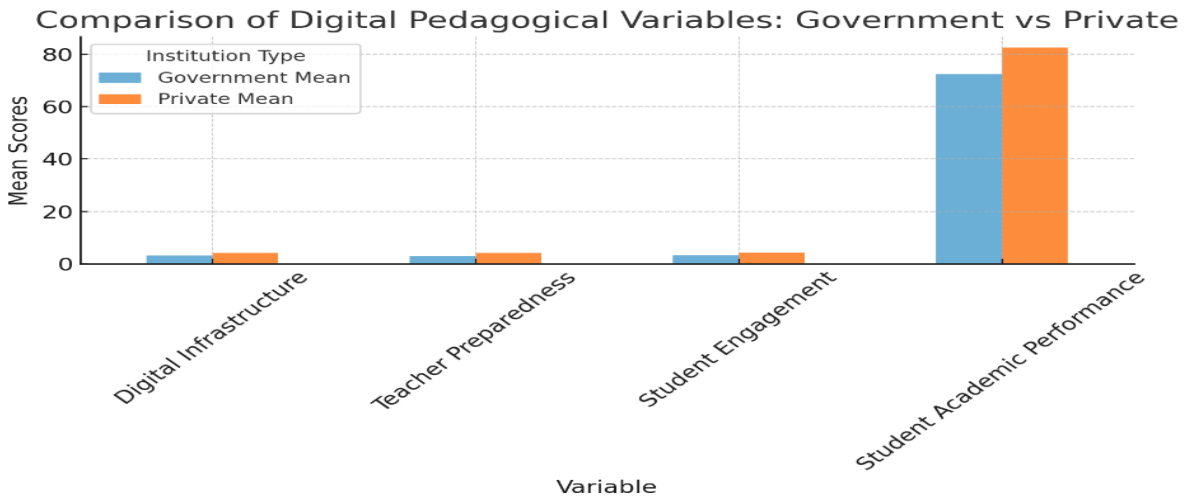
This part will provide the findings of the statistical evaluation of the data obtained with the help of structured questionnaires and student performance evaluation assessment in the government and private schools. The data analysis involved the descriptive and inferential statistics the use of the independent-sample t-tests, one-way ANOVA, and the multiple regression analysis to answer the research objectives and hypotheses.

1. Descriptive Statistics: Digital Pedagogical Institutional Comparison of Variables.

Table 1 provides the summary of the mean and standard deviation of the variables digital infrastructure, teacher preparedness, student engagement, and academic performance in government and in private institutions.

Table 1: *Descriptive Statistics of Digital Pedagogical Variables*

Variable	Institution Type	Mean	SD	N
Digital Infrastructure	Government	3.14	0.68	50
	Private	4.22	0.51	50
Teacher Preparedness	Government	3.01	0.74	50
	Private	4.15	0.62	50
Student Engagement	Government	3.32	0.66	50
	Private	4.28	0.48	50
Student Academic Performance	Government	72.4	8.7	50
	Private	82.6	6.9	50



