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Integrating Artificial Intelligence in Educational Technology: Assessing Its Impact on Student Learning Outcomes and Engagement in Pakistani Schools

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Abstract
This study examines the integration of Artificial Intelligence (AI) within Pakistan's educational technology (EdTech) landscape and evaluates its impact on student learning outcomes and engagement. Drawing on policy analysis, empirical studies, and case examples from leading EdTech platforms such as Maqsad, SABAQ Muse, Noon Academy, and Knowledge Platform, the research highlights how AI-driven tools particularly adaptive learning systems, AI-powered tutoring, and gamified platforms are transforming traditional pedagogical practices. The findings indicate that AI integration is positively associated with improved academic performance, enhanced motivation, increased participation, and personalized learning experiences, especially in STEM education and early-grade learning environments. At the policy level, national initiatives including the National AI Policy 2025, the Digital Nation Pakistan Act 2024, and large-scale investment commitments reflect a strong governmental push toward AI-enabled education reform. Furthermore, AI is reshaping teacher roles by automating administrative tasks, enabling data-driven instruction, and supporting professional development through targeted training programs. However, the study also identifies significant challenges, including a persistent digital divide across urban and rural regions, limited infrastructure, gaps in digital literacy, linguistic biases in AI systems, and concerns related to data privacy and ethical governance. These barriers risk reinforcing existing educational inequalities if not addressed through inclusive policy design and equitable resource distribution. The paper concludes that while AI holds substantial potential to enhance educational quality and accessibility in Pakistan, its success depends on strategic investments in infrastructure, comprehensive teacher training, localized AI solutions, and the establishment of robust ethical frameworks. When implemented responsibly, AI can serve as a transformative force for improving learning outcomes, increasing student engagement, and advancing inclusive and sustainable educational development in Pakistan.

Keywords: Artificial Intelligence In Education, EdTech Pakistan, Student Learning Outcomes, Student Engagement, Digital Divide, Personalized Learning, Teacher Training, National AI Policy, Adaptive Learning Platforms, Ethical AI Governance

1. Introduction

The educational landscape of Pakistan is currently at a critical juncture, navigating a profound transition from traditional, rote-based pedagogical models to a digitally-integrated ecosystem underpinned by Artificial Intelligence (AI) (Abbasi et al., 2026). This shift is not merely an adoption of new tools but a fundamental reimagining of how knowledge is delivered, accessed, and assessed in a country where the student-teacher ratio remains alarmingly high at approximately 44:1 (Hinduja et al., 2023). The state's commitment to this transformation is underscored by a landmark announcement to invest 1.0 \times 10^ {9} (one billion) dollars in the national AI ecosystem by 2030, a strategic move intended to catalyze innovation across all sectors, with education serving as a primary pillar for human capital (Ahmed, 2024). This investment is projected to support 1,000 fully-funded PhD scholarships and a nationwide program to train 1 million non-IT professionals in AI skills, reflecting a comprehensive approach to building a "world-class research center" within the country (Sumra et al., 2021). This transition represents a systemic evolution in how pedagogical frameworks and instructional models are constructed (Beyer, 2025).

2. National Strategic Framework and the Policy Mandate for AI

The integration of AI into Pakistani schools is governed by an evolving regulatory framework that seeks to align technological advancement with national development goals. The National AI Policy, approved in July 2025, represents the first cohesive effort to democratize access to AI and enhance public service delivery (Atta & Khan, 2025). This policy is reinforced by the Digital Nation Pakistan Act 2024, which establishes governance bodies such as the National Digital Commission (NDC) and the Pakistan Digital Authority (PDA) to oversee the country's digital transformation into a "forward-looking digital society." ((MIT, 2024).

Despite these high-level commitments, Pakistan's readiness for AI adoption presents a complex picture. The Government AI Readiness Index currently ranks Pakistan eighth among seventeen countries in South and Central Asia, placing it below regional peers like India, Bangladesh, and Sri Lanka (Nasution et al., 2024). These ranking highlights significant gaps in data infrastructure and digital capacity that the state aims to address through the "Awareness and Readiness" pillar of its 2025 policy (Atta & Khan, 2025). The government's vision includes the introduction of an AI curriculum across all federally-run schools, as well as in regions such as Azad Jammu and Kashmir (AJK) and Gilgit-Baltistan (GB), ensuring that the benefits of the digital revolution are not confined to urban centers (Oxford Insights, 2025).

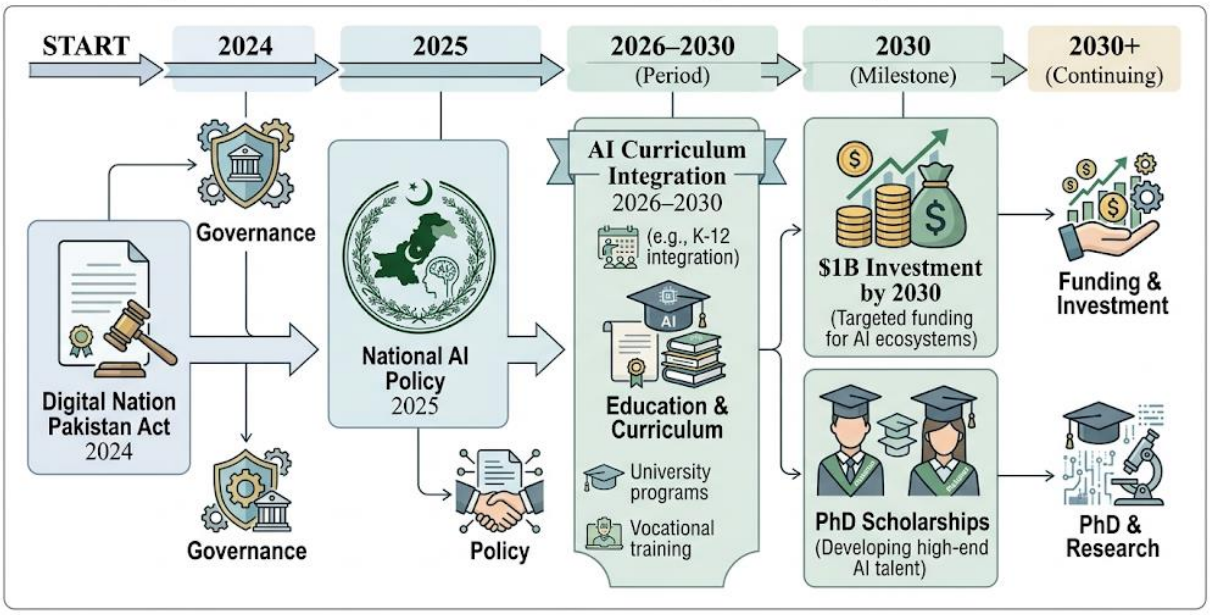
Table 1: National AI Policy Framework and Strategic Objectives

Policy Initiative	Target Date	Key Objectives	Projected Reach
National AI Policy	2025 (Approved)	Democratize AI access, enhance public services, and open employment avenues (Rao, 2025).	Nationwide
National AI Investment	2030	1 billion investment in the AI ecosystem (Sharif, 2026).	National Ecosystem
Digital Nation Pakistan Act	2024	Transformation into a digital society, economy, and governance (Ahmed, 2024).	National Governance
AI Curriculum Integration	2026-2030	Introduction of AI studies in federal, AJK, and GB schools (Sharif, 2026).	All Federal Schools
PhD AI Scholarships	2030	1,000 fully-funded PhDs to build a research center (Sharif, 2026).	Graduate Students

The strategic emphasis on AI is further validated by the "Future of Jobs Report 2025," which suggests that 40% of global workforce skills will undergo significant change within five years (UNESCO, 2025). In

response, the Ministry of Information Technology and Telecommunications (MoITT) has prioritized the development of a ten-year roadmap for AI adoption across education, healthcare, and governance, aiming to resolve the chronic mismatch between graduate skills and market demands (Council Science, 2025). Figure 1 illustrates Pakistan's strategic roadmap for AI integration in education, highlighting key policy initiatives and projected timelines

