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Adaptability and Outcomes of AI-Driven Personalized Learning: A Study among University Students in Pakistan

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Abstract

The current study discloses the adaptability and subjective viability of individualized learning technologies, which are driven by Artificial Intelligence among Pakistani university pupils with regards to academic achievement in the form of inspiration, reading and writing skills, critical thinking, and self-managed learning. Using the Elaboration Likelihood Model (ELM) and Self-Directed Learning (SDL) theory, the mixed-methods approach was used to examine the role of the demographic variables including the pattern of use and motivation of the students in connection with the AI usage on the outcome of the learning process. The questionnaire was prepared in a tabular format and administered to 500 students in various learning institutions. The quantitative analysis focuses on the fact that students consider AI tools to be highly effective, especially when they are supposed to produce superior academic writings, as well as when they are supposed to be capable of producing multiple ideas. The perceived effectiveness of gender differences was high among female students compared to male students ($p = 0.015$), and students with higher GPAs and students between the age of 21 and 23 years had more positive perceptions concerning AI. The AI use was significantly correlated with self-directed learning ($r = 0.58$, $p < .001$) and it implies that AI promotes the ability of learners to work independently. It was also observed that the students who utilize AI enhance their learning experiences. Besides, the issue of ethical concerns was also reported among rural students. The qualitative study had positive outcomes in terms of enhancing personalized pacing and the improvement of academic outcomes as well as the development of independent learning. This paper suggests that AI should be utilized and incorporated into teaching systems to facilitate the use of digital in the higher education industry.

Keywords: Personalized learning, AI, ANOVA, Pearson correlation

1. Introduction and Literature Review

1.1 Introduction

With the growing influence of artificial intelligence in education, it has reshaped the traditional way of learning with a high-tech intelligent learning mechanism. Artificial learning driven learning has transformed the educational content, delivery, and pace to meet the needs of a learner. Artificial intelligence is quick, available in real time, and can monitor progress and offer instant feedback, due to which enhances the overall learning experience. In the higher education sector, students are asked by professors for numerous academic tasks; therefore, AI has been an easy way to accomplish these tasks with ease and efficiency. According to Zohuri & Mossavar-Rahmani (2024), the traditional classrooms and the way of acquiring educational content were time-consuming and restricted personalized learning. AI has helped in providing accessible learning within the reach of a learner. Now, the educational institutes are embedding various AI assistants in their systems to offer learners real-time support. These tools not only boost analytical thinking, self-responsibility, creativity, and academic performance. Al-Zahrani & Alasmari (2025) state that in advanced countries, the adoption of AI is very quick, which is supported by digital transformation infrastructures and well-designed strategies. While in countries like Pakistan, its adoption in the educational system is still a huge task. There is a promising interest among the learners regarding AI. Still, there is a growing trend of using AI among students, especially in urban educational institutes. They are using various tools of AI, such as ChatGPT, Google Bard, Grammarly, and Khan Academy's AI.

There are 200 educational institutions in Pakistan with more than 3 million students. This system is experiencing a major transformation with the advent of AI. However, there are severe issues in providing internet access, device accessibility, and digital literacy between urban and rural areas. If these issues are sorted, they can help students in rural or urban areas with strong support in personalized learning. The other important factor is the desire of teachers or instructors and institutions to integrate AI in teaching. Research, including Hess (2008), has highlighted the conflict between the faculty members on account of the lack of training and fear of being phased out of the system by intelligent systems. The adoption of AI as an educational tool is not yet full in Pakistan, and most of the university faculty is either unaware of such technologies or skeptical about their usefulness. It is highly significant to bridge this gap so that the orchestration of personalized learning led by AI can be not merely a self-directed, informal endeavor but a standard scholastic practice with the backing of faculty, prospectuses and university policies. The ability to think and perceive an individualized education is a skill that is being increasingly accepted as a great 21st century skill, and this aspect is called self-directed education. The capability to establish educational objectives, self-screening, and self-reflection makes students strong enough to oversee their educational paths. In such an area of Pakistan where the supply is usually scarce and the number of students to the teacher is high, AI can be used as a computer-generated/ virtual teacher that is assisting students in locating complicated academic practices as well as aiding them in gaining trust in their academic ability. The potential of AI-based personalized learning in Pakistan, however, is determined by many situational factors. To begin with, digital infrastructure should be enhanced. Second, the faculty and the students of the institutes should be competent. Third, artificial