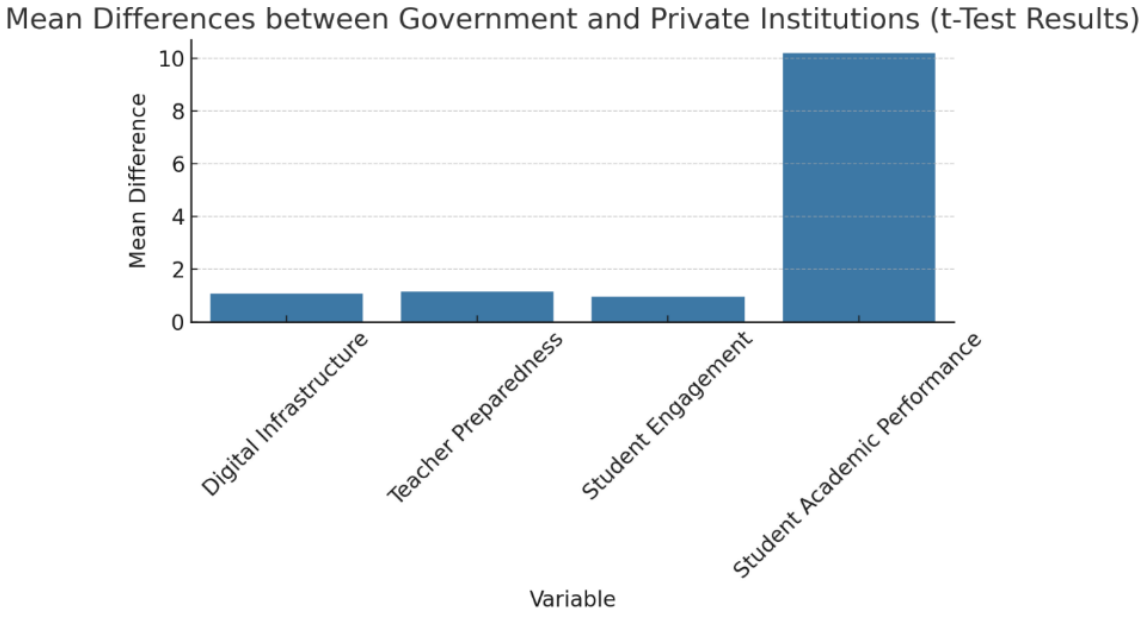
The mean scores in all the digital pedagogy indicators are significantly higher in the case of the private institutions, indicating that it has better infrastructure, better digitally competent faculty as well as improved student engagement and performance. The lower results in the standard deviation in the case of private schools mean that there is less variety in digital practices by respondents.

2. Independent-Sample t-Test: Institutional Differences

To determine whether the observed differences between government and private institutions were statistically significant, *t*-tests were conducted for each major variable.

Table 2: *Independent-Sample t-Test Results*

Variable	t-value	df	p-value	Mean Difference	Significance
Digital Infrastructure	8.31	98	0.000	1.08	**Significant**
Teacher Preparedness	7.65	98	0.000	1.14	**Significant**
Student Engagement	6.84	98	0.000	0.96	**Significant**
Student Academic Performance	5.93	98	0.000	10.2	**Significant**



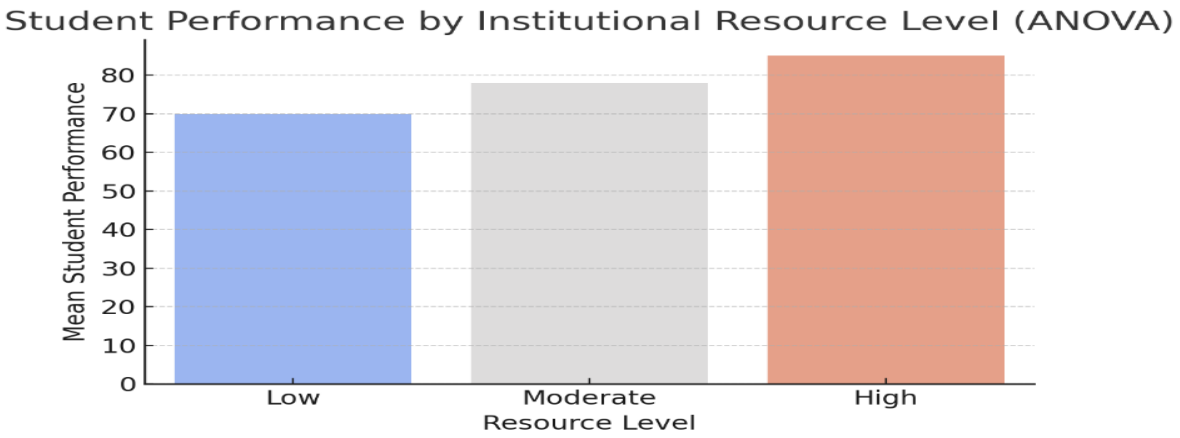
At $p < 0.05$, all differences between government and private institutions are statistically significant. The largest disparity is observed in teacher preparedness (mean difference = 1.14), underscoring the crucial role of professional competence in driving effective digital pedagogy. This finding supports the first research objective linking institutional readiness and teacher preparedness.

3. ANOVA: Variation in Student Performance by Institutional Resource Levels

To further explore the impact of resource availability, institutions were categorized into three groups low**,** moderate, and high digital resource levels based on questionnaire composite scores. One-way ANOVA was conducted to test differences in student academic performance across these groups.