Figure 1: National AI Policy and Strategic Roadmap for Pakistan



3. EdTech Ecosystem: Catalysts for Pedagogical Disruption

The practical implementation of AI in Pakistani classrooms is primarily spearheaded by a vibrant EdTech sector that addresses specific local challenges, such as teacher shortages and the lack of quality instructional materials in remote areas (Khurshid et al., 2025). These platforms leverage machine learning (ML), natural language processing (NLP), and predictive analytics to create personalized learning environments that adapt to the unique needs of each student (Noon Academy, 2023).

3.1 Maqsad: Democratizing Access through Mobile-First Solutions

Founded in 2021, Maqsad has rapidly become the leading education application in Pakistan, reaching over 4 million students. The platform's core innovation, "DoubtSolve," utilizes AI to provide instant solutions to academic queries. Students can photograph a difficult math or science problem and receive a step-by-step solution instantly, a feature that effectively mitigates the lack of ready access to high-quality instructors (Ahmed, 2023). Maqsad's mission extends beyond exam preparation; it seeks to transition students from rote memorization to "real comprehension," a critical shift for a student population traditionally reliant on standardized testing patterns (Ahmed, 2021). In 2024, the platform successfully assisted over 500 students in securing admissions to top-tier medical colleges, illustrating the tangible impact of AI-assisted learning on high-stakes academic outcomes (Dar, 2025).

3.2 SABAQ Muse: Transforming Primary Education in Low-Resource Settings

SABAQ Muse focuses on the K-5 segment, converting the national curriculum into animated, story-based digital lessons delivered via low-cost mobile devices (Rao, 2025). A landmark pilot study conducted in collaboration with the Engro Foundation in Ghotki, Sindh, demonstrated the transformative potential of this

technology in remote, underserved regions where literacy levels are low and qualified teachers are scarce (Engro Foundation & SABAQ, 2023).

Table 2: Performance Growth in SABAQ Muse Ghotki Pilot Study

School (Ghotki Pilot)	Grade	Performance Growth (Baseline vs. End-line)	Outcome Level
Ghazi Chachar	Grade 1	581\% improvement (Engro Foundation & SABAQ, 2023)	Advanced
Ghazi Chachar	KG	172\% improvement (Engro Foundation & SABAQ, 2023)	Advanced
Sahara School	Grade 5	156\% improvement (Engro Foundation & SABAQ, 2023)	Advanced
Sahara School	Grade 4	67\% improvement (Engro Foundation & SABAQ, 2023)	Competent
Jung Madarssa	Grade 5	59\% improvement (Engro Foundation & SABAQ, 2023)	Competent

The pilot results showed that students in the early grades (KG and Grade 1) experienced the most dramatic shifts, moving from "below basic" (scores < 49%) to "advanced" (66–80%) competency levels (Braun et al., 2020). This success is attributed to the "fun and engaging" nature of animated content, which replaced monotonous traditional instruction and filled the instructional gap in schools where teachers lacked technological literacy (Sharif, 2026).

3.3 Noon Academy: The Social Learning Revolution

Noon Academy addresses the challenge of student engagement through a "social learning" model, creating a vibrant community where students learn alongside peers and top-tier educators in real-time (Ali & Hussain, 2022). The platform integrates AI to facilitate group learning tasks, generate collaborative assignments, and provide targeted assistance within a social setting (Siddiqui, 2023). In March 2021, Noon Academy formalized its role in the national landscape through a Letter of Understanding with the Ministry of Federal Education and Professional Training (MoFEPT) to provide digital education across the country (Government of Pakistan, 2021). Its gamified elements such as quizzes, games, and forums aim to maintain high levels of motivation, a frequent hurdle in traditional online learning (Noon Academy, 2023).

4. Assessing Impact on Student Learning Outcomes

The integration of AI in Pakistani schools has yielded measurable improvements in academic performance, cognitive development, and learning efficiency. Empirical research indicates that AI-powered tutoring systems (AIPTS) and adaptive learning platforms are particularly effective in improving results in STEM subjects (AI-Powered Tutoring Systems Study, 2025).

4.1 Quantitative Correlations and Academic Gains

A study involving secondary school students in Khyber Pakhtunkhwa (KP) reported a medium positive correlation ($r = 0.42$) between the frequent application of AI tools and learning performance (Farooq et al., 2024). The data suggests that students who utilize AI for interactive practice and instant feedback develop better learning habits and achieve significantly higher test scores than those reliant on traditional methods (Khyber Pakhtunkhwa Secondary Education Report, 2025).

Table 3: Correlation Between AI Usage and Secondary Learning Outcomes

Learning Outcome Metric	Mean Score (1–5 Scale)	Correlation with AI Usage
Enhanced Motivation	4.10 (Gujranwala Secondary Schools Report, 2025)	r = 0.37 (Khyber Pakhtunkhwa Secondary Education Report, 2025)
Participation Levels	N/A	r = 0.39 (Khyber Pakhtunkhwa Secondary Education Report, 2025)
Learning Engagement	4.21 (Gujranwala Secondary Schools Report, 2025)	Moderate Positive (Arxiv Education Study, 2025)
Personalized Pace	4.18 (Gujranwala Secondary Schools Report, 2025)	High Endorsement (Zahid et al., 2025)
Cognitive Skill Improvement	N/A	Significant (Zahid et al., 2025)

In higher education settings, regression analysis has demonstrated that AI adoption (beta = 0.32, $p < 0.001$) and student engagement (beta = 0.29, $p < 0.001$) are strong predictors of learning outcomes, collectively accounting for 44% of the variance in student performance (Bashir and Malik, 2024). Furthermore, AI tools have been found to reduce "speaking anxiety" and enhance communication confidence, suggesting that the non-judgmental nature of AI interfaces allows students to practice skills they might be hesitant to perform in a public classroom setting (Zia and Ahmed, 2023).

4.2 Knowledge Platform Case Study

Knowledge Platform, an AI-driven learning resource serving millions of learners, reported a significant breakthrough in a pilot program involving 75 schools and 26,000 learners. The implementation of personalized learning paths where the system identifies individual learning gaps and tailors' interventions accordingly resulted in a 60\% improvement in student scores (Anjum, 2025). These results reinforce the argument that AI acts as an essential force multiplier in environments characterized by varied student learning levels and overcrowded classrooms (Khurshid et al., 2025).

5. Dynamics of Student Engagement and Motivation

Engagement in the Pakistani context is often hindered by traditional didactic methods that prioritize passivity over participation. AI interventions have successfully disrupted this dynamic by introducing gamification and real-time interaction into the curriculum (Gujranwala Secondary Schools Report, 2025).

5.1 Motivational Drivers and Behavioral Shifts

The adoption of gamified AI applications has been shown to increase students' "motivation to participate" (mean score of 4.10 on a 5-point scale). By transforming learning into a series of achievable challenges with immediate rewards, AI tools address the psychological barriers to engagement (Xue et al., 2025). Furthermore, AI platforms facilitate a "nomadic" learning lifestyle, allowing students to access materials and participate in live sessions "anywhere, anytime" from their mobile devices (Majeed et al., 2025).

5.2 Urban-Rural and Socioeconomic Disparities

While the overall impact on engagement is positive, the data reveals a stark divide based on geography and school type. Students in urban centers like Peshawar report significantly higher engagement and learning gains from AI than their peers in rural areas such as Charsadda (Khan & Jan, 2023). Similarly, private school students, who often have better access to high-speed internet and modern hardware, use AI more frequently and achieve better grades than their counterparts in public schools (Rehman et al., 2024). This

suggests that the "motivational boost" provided by AI is currently contingent on the availability of a stable digital environment (Digital Rights Foundation, 2025).