intelligence use should be controlled by having a policy background that is industrialized. Lastly, limited research is required to understand the ways in which cultures, language, and socio-economic factors affect the application and utility of AI in education.

The proposed study thus seeks to address this gap and carry out research on the flexibility and implications of AI-driven personalized learning among students studying in various universities in Pakistan. It is based on a structured, data-driven methodology to measure the level of understanding AI tools, AI usage patterns, the perceived benefits, and difficulties students experience. It also identifies the demographic factors of age, gender, GPA, and regional locations that could be a contributing factor to the differentiating use of AI by students. The research study provides useful insights into the current situation with the AI implementation in the Pakistani higher educational systems by considering the data provided by 500 students at four universities. The findings of this work are expected to contribute to academic literature, illuminate organizational practices, and provide guidelines to policymakers on the development of ethical, holistic and sustainable frameworks of AI integration. With Pakistan striving to make its education department as consistent with global standards as possible, adopting and utilizing AI is not only a technological necessity, but an educational one. In the long run, it will be hoped that AI will support rather than become an obstacle and increase the divergence that is already present.

1.2 Research Objectives

1. To estimate students' efficiency of AI tools in refining academic outcomes such as motivation, writing skills, analytical and abstract thinking, and learning confidence.
2. To test the correlation between the frequency of the use of AI tools and self-directed learning behaviors of students.
3. To identify gender, age, and academic performance (GPA) differences in the perceived effectiveness of AI tools.
4. To investigate the ethical issues and satisfaction of students when using AI in education.
5. To explore unstructured data on the role of AI tools to promote learner agency and individual learning speed.

1.3 Research Questions

1. How effective do AI tools seem to be in promoting academic motivation, writing abilities, critical thinking, and confidence in university students?
2. Does the frequency of using the AI tools have a strong correlation with self-directed learning abilities of students?
3. Are there significant differences in perceptions of the effectiveness of AI tools based on gender, age group and GPA level?
4. How do the students feel about the ethical side of using AI and how does it vary depending on the region?
5. What is the overall student satisfaction with learning with AI engagement?

1.4 Literature Review

Researchers all over the world have been interested in the introduction of AI into the education sphere. The multiple researchers have examined the multiple applications and advantages of AI-based personalized learning tools. In the study, Hashim et al. (2022) have performed a systematic review of AI trends in education and have identified the three trends of adaptive learning, intelligent tutoring systems, and learning analytics. This knowledge makes a learner-centered approach whereby instruction is adjusted according to the student performance. The article by Gligorea et al. (2023) highlighted the broad scope of technologies that facilitate AI implementations that are machine learning algorithms, natural language processing, and computer vision tools. These technologies are the core of the personalized learning system as they allow analyzing data in real-time and delivering content according to it Pedro et al. (2019) noticed that the AI related to personalized learning has been implemented, but the issues of data confidentiality and fairness are to be tackled. Indeed, Hess (2008) observed that the faculty confrontation is still one of the obstacles to AI adoption in teacher training methods. Conversely, Kayyali (2024) also noted that AI systems have the capability to identify personal learning styles, which makes the learning experience more operative and personal. In addition, Costa (2023) explained the role of AI tools in explaining the e-learning experience by using virtual instructors, automated tests, and custom-made content delivery. The paper emphasized the role of ethical design and especially in AI distribution. Liando and Tatipang (2024) explored how AI can transform the learning process and, in their findings, they conclude that personalized learning is no longer a hypothetical notion, but a practical reality with the enhanced AI. The study by Holstein et al. (2019) focused on the relationships between educators and AI-based decision-support systems in classroom settings in real-time. They found that although AI tools would provide real-time feedback, the instructors would find it difficult to interpret the output, and this would limit their effectiveness until they practiced it. Zawacki-Richter et al. (2019) demonstrated the international evaluation of the integration of AI in the system of higher education. They discovered AI to be most tangible and most effective in organizational automation, predictive analytics and adaptive content delivery, and made concerns regarding data confidentiality and algorithmic bias. Chen et al. (2020) revisited the impact of AI-based chatbots on the engagement of students. Their mixed learning environment experimental study showed a great improvement in student satisfaction and understanding between students who interrelated with AI chat-bots. Luckin et al. (2016) offered a model of the concept of how AI could sustain teaching and learning. Their concept of Intelligence Infrastructure demonstrates how AI may be integrated to filter the advances, prescribe measures, and aid in the organization of the classroom. Seo et al. (2021) discussed intelligent teaching system learning analytics. The researchers observed that there were great correlations between AI feedback applications and STEM education performance development among undergraduates in developing nations. Schiff (2021) critically analyzed AI ethics and concluded that most of the existing systems are not clear. The paper has underscored the necessity of regulating error and ethics that are culturally situational at the time of applying AI in various education systems.

1.5 Theoretical Framework

The two introductory theories that guide the proposed study are Elaboration Likelihood Model (ELM) and Self-Directed Learning (SDL) Theory, which taken together can serve as the overall perspective through which

the interaction of students with AI tools in the academic setting can be analyzed. The Elaboration Likelihood Model (ELM) is the model created by Petty and Cacioppo (1986) in order to explain the processing that people have to do with data via the two routes: one is the central route (in-depth, reflective thinking), and the other one is the peripheral route (superficial, quick thinking). ELM, in this research, will be employed to understand the cognitive use by the students of AI tools, including whether they apply them judgmentally in writing academic texts and learning, or they use them passively. The differences in the levels of perceived effectiveness among the GPA and age groups replicate the variation in explanation and the higher-performing students tend to be more extensively involved through the central route.

The Self-Directed Learning (SDL) Theory which was proposed by Knowles (1975) underlines the autonomy of the learner in categorizing the learning needs, establishing objectives and determining progress. These SDL characteristics are promoted by AI applications that can provide individual feedback, intelligent guidance, and learning routes. This theory is predetermined by the persistence of the strong association between academic work with the use of AI and self-directed learning found in the study, which indicates that the active use of AI promotes self-sufficiency, self-motivation, and self-control in academic activities. Combined, ELM and SDL offer a solid theoretical base that can be used to study the impact that AI tools have on the learning process of students and its overall academic implications.

2. Methodology

The research design adopted in the study was a mixed-methods one to unravel the flexibility and academic implications of AI-powered personalized learning tools on university students in Pakistan. The system piloted a cross-sectional survey based on a structured questionnaire, which was constructed through validated instruments and literature and subject experts about content validity. The sample was a group of 500 students who were chosen using stratified random sampling and were representative in terms of gender, age, GPA level and geographical area. The questionnaire contained questions about the use of AI tools, the perceived academic outcomes, self-directed learning and ethical issues on a 5-point Likert scale. The internal consistency of the instrument was confirmed as the Cronbach alpha was 0.84, which is high. The SPSS (Version 26) was used to provide quantitative data analysis by means of descriptive statistics, independent samples t-tests, one-way ANOVA, and a Pearson correlation to detect patterns and relationships. Besides, thematic analysis was applied to qualitative answers to obtain more profound understanding of perceptions of students regarding their sense of autonomy, learning speed and digital ethics. Ethical permission was obtained through the Institutional Review Board that was in place and the participants were also given information regarding the voluntary nature of the study and were guaranteed anonymity and confidentiality.

2.1 Data Analysis

Table 1: Reliability

Instrument Section	Number of Items	Cronbach's Alpha
AI Tool Usage Patterns	5	0.81
Perceived Academic Outcomes	6	0.85
Self-Directed Learning	4	0.83

Instrument Section	Number of Items	Cronbach's Alpha
Challenges and Ethical Concerns	5	0.78
Overall Scale	20	0.84

According to commonly accepted thresholds, a Cronbach's alpha value above 0.70 indicates acceptable internal consistency, and values above 0.80 are considered good. With an overall score of 0.84, the instrument demonstrates strong reliability. Each subsection of the questionnaire also exhibits acceptable to high consistency, confirming that the items within each construct reliably measure the intended concepts.

The perceptions and attitudes of the students were measured using a 5-point Likert scale (with the options being Strongly Disagree, Strongly Agree, etc.). To enhance the questionnaire accuracy, clarity, relevancy and reliability, the 20-item questionnaire was pre-tested on a pilot sample (30 students). Small changes were made depending on feedback. The resulting tool was then made available online (through Google Forms) and offline, when institutions had access to it, which was inclusive of the students that have less access to digital tools.

The questionnaire has been created on the foundation of an extensive analysis of the available literature on the topic of AI in education (e.g., Gligorea et al., 2023; Costa, 2023; Pedro et al., 2019). Three educational and technological scholars at other universities were then consulted to make sure that the questions are inclusive of the core constructs of AI exposure, perceived outcomes, self-directed learning, and ethical challenges.

Table 2: Demographic Profile of Respondents

Category	Sub-Category	Frequency (n)	Percentage (%)
Gender	Male	260	52%
	Female	240	48%
Age Group	18–22 years	225	45%
	23–27 years	190	38%
	Above 27 years	85	17%
GPA Range	Above 3.5	105	21%
	3.0–3.49	220	44%
	2.5–2.99	145	29%
	Below 2.5	30	6%

This merged demographic profile presents a balanced sample of 500 students. Gender distribution is nearly even, enabling equitable gender-based comparisons. Most respondents are aged 18–27, reflecting a typical

university-age population. GPA data shows that a significant portion of students fall within the 3.0–3.49 range, suggesting a generally average-to-above-average academic profile. This demographic mix is appropriate for evaluating AI adaptability across diverse student segments.

Table 3: AI Tool Usage Frequency by Age Group

Age Group	Daily Use (%)	Weekly Use (%)	Rare Use (%)
18–22 years	22%	51%	27%
23–27 years	14%	62%	24%
Above 27 years	9%	58%	33%

Younger students show more frequent daily usage, indicating higher adaptability and willingness to explore AI tools independently.

Table 4: Independent Samples t-Test (Gender)

Variable	Gender	M	SD	t	df	p	Interpretation
Perceived Effectiveness	Male (n=240)	4.10	0.68	-2.45	498	0.015*	Significant difference
	Female (n=260)	4.28	0.65				Female students reported higher scores

Note: *$p < .05$ indicates a statistically significant difference.*

Table 5: One-Way ANOVA (Age Group)

Age Group	n	M	SD
18–20 years	180	4.05	0.69
21–23 years	220	4.27	0.61
24+ years	100	4.18	0.72

ANOVA Results: F (2, 497) = 4.21, p = 0.016*

There is a statistically significant difference in the perceived effectiveness of AI tools among different age groups. Post-hoc comparisons (Tukey HSD) revealed that students aged 21–23 perceived AI tools as significantly more effective compared to those aged 18–20.

Table 6: One-Way ANOVA (GPA)

GPA Range	n	M	SD
Below 2.5	80	3.89	0.75
2.5–3.5	260	4.22	0.62
Above 3.5	160	4.35	0.58

ANOVA Results: F (2, 497) = 9.67, p < 0.001*

There is a highly significant difference in the perceived effectiveness of AI tools based on GPA. Students with a GPA above 3.5 reported the highest perceived effectiveness. Post-hoc tests confirmed significant differences between each group.

Table 7: Correlation Between AI Usage and Self-Directed Learning

Variable 1	Variable 2	Pearson r	p-value
AI Tool Frequency	Self-Directed Learning	0.58	<0.001

The positive and significant correlation shows that more frequent AI tool usage is associated with greater self-directed learning skills.

Table 8: Perceived Effectiveness of AI Tools in Improving Academic Outcomes

Item	M	SD	SD (%)	D (%)	N (%)	A (%)	SA (%)
AI tools help me stay motivated during academic tasks.	4.12	0.73	2%	4%	12%	58%	24%
AI tools improve the quality of my academic writing.	4.35	0.61	1%	2%	8%	54%	35%
Using AI tools helps me think more critically about academic content.	3.78	0.85	3%	7%	19%	48%	23%
AI tools assist in organizing my ideas clearly for assignments.	4.25	0.67	1%	3%	10%	56%	30%
AI-based feedback helps me reflect on my learning strategies.	4.01	0.76	2%	6%	15%	52%	25%
I feel more confident completing assignments with the help of AI tools.	4.18	0.70	1%	4%	11%	55%	29%

The data provided in Table 8 demonstrate the way students evaluated the efficiency of AI tools to enhance the range of academic results, including six Likert items. In general, the reactions demonstrate a highly positive perception. The most consensus was also noted on the item: AI tools enhance the quality of my academic

writing (M = 4.35, SD =0.61) where 89 percent of participants chose Agree or Strongly Agree. It implies that AI is especially helpful to students in improving the organization, clarity and cohesion of the written text.
In the same way, students demonstrated a high degree of consensus in the aspect of AI in developing confidence (M = 4.18) and in organizing ideas (M = 4.25) with more than 80 percent giving positive responses in both aspects. It also influenced motivation positively (M = 4.12), with 82 percent of them concurring that AI tools can maintain their academic motivation. Conversely, the item associated with critical thinking was rated slightly lower (M = 3.78) and 71% said it works, which is to say that although AI tools are associated with higher-order thinking, students might still find them somewhat wanting in the one-dimensionality of encouraging deep thinking. Also, the scale that evaluates the contribution of AI to improving metacognitive reflection (AI-based feedback helps me reflect on my learning strategies) had a mean of 4.01, and 77% respondents agreed.

Table 9: Writing Skill Improvement by Gender

Gender	Improved Writing (%)	No Change (%)	Total N
Male	61%	39%	260
Female	70%	30%	240

Female students report greater perceived improvements in writing skills, possibly due to more sustained engagement with AI writing assistants.

Table 10: Ethical Concerns About AI by Region

Region	High Concern (%)	Medium Concern (%)	Low Concern (%)
Punjab	29%	43%	28%
Sindh	31%	37%	32%
KPK	42%	40%	18%
Baluchistan	45%	39%	16%

Students from underdeveloped regions report greater ethical concerns, suggesting digital trust gaps and a need for awareness.

Table 11: Satisfaction by Weekly AI Usage

Weekly AI Usage	Mean Satisfaction	SD	N
<2 hours	3.1	0.73	102

Weekly AI Usage	Mean Satisfaction	SD	N
2–5 hours	3.9	0.56	198
>5 hours	4.4	0.44	200

Student satisfaction increases significantly with higher AI tool engagement, reinforcing the value of personalization in learning.

Qualitative Part

Theme: *Autonomy and Personalized Pace*

Many students commented that AI allowed them to "learn at their own speed" and "feel more confident before class discussions." This suggests that beyond quantitative impact, AI fosters emotional comfort and cognitive control, which are crucial in learner-centered education.

3. