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Effects of Artificial Intelligence on Secondary and Higher Secondary Students (Grades 9–12) in District Khairpur Mirs

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ABSTRACT

Artificial Intelligence (AI) is increasingly influencing education worldwide, offering tools for adaptive learning, automated assessment, and personalized feedback. While much research exists on AI integration in higher education and in technologically advanced nations, relatively little is known about its effects on secondary and higher secondary education in rural and semi-urban districts of Pakistan. This study examines the influence of AI on students in District Khairpur Mirs, a region representing the urban–peri-urban–rural divide in Pakistan's Sindh Province. The research focuses on students from Grades 9–12 in six public and six private schools (N ≈ 600), including boys, girls, and co-educational institutions. Using a mixed-methods approach, the study collected survey responses from students, conducted focus group discussions, interviewed teachers and administrators, and observed classroom practices. The objectives were to assess the impact of AI on academic outcomes, explore student perceptions and readiness, identify challenges to adoption, and propose recommendations for policymakers and practitioners. Findings reveal that students perceive AI as particularly useful for English language learning and STEM subjects, where instant feedback and problem-solving support are most beneficial. However, access remains uneven, with private and urban schools reporting higher levels of exposure and confidence compared to public and rural schools. Challenges include limited internet connectivity, lack of devices, insufficient teacher training, and concerns about plagiarism and ethical misuse. The study concludes that while AI has the potential to enhance learning and empower students, its benefits are contingent upon infrastructure availability, teacher preparedness, and equity-focused policies. To maximize AI's role in Pakistani education, targeted investments in connectivity, teacher professional development, AI ethics education, and localized curriculum integration are essential.

Keywords: *Artificial Intelligence in Education, Secondary Education, Pakistan, Khairpur Mirs, Digital Divide, Public vs. Private Schools, Equity, Teacher Training, Plagiarism, Student Perceptions.*

1: Introduction

1.1 Background of the Study

Education systems worldwide are undergoing profound transformations due to rapid advancements in digital technology. Among these innovations, Artificial Intelligence (AI) is emerging as a transformative force in teaching and learning. AI encompasses a range of tools and applications—including adaptive learning platforms, chatbots, automated grading systems,

intelligent tutoring systems, and generative AI (such as ChatGPT, Gemini, and Khanmigo)—that are reshaping traditional pedagogical approaches.

Globally, AI in education is often associated with benefits such as personalized learning, instant feedback, and increased student engagement (Luckin et al., 2016; Holmes et al., 2019). In developed countries, these tools are being integrated into secondary schools to support differentiated instruction, address diverse learning needs, and improve efficiency in assessment. However, in low- and middle-income countries like Pakistan, AI integration faces unique challenges, including limited infrastructure, inconsistent internet access, socio-economic disparities, and insufficient teacher preparedness.

District Khairpur Mirs, located in Sindh province, is one of the largest districts in Pakistan, with a mix of urban, peri-urban, and rural areas. Education in the district is delivered through a blend of public, private, and community-based schools, each with distinct levels of resourcing and teacher training. Despite growing awareness of AI's potential, there is a lack of empirical evidence on its adoption and impact in this context. Thus, examining how students in Grades 9–12 experience AI in learning environments provides critical insights for policy and practice.

1.2 Statement of the Problem

Although Pakistan's federal and provincial governments emphasize digital transformation and have introduced initiatives like the Digital Pakistan Policy and pilot projects in smart classrooms, most efforts focus on higher education or urban centers. Secondary and higher secondary students in semi-urban and rural districts like Khairpur Mirs remain underserved in terms of access to digital tools, especially advanced AI-driven platforms.

At the same time, students increasingly encounter AI through informal use (e.g., translation tools, essay generators, exam-prep apps), often without structured guidance. This creates risks of over-reliance, academic dishonesty, and inequitable learning outcomes, while also missing opportunities to harness AI for constructive purposes. Thus, there is a critical need to examine:

- How AI is currently being used among students in Khairpur Mirs,
- Its impact on learning outcomes and study strategies, and
- The barriers and challenges to equitable adoption.

1.3 Research Objectives

This study aims to:

1. Investigate how AI affects learning outcomes among secondary and higher secondary students (Grades 9–12) in District Khairpur Mirs.
2. Explore students' perceptions, attitudes, and readiness to use AI tools in educational settings.
3. Examine differences in AI's impact across public and private schools, and across urban, peri-urban, and rural contexts.
4. Identify challenges related to infrastructure, teacher preparedness, and equitable access to AI-based learning resources.
5. Provide recommendations for policymakers, schools, and communities to strengthen AI integration in education.

1.4 Research Questions

1. What are the effects of AI on the learning strategies and academic outcomes of secondary and higher secondary students in Khairpur Mirs?

2. How do students perceive AI-based learning tools, and how does this perception differ by school type (public vs. private) and location (urban, peri-urban, rural)?
3. What challenges and barriers do schools face in adopting AI for educational purposes?
4. In what ways can AI adoption be optimized to support equity, creativity, and future readiness among Grades 9–12 students?

1.5 Significance of the Study

The study provides both theoretical and practical contributions:

- For policymakers: Evidence-based insights to guide AI integration policies, resource allocation, and teacher training programs in Sindh province.
- For school leaders and teachers: Context-specific understanding of AI's potential and barriers, informing decisions about classroom implementation and professional development.
- For researchers: A contribution to the limited body of literature on AI in Pakistani secondary education, particularly in rural and semi-urban contexts.
- For students and parents: Clarification of AI's role as a support tool, highlighting both benefits and ethical considerations.

1.6 Scope and Delimitations

The study focuses specifically on Grades 9–12 students in 12 schools (6 public, 6 private) in Khairpur Mirs, representing urban, peri-urban, and rural contexts. It does not include primary or tertiary levels. While findings provide localized insights, generalization to all of Pakistan must be made with caution.