6. The Transformation of Teaching Practices and Teacher Agency

The introduction of AI in Pakistani schools has sparked a fundamental shift in the role of the educator. Rather than serving as the sole source of information, teachers are increasingly becoming facilitators and mentors, leveraging AI to handle administrative burdens and tailor their instruction to individual student needs (Majeed et al., 2025).

6.1 Reallocating Teacher Time and Reducing Workload

McKinsey estimates that current AI technologies could allow teachers to reallocate 20% to 40% of their time to higher-value activities such as mentoring and creative lesson planning by automating routine tasks like attendance tracking and grading (Bryant et al., 2020). In Pakistan, where classrooms are frequently overcrowded, this automation is viewed as essential for maintaining instructional quality (Iqbal and Sajjad, 2023). Surveys of secondary school educators indicate that AI tools are highly valued for their ability to support lesson preparation (mean score of 4.12) and provide timely feedback to students (mean score of 4.20) (Nasir and Parveen, 2024).

6.2 Large-Scale Teacher Training Initiatives

To bridge the "competency gap" created by rapid technological advancements, the state and its partners have launched several extensive training programs (Shahid, 2022). UNESCO, in collaboration with the Federal Directorate of Education (FDE), initiated the ICT Professional Development Program, which trained 200 educators in AI tools such as Khanmigo (an AI tutor), MagicSchool (for administrative streamlining), and Teach AI (for ethical integration) (UNESCO, 2025).

Table 4: Key AI Teacher Training and Development Initiatives

Training Initiative	Target Audience	Primary Tools / Focus	Impact / Reach
Sindh Govt / UNICEF / KAP	3,500 Teachers	Khanmigo AI assistant for lesson planning (Sindh Government, 2026).	Remote districts (Dadu, Tharparkar)
HEC / Meta / Atomcamp	300 Faculty Members	AI, Data Science, and skill upgrading (Arab News Pakistan, 2026).	Higher Education (HEIs)
UNESCO AI Program	200 Educators	Khanmigo, MagicSchool, Teach AI (UNESCO, 2025).	Federal Schools & ASPnet
Iqra University Intervention	20 Teachers	Mobile-based GenAI (ChatGPT, Meta AI) (Hafeez & Zehra, 2025).	Low-resource Public Schools

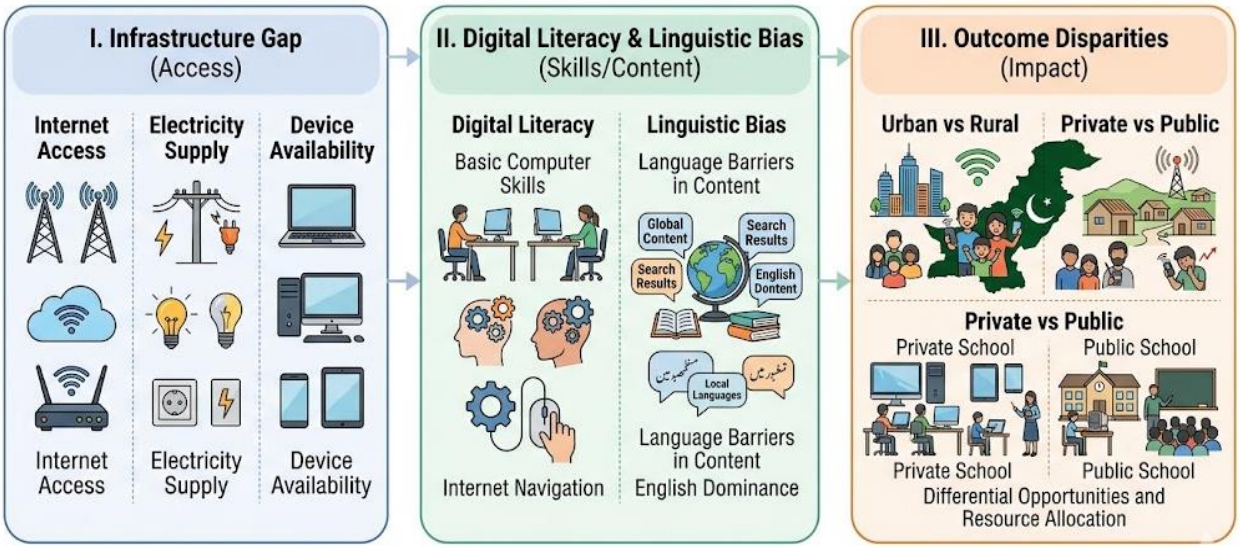
In Sindh, a six-month pilot project is currently training 3,500 public school teachers in remote districts such as Dadu and Umerkot, providing them with AI assistants to instantly generate lesson plans and worksheets aligned with provincial textbooks (Sindh Government, 2026). Results from localized case studies indicate that such training leads to a 70\% reduction in teacher workload and a noticeable increase in classroom delivery quality (Hafeez & Zehra, 2025).

7. Systemic Barriers and the Multidimensional Digital Divide

The optimistic narrative of AI integration in Pakistan is tempered by deep-seated structural and socioeconomic barriers. These challenges are often analyzed through the lens of a "three-level digital divide" that threatens to exacerbate existing inequalities (Mokoena & Seeletse, 2025). Figure 2 highlights

the multidimensional digital divide affecting AI adoption in Pakistani schools, from infrastructure limitations to disparities in learning outcomes.

Figure 2: Multidimensional Digital Divide in Pakistan



7.1 The Infrastructure Gap: A First-Level Divide

The most immediate barrier is the lack of basic digital infrastructure. In regions like District Mardan, public secondary schools struggle with unreliable electricity, slow internet, and a lack of functional computer labs (Jamaldini et al., 2026). Teachers report that even when computers are available, they often run outdated operating systems that are incompatible with modern AI software (Rafiuddin et al., 2023). Budget constraints frequently delay the purchase of new hardware for months, making it impossible to scale AI pilots into sustainable institutional practices (District Mardan Public Schools Report, 2025).

7.2 Digital Literacy and Linguistic Bias: Second-Level Divide

Even when hardware is available, a "skills gap" often prevents meaningful engagement with AI. Many teachers feel they lack the training and confidence to integrate AI into their pedagogy effectively. Furthermore, most AI systems exhibit a linguistic and cultural bias toward English and Western norms (Arxiv Education Study, 2025). This creates a "linguistic digital divide," where the accuracy and relevance of AI tools are diminished for students speaking non-dominant or indigenous languages. While some local innovations, such as the AI-powered "Sindhi Calculator," attempt to bridge this gap, institutional support for localized AI development remains limited (United Nations Development Programme, 2025).

7.3 Outcomes and Equity: The Third-Level Divide

The ultimate risk of AI integration is that it will amplify the advantages of already-resourced groups, leading to unequal educational outcomes. If AI is primarily accessible in elite urban schools, it will produce a generation of "AI-ready" graduates in those areas while leaving rural and low-income students further behind (Khyber Pakhtunkhwa Secondary Education Report, 2025). As noted by the National Human Development Report 2024, without universal internet access and affordable technology, AI may become a tool of exclusion rather than inclusion (UNDP, 2025). Advanced AI models in flood management and urban resilience also highlight the disparity in how technology is deployed to protect infrastructure in different regions (Ramya et al., 2025).

8. Ethical Governance and the Policy Void

As Pakistan deploys AI in its education system at scale, the lack of a dedicated governance policy for AI in education has emerged as a significant risk. While the National AI Policy 2025 provides an economy-wide vision, the educational sector requires specific safeguards regarding the rights of children and the integrity of the learning process (Khan, 2026).

8.1 Data Privacy and Algorithmic Accountability

The current legal framework, including the Prevention of Electronic Crimes Act (PECA) and the proposed Personal Data Protection Bill, is often criticized for prioritizing state authority over individual rights (Digital Rights Foundation, 2025). In the school context, there are no national standards for bias testing in educational algorithms, data retention policies for student information, or mechanisms for appeal when AI-assisted decisions cause harm (Mokoena & Seeletse, 2025). UNESCO has emphasized that Pakistan must anchor its AI transition in the "Recommendation on the Ethics of Artificial Intelligence" to ensure that systems are transparent and accountable (UNESCO, 2026).

8.2 Maintaining Human Interaction

A recurring theme among both students and faculty is the fear that an over-reliance on AI will erode critical thinking and socio-emotional development. Faculty members have expressed concern that AI could lead to a "loss of human interaction," which is essential for mentorship and ethical development (Majeed et al., 2025). Students also worry about "cognitive disengagement," where the ease of obtaining AI-generated answers might replace the deep struggle required for genuine mastery of a subject (Abbasi et al., 2026).

9. Economic and Long-term Strategic Implications

The economic potential of AI in Pakistan's education sector is substantial, with a forecasted annual spend of \37 \times 10^{9} by 2032. A quarter of this expenditure currently goes toward expensive after-school support, an area where AI-powered EdTech startups offer a cost-effective alternative (Ahmed, 2023).

Table 5: Economic Indicators and Investment Forecasts for EdTech

Economic Indicator	Value / Forecast	Context
Education Spend (2032)	37 billion	Total forecasted annual spend in Pakistan (Ahmed, 2023).
After-School Support	25% of Spend	Often expensive and difficult to access (Ahmed, 2023).
AI Rapid Competition Pool	8.75 million PKR	Government fund to scale AI startups (Ignite, 2025).
Maqsad Seed Funding	2.8 million	Funding to develop AI initiatives (Ahmed, 2023).
Noon Academy Funding	41 million	Series B funding for AI-powered global expansion (Noon Academy, 2023).

The growth of startups like Maqsad, which raised \2.1 million in pre-seed funding and an additional \2.8 million in seed funding, signals strong investor confidence in the capacity of AI to disrupt the traditional tutoring market (Ahmed, 2021). However, the long-term sustainability of this growth depends on the government's ability to act as a "lead user" of AI, embedding these tools into everyday public sector workflows rather than treating them as isolated innovations (Oxford Insights, 2025).

10. Conclusion

The integration of Artificial Intelligence into Pakistan's educational technology landscape marks a pivotal opportunity to address longstanding challenges of access, quality, and equity in a system strained by high

student-teacher ratios, resource limitations, and traditional rote-learning models. National strategic frameworks including the National AI Policy 2025, substantial government investment, the Digital Nation Pakistan Act, and curriculum reforms signal strong political commitment to leveraging AI for human capital development. EdTech platforms such as Maqsad, SABAQ Muse, Noon Academy, and Knowledge Platform have already demonstrated tangible benefits through personalized learning paths, instant doubt-solving, gamified engagement, and animated content, leading to improved academic performance (e.g., 60% gains in pilot studies), higher motivation, and better learning habits, particularly in STEM subjects and early grades. AI also supports teachers by automating administrative tasks, generating lesson materials, and providing real-time feedback, thereby freeing time for higher-value mentoring and reducing workload in overcrowded classrooms. Nevertheless, the promise of AI is tempered by persistent barriers: the multidimensional digital divide (infrastructure, skills, linguistic bias), stark urban-rural and public-private disparities, concerns over data privacy and algorithmic accountability, and the risk that over-reliance on AI may diminish critical thinking and human socio-emotional development. To realize equitable and sustainable impact, future efforts must prioritize universal digital infrastructure, culturally and linguistically localized AI solutions, comprehensive teacher training programs, and robust ethical governance aligned with international standards. When implemented responsibly, AI-driven educational technology can serve as a powerful equalizer, enhancing learning outcomes, boosting student engagement, empowering educators, and preparing Pakistan's youth for a rapidly evolving digital economy ultimately contributing to broader goals of inclusive growth and national development.

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