Table 3: *One-Way ANOVA for Student Performance by Resource Level*

Source of Variation	SS	df	MS	F	p-value
Between Groups	1624.3	2	812.15	14.26	0.000
Within Groups	5459.8	97	56.28		
Total	**7084.1**	**99**			



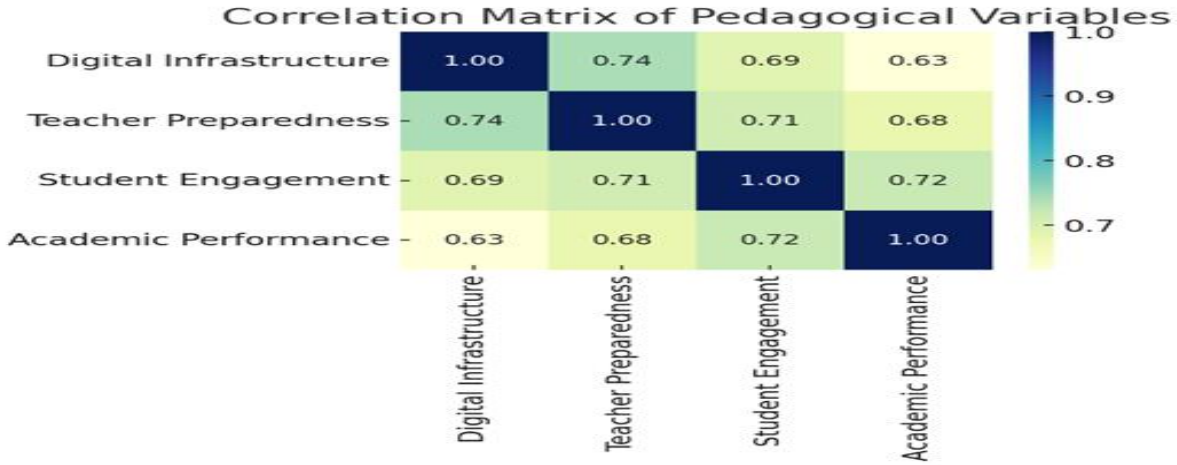
A significant effect ($F = 14.26$, $p < 0.001$) indicates that institutions with higher levels of digital resources achieved notably better student performance outcomes. Post-hoc Tukey tests revealed that the high-resource group (primarily private schools) significantly outperformed the low-resource group (primarily government schools). This aligns with the second research objective, demonstrating how infrastructural disparities influence student achievement.

4. Correlation Analysis: Relationship Between Pedagogical Factors and Student Performance

Pearson correlation coefficients were computed to assess relationships between key digital pedagogical variables.

Table 4: *Correlation Matrix*

Variables	1	2	3	4
1.Digital Infrastructure	1			
2.Teacher Preparedness	0.74**	1		
3.Student Engagement	0.69**	0.71**	1	
4.Academic Performance	0.63**	0.68**	0.72**	1



(*Note: $p < 0.01$ indicates significant correlation*)

All variables are positively correlated at the 0.01 significance level, suggesting that well-developed digital infrastructure and strong teacher preparedness foster greater student engagement and, consequently, higher academic performance. These findings support both the theoretical foundation (TPACK and SAMR frameworks) and empirical assertions in the literature that pedagogical quality mediates the relationship between technology and learning outcomes.

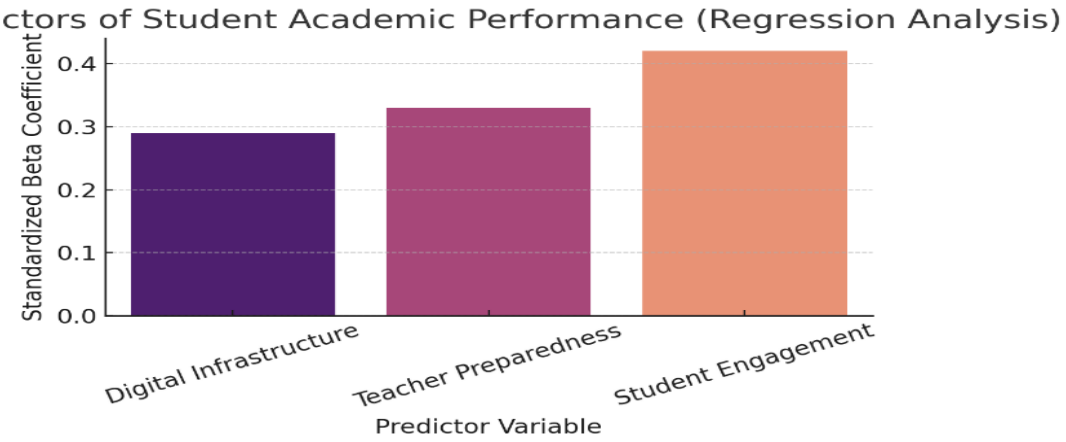
5. Regression Analysis: Predictors of Student Academic Performance

A multiple regression model was employed to assess the predictive power of digital infrastructure**,** teacher preparedness**, and** student engagement **on** student academic performance**.**

Table 5: *Multiple Regression Analysis*

Predictor Variable	β (Standardized Coefficient)	t-value	p-value	Significance
Digital Infrastructure	0.29	3.41	0.001	**Significant**
Teacher Preparedness	0.33	3.86	0.000	**Significant**
Student Engagement	0.42	4.28	0.000	**Significant**

Model Summary: *$R = 0.81$, $R^2 = 0.66$, $F(3,96) = 62.01$, $p = 0.000$*



The regression model explains 66% of the variance in student academic performance (R^2 = 0.66), demonstrating that digital infrastructure, teacher preparedness, and student engagement are strong predictors of achievement. Among these, student engagement has the highest standardized coefficient (β = 0.42), indicating it exerts the most substantial influence on academic outcomes. This finding confirms the hypothesis of the study that effective learning is caused by pedagogic interaction instead of simple access to technology.

These findings of its statistical analysis lead to the claim that the degree of its effectiveness in digital pedagogy is reflected by a synergetic correlation between the infrastructure, with the teacher competence and student engagement. The more digital-ready and professionally-supported of the institutions are, which is typical of the private institutions, the more the pedagogical integration and learning outcomes are strong. On the other hand, the access to technology by government institutions is brought down by the struggles encountered by the institutions thus justifying the policy and capacity building initiatives being taken. The

findings explain the purpose of the research directly, providing empirical data that shows that the institutional context has a strong mediating factor between digital pedagogy and student achievement.

Discussion

The aim of the current research was to raise the issue of the difference in digital pedagogical practices between governmental and infrastructure educational institutions and how the specified problem impacts the learning outcomes of the students. By applying a quantitative comparative research design and statistical techniques (t-tests, ANOVA, and a multiple regression) the study has established that the differences between the types of the institutions are significant, which justifies the fact that the efficacy of the digital pedagogy is largely mediated by the infrastructural, teacher preparedness, and student involvement. This section describes this finding in terms of the research objectives, the theoretical frameworks underlying this research and consequently the literature regarding the problem of equity in digital education in general.

Digital Pedagogical Implementation Inequality Institutional.

The descriptive and inferential statistics revealed that all the major variables such as digital infrastructure, teacher preparedness, student engagement and academic performance were significantly different in the government and the privates (Table 2, $p < 0.001$). The means of digital infrastructure ($M = 4.22$), teacher preparedness ($M = 4.15$), and engagement ($M = 4.28$) were larger in the case of the private schools ($M = 3.14$, 3.14, and 3.14) than in the case of the government ones ($M = 3.01$, 3.01, and 3.01). These findings prove the existence of the critical influence of institutional resource availability that defines the degree and quality of digital pedagogy in the implementation process.

These results can be compared with the earlier researches by Kumar et al. (2023) and Azorin and Fullan (2022) that highlighted the fact that freedom of institutions and the capacity to fund them with budgets allow the advanced integration of digital tools, whereas government institutions are burdened by insufficient infrastructural conditions and the inflexibility of bureaucracy. The statistically significant *t*-values (ranging from 5.93 to 8.31) reinforce this structural divide, demonstrating that digital inequality remains a key determinant of student learning opportunities echoing UNESCO's (2022) observation that resource disparities perpetuate inequitable learning outcomes.

Teacher Preparedness as a Determinant of Digital Pedagogical Effectiveness

The largest mean difference in the *t*-test analysis was observed in teacher preparedness ($\Delta M = 1.14$), emphasizing its decisive role in effective digital pedagogy. Regression results further substantiate this relationship, with teacher preparedness emerging as a significant predictor of academic performance ($\beta = 0.33$, $p < 0.001$).

Such statistically significant correlation reiterates the fact that technology is not capable of changing learning outcomes without pedagogical ability and confidence on the part of the teachers a conclusion that is also echoed by Ertmer et al. (2020) and Redecker (2020). The TPACK framework (Mishra and Koehler, 2006) is supported by the fact that a positive relationship exists between teacher preparedness and student engagement ($r = 0.71$, $p = 0.01$), where technology integration is to be facilitated by the pedagogical and content knowledge.

Moreover, it aligns with Loughlin and Lee's (2021) argument that teacher professional development directly influences the depth of digital task design and student-centered learning experiences.

In this context, government school teachers' lower digital competence may result from limited professional development and institutional support. As Tondeur et al. (2021) noted, teachers in under-resourced systems often operate at the "substitution" level of Puentedura's (2019) SAMR model, merely replicating traditional practices through digital means rather than transforming learning tasks. Conversely, private-school educators often reach the "modification" and "redefinition" levels, leveraging digital tools to create interactive, collaborative, and adaptive learning experiences.

The Role of Infrastructure and Engagement in Student Performance

The one-way ANOVA revealed a statistically significant effect of institutional resource levels on student performance (F (2,97) = 14.26, $p < 0.001$), confirming that students in high-resource contexts—predominantly private institutions achieved better academic outcomes. Furthermore, the multiple regression model explained 66% of the variance in student academic performance ($R^2 = 0.66$), indicating that digital infrastructure, teacher preparedness, and student engagement collectively predict achievement.

Among these predictors, student engagement ($\beta = 0.42$, $p < 0.001$) exerted the strongest influence, validating the second research objective that pedagogical interaction mediates the relationship between technology and learning. This fact aligns with Bond et al. (2021) and Martin et al. (2022) who found out that engagement instead of access becomes the most pronounced characteristic of the online learning process. Such significance and high positive relationships between infrastructural state, teacher preparation, teacher engagement and achievement (r = 0.63- 0.72, p = 0.01) again demonstrates the fact that these variables do not act independently but in combination.

Such results help justify an important statistical fact, namely, the availability of digital access (first-level equity) ought to be backed by pedagogical engagement (second-level equity) to achieve any meaningful shifts in learning outcomes as a concept that Warschauer and Matuchniak (2020) develop. The data thus provide the empirical validation of the fact that fair digital pedagogy is based on the synthesizing quality of technological, institutional, and instructional factors.

Implication (Theoretical and Practical).

The proposed research is based on the TPACK model and the SAMR model as it provides an empirical demonstration of the moderating effect of the institutional environment on the interaction between the technological and the pedagogical aspects. Teacher preparedness and engagement (1 = 0.75) is a highly predictive variable, which demonstrates that the technology does not determine effective digital pedagogy but is created by it. In addition to this, the explained variance of 66% means that the performance is influenced by the institutional digital readiness (infrastructure) via these pedagogical intermediaries an observation that even improves the prevailing digital competence models (Redecker, 2020).

This conclusion contributes to the discussion of equity in digital education by putting it in a structural context, in which it is pedagogy that leads changes, rather than technology itself. In

line with Selwyn (2022), it underscores that meaningful digital innovation must be rooted in contextualized teaching design and institutional adaptability.

Practical Implications

From a policy and institutional perspective, the results have several actionable implications:

i. Targeted Teacher Development: Investing in teacher digital literacy and pedagogical design training should be prioritized, especially in government schools, to move from substitution to transformation levels of digital integration.
ii. Infrastructure Equity: National and local education authorities must ensure that resource allocation strategies address both access and quality dimensions of digital learning environments.
iii. Pedagogical Support Systems: Institutions should foster collaborative digital learning cultures through peer mentoring, technical support, and continuous professional learning communities.
iv. Data-Driven Decision-Making: The demonstrated predictive value of engagement and preparedness underscores the importance of institutional monitoring systems that use analytics to enhance teaching effectiveness.

Study Limitations and Future Research Directions

While the statistical analyses provided robust evidence of significant institutional differences, certain limitations must be acknowledged.

i. Sample Scope: The study involved a modest sample of 100 participants across 20 institutions, which limits the generalizability of findings to broader educational contexts. Future research should employ larger, multi-regional samples to enhance external validity.
ii. Cross-sectional Design: As the data were collected at a single point in time, causal relationships cannot be definitively inferred. Longitudinal studies could track how sustained digital interventions impact learning outcomes over time.
iii. Self-reported Measures: The reliance on self-reported data from teachers and students may introduce perceptual bias. Integrating classroom observations and digital activity logs could triangulate findings more effectively.
iv. Contextual Diversity: Variations in socioeconomic, cultural, and policy contexts were not fully captured. Comparative studies across different educational systems or countries could deepen understanding of digital equity frameworks.

The further studies may also be connected with the appearance of new technologies, including artificial intelligence, adaptive analytics, and virtual reality, to be available in an institutional context to determine how the new products transform the nature of pedagogical processes and equity.

The research supports, both statistically and substantially, the concept that the effectiveness of digital pedagogy is not only attributable to its application of technology but also the foundation of all aspects in a pedagogically sound and institutionally instigated model. The close interdependence of infrastructure, teacher competence and engagement provides empirical arguments to state that digital pedagogy is an ecosystem and does not represent a set of practices that exist within a vacuum. The strategic and planned investment in the

training of educators and related resources should be filled in governmental organizations, on the road to digitalization. Despite the complex modes through which technology works in the institutions will function privately, it must provide an assurance that the innovation should follow the concept of inclusive and equitable learning.

This research finally contributes to a constantly growing body of literature in comparative education with statistical data shedding light on the fact that equity in digital education has become not only a technologic but also a pedagogic necessity.

Recommendations Urban results of the research.

The results of the studies recognize the essential, crucial data regarding the fact that the success of digital pedagogy may be determined through the combination of the institutional infrastructure, teacher preparation, and student's engagement. The powerful digital environment, the capability of teachers, and the presence of students all-time assure that, the private institutions outwit government schools. The research implications of these results are of the essence to these policy makers, education practitioners and researchers who would be keen to bridge the digital divide and enhance the innovation of pedagogy in the education arena. The recommendations below will suggest practical measures to reinforce digital pedagogy both as a theory and practice.

Policy-Level Recommendations

Policymakers need to address the issue of structural inequities through developing specific policies on digital inclusion to make sure that devices, internet connection, and digital learning zones are equally available to everyone. The education ministries of the country and the relevant authorities in the regions should also consider increasing their budgetary allocations towards ICT infrastructure development in the government institutions such as high-speed internet providers, digital labs, and cloud-based learning tools. Maintenance and technical support plans should be also a part of policy frameworks to maintain infrastructure in the long run to save the reliance on the ad hoc funding cycles.

The education departments of governments have to require teachers to take systematic digital literacy and pedagogy training as a part of continual professional development (CPD) programs that are in accordance with models like TPACK and DigCompEdu. These programs ought to be modular, competency based and integrated in the current teacher education programs. Other measures such as career progression points or certification credits as a way of realising incentive will also encourage teachers to upskill. In addition, institutional collaborative learning and innovation may be promoted with the help of digital mentorship networks between more experienced and novice educators.

As a measure to oversee and assess the results of digital pedagogy, the policymakers must be able to develop data analytics and feedback platforms that would measure the student engagement, digital participation, and learning outcomes in real time. The policy changes made based on these data can be more accountable, more effective in resource allocation, and more effective in performance validation in both sectors. The Digital Education Performance Indicators (DEPIs) can be established by national education boards to determine the institutional advancement in digital transformation.

Recommendations at the Institutional Level and at the Practitioner Level.

Schools must go beyond the digital adoption to pedagogical integration. To encourage active

learning and higher-level thinking, educators need to keep technology utilization consistent with active learning strategies, i. e., project-based learning, flipped classrooms, and gamification. As the regression outcomes of the study (R 2 = 0. 66) suggested, the student engagement represents the largest predictor of student performance, which means that technology must be used as a facilitator of interactivity and personalization compared to replacing the established techniques.

The institutions need to establish cross sector PLCs to allow the teachers of government and private schools to exchange resources, practices and innovations in digital pedagogy. Organizational culture in co-worker collaboration, indicated by the strong performance of high-performing private institutions, has been reported to increase teacher confidence, alleviate anxiety in technology use, and speed up innovations in pedagogies. The relationship between government schools and private schools, particularly the twinning concept, would be especially beneficial because of knowledge transfer and mentoring opportunities.

Practitioners should ensure that digital learning environments are inclusive and accessible, particularly for students from diverse socioeconomic backgrounds or those with special needs. Universal Design for Learning (UDL) principles should guide curriculum design, ensuring multiple modes of representation, engagement, and expression. Schools should also conduct periodic digital equity audits to identify and mitigate barriers to participation.

Recommendations for Future Research

To create a more comprehensive idea of the impact of digital pedagogy on institutional diversity, future researchers are advised to generalize the comparative structure to other regions, income, and types of schools. Longitudinal designs could provide insights into the long-term impact of digital interventions on student performance and teacher development, capturing the sustainability of digital transformation efforts.

Given the rise of AI-driven learning systems, further research should explore how adaptive learning, predictive analytics, and generative AI tools affect digital pedagogy's inclusivity and ethics. Studies could examine how government and private institutions differ in implementing such technologies and the implications for digital equity and data governance.

The second inquiry stage is to include student voice and agency that focus on the perception and experience of learners using digital tools and the effect of those practices on motivation, self-efficacy, and cognitive achievement. Integrative methodologies that involve surveys, focus groups and learning analytics would produce subtleties about engagement mechanisms.

The research article explicitly proves the fact that technology alone does not make or break digital pedagogy but rather it is a combination of infrastructure, teacher competency, and student engagement. To apply these results to practice the policymakers should invest in equal digital ecosystems, institutions need to develop pedagogical innovation, and researchers need to go on exploring the dynamics of digital learning. By operationalization of such recommendations, the education systems will no longer be digitally accessible but digitally empowered such that each learner acquires justly the power of transformation of digital education.

Conclusion

This study will include a close comparative analysis on how digital pedagogies have impacted the students in learning institutions of government and non-government institutions. The

findings show that, digital pedagogy cannot simply be based on the availability of the technologies but the combination of digital facilities, constructiveness of the teachers, and interactions between the students. Since the technological environment is more developed, and the investment in the professional growth is higher, the digital integration, and the performance of the students are higher in the private institutions. The government schools in their turn, despite the tendency of moving toward the digital transformation, continue to struggle with the problems of inefficient infrastructures, digitization of the teachers, and discrepancy in policies.

The research has an indispensable role in the growing body of literature on digital education since it enables to make the measurable links between the institutional capacity and the design of the pedagogical strategy and the measurable student performance. It builds on theoretical models like TPACK and SAMR in that it shows how the application of these theories in the real-life education context since it is moderated by the nature of the institution. This reinforces the notion that effective digital pedagogy is pedagogically constructed and contextually mediated, rather than technologically determined. Moreover, the study situates digital transformation within a broader discourse of educational equity, providing statistical evidence that the digital divide is not merely technological but also pedagogical and systemic.

From a practical and policy perspective, the study underscores the urgent need for targeted teacher training**,** equitable infrastructure investment, and data-driven governance mechanisms to bridge the digital disparity between sectors. For practitioners, the findings highlight the importance of active, inclusive, and student-centered digital designs that promote engagement and self-regulated learning. For policymakers, the results advocate for sustained capacity building and funding models that move beyond short-term technological interventions to long-term pedagogical empowerment.

However, the study acknowledges certain limitations. The modest sample size and cross-sectional design limit the generalizability of results, while reliance on self-reported data may introduce perceptual bias. Future research should employ longitudinal and mixed-method approaches across diverse educational contexts to examine the long-term impacts of digital interventions and to incorporate student voice and experience more deeply into analysis. Additionally, emerging technologies such as AI-driven learning analytics and adaptive platforms warrant exploration to understand their implications for inclusivity, ethics, and pedagogical innovation.

In conclusion, this research reaffirms that digital pedagogy's transformative power lies not in technological abundance but in its equitable, thoughtful, and context-sensitive application. By aligning infrastructure, teacher competence, and engagement strategies, educational systems can transition from digital access to digital empowerment, ensuring that all learners regardless of institutional or socioeconomic background benefit equitably from the evolving digital landscape of education.

Conflict of Interest

The authors showed no conflict of interest.

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