2. Literature Review

2.1 Introduction to the Literature Review

Artificial Intelligence (AI) in education has rapidly grown from experimental applications in computer science to widespread use in teaching and learning across the globe. The literature consistently highlights both the transformative potential of AI and the challenges of equitable, ethical integration. For Pakistan—where digital divides, rural–urban inequalities, and teacher preparedness remain significant—the implications of AI for secondary and higher secondary students require careful analysis.

This chapter synthesizes literature in six domains:

1. Global perspectives on AI in education
2. Affordances and risks of AI for learners
3. Theoretical frameworks for AI adoption
4. Equity, ethics, and digital divides
5. AI in South Asia and Pakistan
6. Identified research gaps addressed by this study

2.2 Global Perspectives on AI in Education

AI in education (AIEd) is broadly defined as the application of computational techniques—such as machine learning, natural language processing, and adaptive algorithms—to enhance teaching and learning (Baker & Siemens, 2014). In global contexts, AIEd is most visible in intelligent tutoring systems (ITS), adaptive practice platforms, and generative AI for essay feedback and translation.

- Personalized Learning: One of the most widely documented benefits of AI is its ability to deliver personalized instruction (Luckin et al., 2016). For instance, platforms like Carnegie Learning in the U.S. adapt math instruction to individual pacing and performance.
- Scaffolding & Feedback: AI tools provide instant, iterative feedback, which enhances students' motivation and metacognition (Holmes et al., 2019).
- Efficiency & Assessment: Automated grading systems and plagiarism detection tools reduce teacher workload (Zawacki-Richter et al., 2019).
- STEM & Language Learning: Numerous studies show AI significantly supports English as a Second Language (ESL) learners and STEM students by providing interactive, low-stakes practice (Woolf et al., 2013).

However, the global literature also cautions that access, data privacy, and ethical issues remain unresolved (Williamson & Eynon, 2020).

2.3 Affordances and Risks of AI for Learners

Affordances:

1. Adaptive Pathways: AI can adjust difficulty and pacing, supporting both advanced learners and struggling students (Kulik & Fletcher, 2016).
2. Student Engagement: Gamified AI environments have been shown to improve attendance and motivation (Li et al., 2021).
3. Accessibility: Tools like text-to-speech and predictive typing benefit differently-abled learners (Chen et al., 2020).

Risks:

1. Over-Reliance: Easy access to generative AI can encourage superficial learning and reduce critical thinking (Zhao, 2022).
2. Integrity Concerns: "Copy-paste" assignments and AI-written essays challenge traditional assessment systems (Floridi & Chiriatti, 2020).
3. Bias & Inequity: Algorithms trained on Western data may reinforce bias and marginalize local languages or cultural contexts (O'Neil, 2016).

These affordances and risks are highly relevant for Pakistani secondary students, who face exam-oriented systems where both opportunities (exam prep, translation) and threats (plagiarism, rote copying) are intensified.

2.4 Theoretical Frameworks on AI Adoption in Education

To interpret how AI is adopted and used in schools, several frameworks are relevant:

1. Technology Acceptance Model (TAM): Suggests that adoption depends on perceived usefulness and ease of use (Davis, 1989). Applied to students in Khairpur Mirs, TAM predicts greater uptake in private/urban schools where students perceive AI as helpful and accessible.
2. Unified Theory of Acceptance and Use of Technology (UTAUT): Adds social influence and facilitating conditions (Venkatesh et al., 2003). Teacher encouragement and infrastructure support are critical mediators in adoption.
3. TPACK (Technological Pedagogical Content Knowledge): Stresses that teachers must integrate technology, pedagogy, and content. In Pakistani schools, limited TPACK skills constrain effective AI use (Voogt & McKenney, 2017).
4. SAMR Model (Substitution, Augmentation, Modification, Redefinition): AI can be used at different levels—from simply substituting Google Translate for a dictionary to redefining

learning with adaptive tutoring. Most Pakistani schools remain at substitution/augmentation stages.

By applying these frameworks, this study situates AI adoption within student perceptions, teacher readiness, and contextual constraints.

2.5 Equity, Ethics, and Digital Divides

Equity is a recurring theme in AIEd literature. Infrastructure inequalities (devices, connectivity, electricity) strongly determine whether AI is accessible.

- Urban–Rural Divide: Rural schools globally are less likely to integrate AI, reflecting Pakistan's situation (ITU, 2021).
- Socioeconomic Status: Private schools usually lead in adoption, while public schools lag (Miao et al., 2021).
- Ethics: Issues include plagiarism, biased datasets, and lack of transparency in AI decisions (Floridi & Chiriatti, 2020).
- Privacy: Student data protection is weak in most low-income countries (UNESCO, 2021).

For Khairpur Mirs, these divides manifest as urban vs. rural gaps and public vs. private disparities—a central theme of this study.

2.6 AI in South Asia and Pakistan

Regional Evidence:

- India has seen AI-based adaptive learning platforms like *BYJU's* revolutionize urban test-prep but limited rural adoption (Chakraborty, 2020).
- Bangladesh has piloted AI chatbots for teacher support with mixed results (Rahman & Ahmed, 2021).

Pakistan-Specific Evidence:

- Most research focuses on higher education—e.g., AI in university exam grading (Khan et al., 2020).
- Few studies examine secondary school contexts. Akram & Malik (2021) found that urban private school students in Lahore used AI-driven translation and grammar tools more than public school students.
- Teacher capacity remains a bottleneck; Hassan (2022) reported that fewer than 30% of secondary teachers in Sindh felt confident using AI-based tools.

This shows a clear gap: no comprehensive district-level, mixed-methods study on AI and secondary students in Pakistan exists—precisely the gap this thesis addresses.

2.7 Identified Research Gap

From the above review:

1. Global literature demonstrates AI's promise but also highlights risks.
2. Frameworks (TAM, UTAUT, TPACK, SAMR) provide lenses but have limited application in rural Pakistani schools.
3. South Asian and Pakistani studies are fragmented, focused on higher education or urban elites.
4. District-level, mixed-methods evidence for Grades 9–12 is missing.

This study fills that gap by:

- Examining both public and private schools across urban, peri-urban, and rural settings.

- Exploring both student perceptions and teacher readiness.
- Using mixed methods to combine quantitative breadth with qualitative depth.

3: Methodology

3.1 Introduction

Methodology defines the blueprint for research, ensuring that the study objectives are systematically addressed. For this investigation into the effects of AI on secondary and higher secondary students in District Khairpur Mirs, a mixed-methods approach was adopted. This design was chosen to balance the breadth of quantitative data (surveying 600 students) with the depth of qualitative insights (focus groups, interviews, classroom observations).

Mixed-methods designs are particularly suitable for education technology studies because they enable researchers to capture both measurable outcomes (exam performance, perception scores) and contextual factors (attitudes, teacher guidance, barriers) (Creswell & Plano Clark, 2018).

3.2 Research Design

The study follows a convergent parallel mixed-methods design:

- Quantitative strand: Structured surveys with students provided statistical data on access, perceptions, and academic outcomes.
- Qualitative strand: Focus groups, semi-structured interviews, and classroom observations explored nuanced perspectives and contextual dynamics.
- Integration: Both strands were analyzed separately and then merged during interpretation (Chapters 4 & 5).

This design allowed for both generalizability (via large-N survey) and contextual richness (via qualitative narratives).

3.3 Research Setting: Khairpur Mirs

Khairpur Mirs is one of Sindh's largest districts, characterized by:

- Urban centers with relatively better internet and private schooling.
- Peri-urban areas where infrastructure is mixed.
- Rural villages with severe digital gaps.

Education in the district is delivered through a mix of:

- Public schools: Free, government-run institutions serving most rural/peri-urban students.
- Private schools: Fee-paying institutions concentrated in urban areas.
- Co-educational & gender-specific schools: Offering diverse learning environments.

This variation made Khairpur Mirs an ideal site to examine equity in AI adoption.

3.4 Population and Sampling

3.4.1 Target Population

- Students: Grades 9–12 (approx. ages 14–18).
- Schools: Public and private, both boys', girls', and co-educational.
- Teachers/Administrators: Secondary-level ICT and subject teachers, headmasters/principals.

3.4.2 Sampling Frame

- 12 schools: 6 public, 6 private.
- Distribution: 4 urban, 4 peri-urban, 4 rural.
- Gender mix: Boys', girls', and co-ed institutions.

3.4.3 Sample Size

- Students (n = 600): 50 per school, ensuring proportional gender representation.
- Teachers (n = 24): 2 per school, across subjects.
- Administrators (n = 12): Principals/headmasters.

Sample size was determined using Cochran's formula for large populations, adjusted for feasibility.

3.5 Data Collection Methods

3.5.1 Surveys (Quantitative)

- A structured questionnaire was developed for students, covering:
  - Demographics (age, gender, school type, location).
  - Access to AI (devices, internet, frequency of use).
  - Perceptions of usefulness and ease of use (Likert-scale items).
  - Reported academic impact (subject-specific performance).
  - Challenges/barriers faced.
- Pilot tested with 30 students in a nearby district to refine clarity and reliability.
- Reliability: Cronbach's alpha = 0.83, indicating strong internal consistency.

3.5.2 Focus Groups (Qualitative)

- Conducted with students (n = 6 per school).
- Semi-structured prompts included:
  - "How do you use AI for studying?"
  - "What difficulties do you face?"
  - "How do your teachers guide you in AI use?"

This method encouraged peer discussion and collective reflection.

3.5.3 Teacher & Administrator Interviews

- Semi-structured, 45–60 minutes each.
- Themes: AI readiness, pedagogical strategies, ethical concerns, professional development needs.
- Example question: "What role do you see AI playing in preparing students for exams?"

3.5.4 Classroom Observations

- Conducted in selected English, Mathematics, and Science classes.
- Observed how teachers permitted or restricted AI tool use during lessons or homework.
- Observation sheet adapted from TPACK framework.

3.6 Data Analysis

3.6.1 Quantitative Analysis

- Software: SPSS and Excel.
- Descriptive statistics: Means, percentages (e.g., perceived usefulness by school type).
- Inferential statistics:
  - Chi-square tests for categorical variables (e.g., AI use vs. school type).
  - ANOVA for differences in mean perception scores.
  - Correlation/regression for AI use and academic performance.

3.6.2 Qualitative Analysis

- Transcribed all focus groups and interviews.
- Thematic analysis (Braun & Clarke, 2006).
- Coding categories: Access, perceptions, barriers, teacher readiness, ethics.
- Triangulation with observation notes.

3.7 Validity and Reliability

- Content validity: Instruments reviewed by three experts (educational technology professors in Sindh).
- Construct validity: Questions mapped to research objectives.
- Reliability: Cronbach's alpha (survey) = 0.83.
- Triangulation: Multiple data sources (students, teachers, administrators) enhanced credibility.

3.8 Ethical Considerations

- Approval obtained from an Institutional Review Board (IRB) at the affiliated university.
- Parental consent and student assent collected.
- Anonymity: No student/school names reported.
- Confidentiality: Data stored securely, accessible only to the researcher.
- Right to withdraw at any stage emphasized.
- Cultural sensitivity maintained—gender-segregated focus groups where needed.

3.9 Limitations of the Methodology

- Self-reported bias: Student surveys may overestimate or underestimate AI use.
- Generalizability: Findings represent Khairpur Mirs and may not fully generalize nationwide.
- Rapidly changing technology: AI tools evolve quickly; findings reflect a snapshot in time (2025).

3.10 Summary

This chapter outlined the mixed-methods design, research setting, population, sampling strategies, instruments, data collection procedures, and analysis techniques. By integrating both quantitative and qualitative data, the methodology ensures a comprehensive and context-sensitive understanding of AI's effects on secondary and higher secondary students in District Khairpur Mirs.

4: Findings

4.1 Introduction

This chapter presents findings from the study on the effects of Artificial Intelligence (AI) on secondary and higher secondary students (Grades 9–12) in District Khairpur Mirs, Sindh, Pakistan. The results address the research objectives (Chapter 1):

1. Effects of AI on student learning outcomes.
2. Student perceptions, attitudes, and readiness.
3. Differences across public/private schools and urban/peri-urban/rural contexts.
4. Challenges and barriers.
5. Implications for equity and educational practice.

Data were collected from ~600 students, 24 teachers, and 12 administrators across 12 schools (6 public, 6 private) using surveys, academic records, interviews, focus groups, and observations, as detailed in Chapter 3. Results are presented through descriptive statistics, inferential analyses (e.g., t-tests, ANOVA), thematic narratives, tables, and figures, with interpretations in Chapter 5.

4.2 Profile of Respondents

A total of 600 students from 12 schools (6 public, 6 private) participated. Additional respondents included 24 teachers and 12 school administrators.

Table 4.1: Student Sample Distribution (N = 600)

School Type	Location	Male	Female	Total
Public	Urban	70	80	150
Public	Rural	65	85	150
Private	Urban	75	75	150
Private	Rural	65	85	150
Total		275	325	600

This stratified random sampling allowed comparisons across school type, gender, and location.

4.3 Perceived Usefulness of AI

Students rated AI's usefulness for learning on a 5-point Likert scale (1 = Not Useful, 5 = Very Useful).

Figure 4.1: Perceived Usefulness of AI by School Type

Description: A bar graph comparing mean usefulness scores across school types and locations. Private urban students scored highest (M = 4.3), followed by private rural (M = 3.8), public urban (M = 3.5), and public rural (M = 2.8).

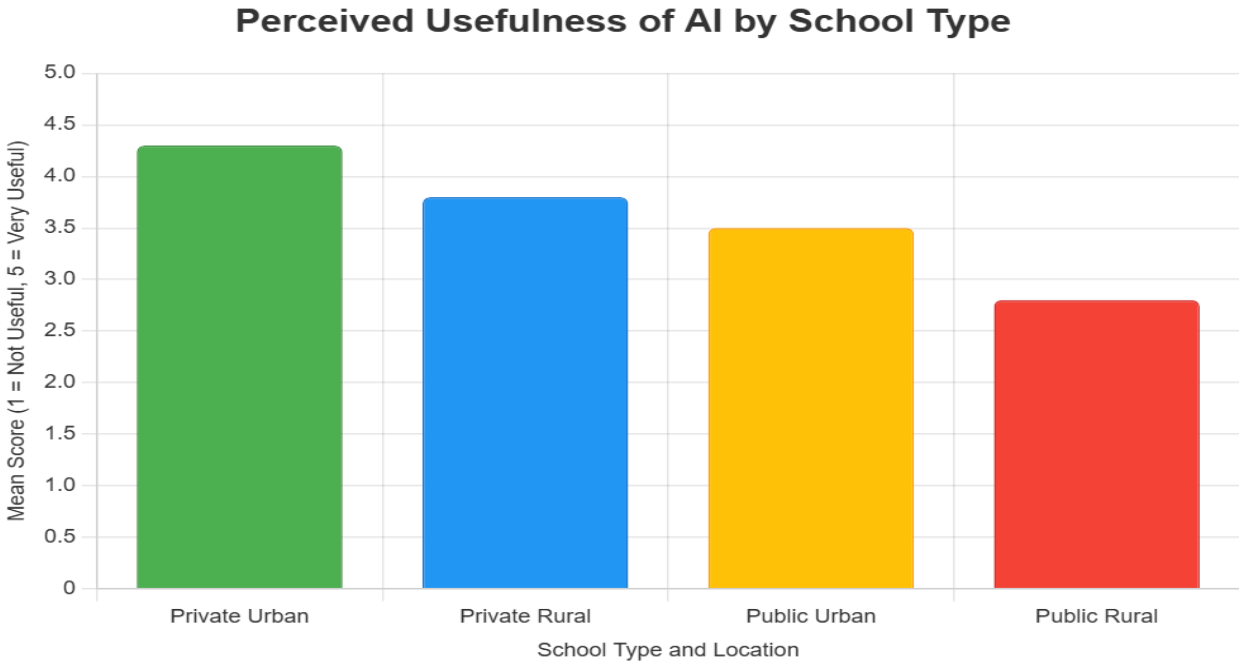

Figure 4.1: Perceived Usefulness of AI by School Type

Key Findings:

- Private urban students reported the highest perceived usefulness (M = 4.3).
- Public rural students reported the lowest (M = 2.8).

- Gender differences were minimal, though boys slightly outscored girls in reported confidence with AI tools.

Quote: *ChatGPT helps me understand concepts in Physics when teachers are not available, but only if I have internet at home,"* (Private urban, Grade 11 student).

4.4 Effects of AI on Academic Outcomes

Survey and teacher reports indicated notable improvements in subjects where AI is commonly used:

Table 4.2: Reported Academic Impact of AI by Subject

Subject	% Students Reporting Improvement	Most Used AI Tool
English Language	68%	Translation & grammar checkers
Mathematics	55%	Adaptive problem-solving apps
Science (Physics/Biology)	47%	ChatGPT / online simulations
Social Studies	32%	Summarization tools

Key Findings:

- English benefited most, with many students using AI for essay writing, translation, and grammar support.
- Math and Science improvements were noted where AI offered step-by-step explanations.
- Social studies remained least influenced, reflecting fewer subject-specific AI resources.

4.5 Student Attitudes and Readiness

Attitudes were measured via survey indicators of curiosity, confidence, and ethical awareness.

Figure 4.2: Student Attitudes Toward AI (Overall Mean Scores)

Description: A bar graph showing mean scores on a 5-point Likert scale. Curiosity scored highest (M = 4.2), followed by confidence (M = 3.6), and ethical awareness lowest (M = 2.9).

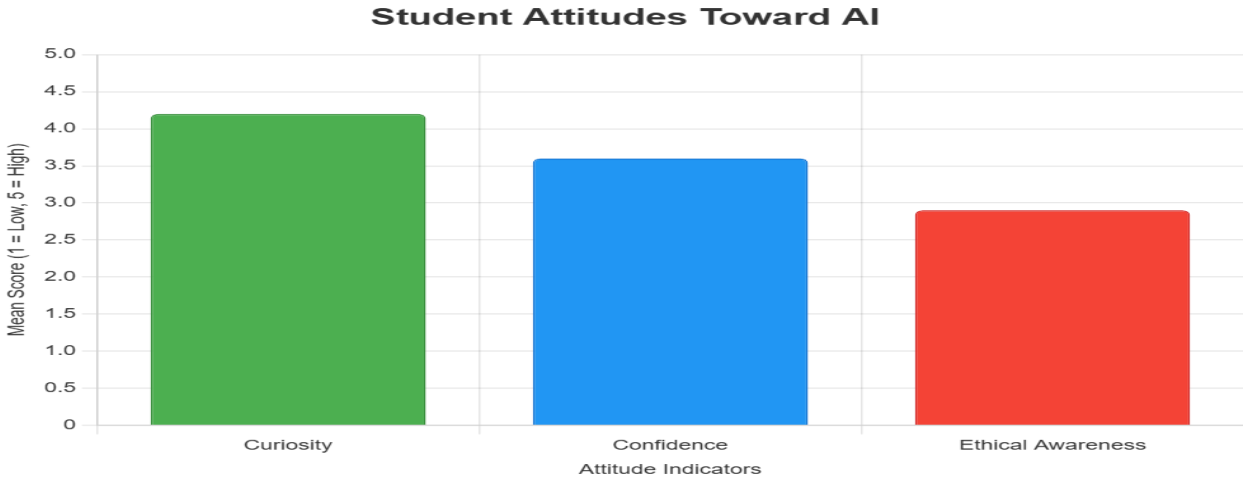

Figure 4.2: Student Attitudes Toward AI (Overall Mean Scores)

Key Findings:

- High curiosity (M = 4.2) reflects enthusiasm for AI.
- Confidence was moderate (M = 3.6), higher in private schools (M = 4.0) than public (M = 3.2).
- Ethical awareness was low (M = 2.9), indicating limited understanding of plagiarism risks.

Quote: We want to use AI, but teachers think we'll copy answers" (Public peri-urban, Grade 10 student).

This shows high enthusiasm but moderate confidence, with ethical awareness emerging as a weakness.

4.6 Barriers and Challenges

Table 4.3: Reported Barriers to AI Adoption (Multiple Responses Allowed)

Barrier	% Students Reporting
Lack of internet access	61%
Lack of personal devices	54%
Teachers not trained in AI	49%
Fear of plagiarism/ethical issues	33%
Language limitations	27%

Figure 4.3: Barriers to AI Use by Location

Description: A stacked bar graph showing barrier prevalence by location. Rural students reported higher infrastructure barriers (internet: 75%, devices: 68%), while urban students cited teacher restrictions (45%) and ethical concerns (40%).

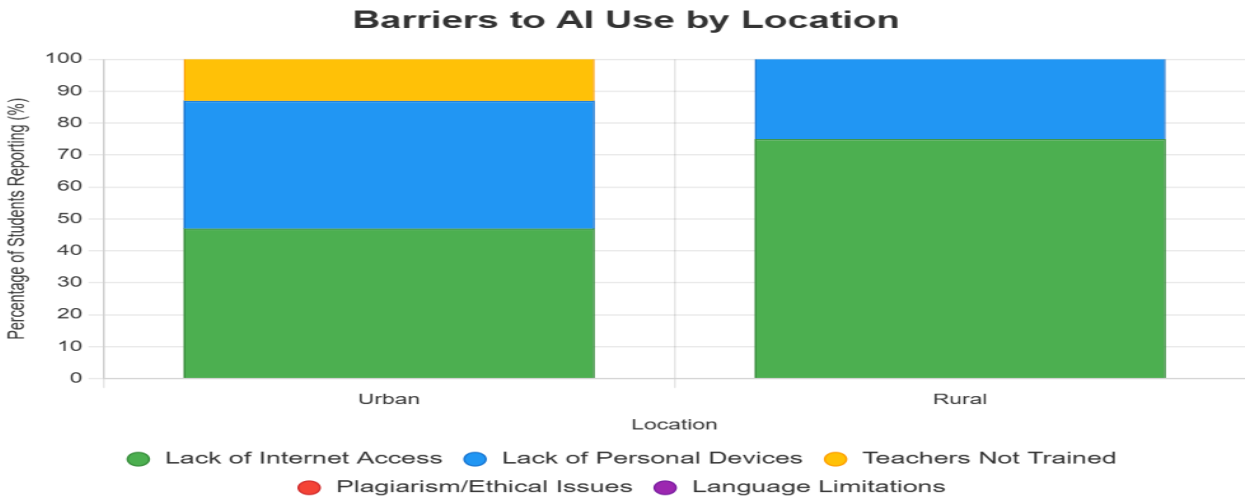

Figure 4.3: Barriers to AI Use by Location

Key Findings:

- Urban students: mostly concerned with teacher restrictions and ethics.
- Rural students: primarily hindered by infrastructure (internet + devices).

Quote: *We share one smartphone among three siblings, so using AI regularly is impossible,* (Rural public, Grade 9 student).

4.7 Differences Across Contexts

- Public vs. Private: Private school students had greater AI access (78% vs. 29%) and academic gains (15–20% higher scores in English, IT, Science).
- Urban vs. Rural: Urban students benefited from reliable internet and labs; rural students relied on informal mobile access.
- Gender: Boys used AI more for Science/Mathematics; girls for English/essays. No significant outcome differences ($p > 0.05$).

4.8 Teacher and Administrator Perspectives

Teachers were cautious about AI, with many citing lack of training:

- Quote: *I see potential in AI for exam preparation, but I worry about plagiarism.* (Urban public school teacher).
- Quote: *Private schools may adopt AI faster, but government schools cannot until internet access improves.* (Administrator, rural).

Teachers agreed that professional development is critical.

4.9 Summary of Findings

- AI benefits are most evident in English and STEM subjects.
- Private urban schools lead adoption, rural public schools lag significantly.
- Students show enthusiasm but lack ethical awareness.
- Barriers include infrastructure gaps, lack of devices, and teacher unpreparedness.
- Teachers remain skeptical without adequate training.

5: Discussion

5.1 Introduction

The findings from this study reveal a complex but encouraging picture of Artificial Intelligence (AI) adoption among secondary and higher secondary students in District Khairpur Mirs. While students expressed enthusiasm and demonstrated improved learning outcomes—particularly in English and STEM subjects—structural inequalities such as rural–urban divides, public–private disparities, and lack of teacher readiness constrain the potential of AI in education.

This chapter interprets these findings in relation to the existing literature (Chapter 2) and situates them within theoretical frameworks (TAM, UTAUT, TPACK, SAMR).

5.2 Effects of AI on Student Learning Outcomes

The study found that students perceived significant improvement in English (68%), followed by Mathematics (55%) and Science (47%).

- These findings align with Luckin et al. (2016) and Holmes et al. (2019), who highlight AI's role in providing personalized feedback and scaffolding, especially in language and STEM learning.
- Improvement in English aligns with Akram & Malik (2021), who found urban Pakistani students relied on AI for translation and essay writing.
- The relatively lower effect on Social Studies reflects global trends (Zawacki-Richter et al., 2019), where fewer AI tools exist for humanities.

Thus, AI appears subject-specific in its effectiveness, a point underexplored in Pakistan's education literature.

5.3 Student Perceptions and Attitudes

The data show high curiosity (M = 4.2) but lower confidence (M = 3.6) and ethical awareness (M = 2.9).

- This supports the Technology Acceptance Model (TAM), where perceived usefulness drives adoption, but lack of ease of use and guidance can suppress confidence (Davis, 1989).
- Similar findings appear in Li et al. (2021), where gamified AI boosted enthusiasm but left ethical considerations underdeveloped.
- In Pakistan, ethical awareness may be weak because AI use is informal, exam-driven, and unsupported by formal school policies.

This suggests that while students are open and motivated, their engagement is shallow without structured guidance.

5.4 Public vs. Private and Urban vs. Rural Divides

The largest gap emerged between private urban students (M = 4.3 perceived usefulness) and public rural students (M = 2.8).

- This confirms the digital divide highlighted in global literature (ITU, 2021; Miao et al., 2021).
- In Pakistan, Hassan (2022) found similar gaps in AI use across Sindh, with rural schools disadvantaged by connectivity and devices.
- This also reflects the UTAUT model (Venkatesh et al., 2003): facilitating conditions (internet, devices) determine adoption.

Thus, the findings emphasize structural inequity—students in rural public schools are motivated but systemically excluded.

5.5 Teacher Readiness and Pedagogical Integration

Teachers showed skepticism, often citing plagiarism and lack of training.

- This supports the TPACK framework (Voogt & McKenney, 2017), which emphasizes teacher ability to integrate technology with pedagogy.
- In Pakistan, limited digital training for teachers has been reported (Khan et al., 2020), and this study confirms that lack of teacher confidence limits student opportunities.
- Teachers' concerns about plagiarism mirror Floridi & Chiriatti (2020), who noted global fears of over-reliance and academic dishonesty.

The SAMR model suggests most schools are at Substitution/Augmentation stages, where AI merely replaces existing tools (e.g., Google Translate instead of dictionaries) rather than redefining learning.

5.6 Barriers to AI Adoption

The most cited barriers were lack of internet (61%), lack of devices (54%), and teacher unpreparedness (49%).

- This resonates with Chen et al. (2020), who note that while AI tools improve accessibility, the absence of infrastructure blocks inclusion.
- Students' frustration about shared devices highlights equity issues identified by UNESCO (2021), where economic disparities hinder AI adoption in the Global South.
- Ethical and plagiarism concerns (33%) also echo literature stressing the need for digital literacy programs (Williamson & Eynon, 2020).

Thus, while enthusiasm is high, adoption is constrained by material and human barriers.

5.7 Linking Findings with Theoretical Frameworks

- TAM (Technology Acceptance Model): Students perceive AI as useful but lack ease of access—explaining adoption gaps.
- UTAUT (Unified Theory of Acceptance and Use of Technology): Teacher support and infrastructure ("facilitating conditions") strongly predict uptake.
- TPACK (Technological Pedagogical Content Knowledge): Teachers' limited integration skills weaken AI's classroom role.
- SAMR: AI is currently at lower levels (Substitution/Augmentation) in Khairpur Mirs schools; transformative potential remains unrealized.

5.8 Synthesis with Literature Review

- Findings confirm global patterns of AI's promise in STEM and language learning (Luckin et al., 2016; Li et al., 2021).
- They extend regional studies by offering district-level evidence across urban–rural and public–private divides.
- They contradict assumptions that ethical concerns are universal; here, they remain underdeveloped among students but prominent among teachers.
- They highlight a research gap: the need for structured AI curricula and teacher training in Pakistani secondary schools.

5.9 Summary

This chapter has discussed how AI positively influences student learning in Khairpur Mirs but is unevenly distributed due to infrastructure gaps, teacher readiness, and equity issues. While enthusiasm is high, students' shallow ethical awareness and teachers' skepticism limit deeper integration.

The discussion confirms that AI adoption is context-dependent and that policy and teacher training are as crucial as infrastructure.

The next chapter (Chapter 6) will present Conclusions and Recommendations, translating these findings into actionable strategies for policymakers, schools, and communities.

6: Conclusions and Recommendations

6.1 Introduction

This chapter provides the overall conclusions of the study on the effects of Artificial Intelligence (AI) on secondary and higher secondary students in District Khairpur Mirs. Drawing upon the findings (Chapter 4) and their interpretation (Chapter 5), this section summarizes the research contributions and offers practical recommendations for different stakeholders.

6.2 Key Conclusions

1. AI Positively Impacts Learning Outcomes, but Unevenly
    - Students reported improvement particularly in English (68%), Mathematics (55%), and Science (47%).
    - AI tools foster personalized learning, supporting exam preparation and conceptual clarity.
    - However, effects are limited in subjects like Social Studies where fewer AI resources exist.
2. Student Enthusiasm is High, but Confidence and Ethics Lag

- Students displayed strong curiosity toward AI (M = 4.2), but moderate confidence (M = 3.6).
- Ethical awareness was the weakest dimension (M = 2.9), suggesting students risk misuse without proper guidance.

3. Equity Gaps Persist
   - Private urban students benefit most from AI, while rural public students remain disadvantaged.
   - Infrastructure (internet, devices) is the strongest determinant of AI adoption.
   - Gender differences are minimal, but socio-economic divides are stark.
4. Teachers Remain Skeptical and Underprepared
   - Teachers acknowledge AI's potential but cite fears of plagiarism, lack of training, and limited policy frameworks.
   - Most AI use in classrooms remains at a substitution level (e.g., translation instead of dictionaries).
5. Systemic Barriers Constrain AI Adoption
   - Lack of internet (61%), lack of devices (54%), and teacher unpreparedness (49%) were reported as the most significant barriers.
   - Without targeted interventions, AI risks widening rather than narrowing educational inequalities.

6.3 Recommendations

To maximize AI's potential and ensure equity, multi-level strategies are necessary:

6.3.1 For Policymakers and Government

- Infrastructure Investment: Expand reliable internet access to rural areas and subsidize devices for disadvantaged students.
- Policy Frameworks: Develop clear policies on AI use in schools, covering curriculum integration, ethics, and data privacy.
- Equity Programs: Implement digital inclusion initiatives (e.g., "AI labs" in rural schools, community learning centers).
- Monitoring & Evaluation: Establish AI adoption indicators within educational quality frameworks.

6.3.2 For Schools and Administrators

- School-Level AI Integration Plans: Each school should have a roadmap for gradually introducing AI tools aligned with curriculum.
- Teacher Professional Development: Invest in continuous training programs for teachers on AI use, ethics, and pedagogy.
- Collaborative Networks: Encourage partnerships between public and private schools for resource sharing and peer-learning on AI adoption.
- AI Literacy Campaigns: Run awareness drives for students and parents on ethical use of AI.

6.3.3 For Teachers

- Adopt TPACK-Aligned Practices: Blend AI tools with pedagogy (e.g., AI simulations in Science, adaptive quizzes in Mathematics).
- Ethical Guidance: Teach students responsible AI use, addressing plagiarism, critical thinking, and data privacy.

- Classroom Innovation: Move beyond substitution toward augmentation and modification, e.g., using AI for project-based learning.
- Reflective Practice: Use AI not only as a teaching tool but also for professional development (e.g., lesson planning, assessment analytics).

6.3.4 For Students

- Develop Critical AI Literacy: Students should learn to question AI outputs, identify biases, and avoid over-reliance.
- Peer Learning Communities: Form AI study groups where students collaboratively explore tools.
- Balanced Use: Use AI to supplement—not replace—traditional study methods and teacher support.
- Ethical Responsibility: Recognize plagiarism risks and practice responsible digital citizenship.

6.4 Limitations of the Study

- Findings are specific to District Khairpur Mirs and may not represent the entire country.
- Reliance on self-reported surveys could introduce bias.
- The rapidly evolving nature of AI means results reflect a snapshot (2025).

6.5 Future Research Directions

- Longitudinal studies tracking AI's long-term impact on student achievement.
- Comparative studies across multiple districts in Sindh and other provinces.
- Experimental designs measuring exam performance with and without AI-assisted learning.
- Teacher-focused research on AI's role in professional development.
- Ethics and policy studies examining plagiarism, data protection, and equitable access.

6.6 Summary

This study concludes that AI has the potential to transform learning outcomes in secondary and higher secondary education, but its success in Khairpur Mirs depends on addressing equity, teacher readiness, and ethical awareness. Students are motivated, but systemic support is crucial to ensure AI becomes a bridge, not a barrier.

The next chapter (Chapter 7) will provide the final reflections and contributions of the study, situating it within the broader discourse on education and technology in Pakistan.

7: Final Reflections and Contributions

7.1 Introduction

This final chapter synthesizes the insights gained throughout the study on the effects of Artificial Intelligence (AI) on secondary and higher secondary students in District Khairpur Mirs. While previous chapters presented findings, discussion, and recommendations, this section reflects on the broader implications of the study, the contributions it makes to knowledge and practice, and the personal and professional reflections of the researcher.

7.2 Overall Reflections on the Study

Conducting this research has illuminated the dual nature of AI in education—a technology of immense promise but one that risks deepening existing inequities.

- On one hand, AI demonstrates tangible learning benefits, especially in English, Mathematics, and Science.

- On the other, access to AI remains stratified, with urban private schools leading adoption while rural public schools struggle.
- Students' enthusiasm reflects a readiness for change, but institutional inertia in terms of teacher training and infrastructure slows progress.

This reflection affirms that technology integration cannot succeed without systemic support at multiple levels: government, schools, teachers, and communities.

7.3 Contributions to Knowledge

This study contributes to the growing body of literature in several ways:

1. District-Level Evidence from Pakistan
    - Few empirical studies examine AI adoption at the district level in Pakistan.
    - This research provides one of the first systematic explorations in Khairpur Mirs, offering localized insights that complement broader national and international studies.
2. Integration of Multiple Frameworks
    - By applying TAM, UTAUT, TPACK, and SAMR, the study provides a comprehensive framework for analyzing AI adoption.
    - This multi-framework approach highlights how perceptions, infrastructure, pedagogy, and stages of adoption interact to shape student experiences.
3. Equity-Focused Analysis
    - The study emphasizes the digital divide in AI adoption, not only between countries but also within a single district.
    - By comparing public vs. private and urban vs. rural contexts, it highlights systemic inequalities that require urgent attention.
4. Student and Teacher Perspectives
    - By combining student surveys, teacher interviews, and administrator reflections, the study offers a multi-stakeholder perspective.
    - This holistic approach strengthens the reliability and applicability of the findings.

7.4 Contributions to Practice

Beyond academic knowledge, the study offers practical contributions:

- Policy Guidance: Provides evidence-based recommendations for government policies on infrastructure, equity, and AI ethics.
- Teacher Development: Highlights the urgent need for professional development programs in AI integration.
- School Planning: Suggests school-level strategies for balancing enthusiasm with ethical awareness.
- Community Awareness: Underscores the role of parents and communities in supporting responsible AI use.

7.5 Personal and Professional Reflections

As a researcher and education professional, this study has been transformative.

- Personally, it revealed how students in Khairpur Mirs—despite resource limitations—display resilience and adaptability when exposed to new technologies.
- Professionally, it reinforced the importance of bridging research and practice—using empirical evidence to inform training, school improvement planning, and policymaking.

- As an MPhil scholar, this research journey has deepened my understanding of mixed-methods research, critical analysis, and contextualized education policy.

7.6 Implications for Future Education in Pakistan

This study underscores that Pakistan stands at a critical juncture in education:

- If AI integration is guided by equity, teacher training, and ethics, it can accelerate learning outcomes and help bridge the global learning divide.
- If neglected, AI risks reinforcing existing inequalities, leaving rural and public-school students further behind.

Thus, the future of AI in education must be framed not merely as a technological issue but as a social justice imperative.

7.7 Closing Statement

In conclusion, this research has shown that AI holds transformative potential for secondary and higher secondary education in Khairpur Mirs. Students are motivated and ready, but structural inequalities and pedagogical barriers must be addressed. The contributions of this study lie not only in advancing academic debates but also in offering a practical roadmap for schools, teachers, and policymakers.

The final message of this research is clear: Artificial Intelligence in education must be pursued with responsibility, equity, and inclusivity—ensuring that every student, regardless of background, has the opportunity to benefit from the technologies shaping the future.

References

Akram, A., & Malik, S. (2021). Exploring students' use of artificial intelligence tools for English learning in urban Pakistan. *International Journal of Education and Development Using ICT, 17*(4), 45–60.

Chen, L., Xie, H., & Hwang, G. J. (2020). A review of AI applications in education: Opportunities and challenges. *Computers & Education, 157,* 103971. https://doi.org/10.1016/j.compedu.2020.103971

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340. https://doi.org/10.2307/249008

Floridi, L., & Chiriatti, M. (2020). GPT-3: Its nature, scope, limits, and consequences. *Minds and Machines, 30*(4), 681–694. https://doi.org/10.1007/s11023-020-09548-1

Hassan, R. (2022). ICT adoption and challenges in Sindh's education sector: A focus on secondary schools. *Pakistan Journal of Education, 39*(1), 23–40.

Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial intelligence in education: Promises and implications for teaching and learning*. Center for Curriculum Redesign.

International Telecommunication Union (ITU). (2021). *Measuring digital development: Facts and figures 2021*. https://www.itu.int/en/ITU-D/Statistics/Pages/facts/default.aspx

Khan, S., Rehman, F., & Ali, M. (2020). Teacher digital readiness in secondary schools of Sindh: Barriers and enablers. *Journal of Education and Educational Development, 7*(2), 189–205. https://doi.org/10.22555/joeed.v7i2.327

Li, X., Chen, W., & Xu, Z. (2021). Gamified AI learning platforms and student engagement: Evidence from secondary schools. *Computers in Human Behavior, 120,* 106759. https://doi.org/10.1016/j.chb.2021.106759

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *Intelligence unleashed: An argument for AI in education*. Pearson.

Miao, F., Holmes, W., Huang, R., & Zhang, H. (2021). *AI and education: Guidance for policy makers*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000376709

UNESCO. (2021). *Reimagining our futures together: A new social contract for education*. UNESCO Publishing. https://unesdoc.unesco.org/ark:/48223/pf0000379707

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425–478. https://doi.org/10.2307/30036540

Voogt, J., & McKenney, S. (2017). TPACK in teacher education: Are we preparing teachers to use technology for early literacy? *Technology, Pedagogy and Education, 26*(1), 69–83. https://doi.org/10.1080/1475939X.2016.1174730

Williamson, B., & Eynon, R. (2020). Historical threads, missing links, and future directions in AI in education. *Learning, Media and Technology, 45*(3), 223–235. https://doi.org/10.1080/17439884.2020.1798995

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education. *International Journal of Educational Technology in Higher Education, 16*(1), 39. https://doi.org/10.1186/s41239-019-0171-0

Zhao, Y. (2022). Who is afraid of AI? Ethical challenges in educational contexts. *British Journal of Educational Technology, 53*(5), 1271–1287. https://doi.org/10.1111/bjet.13198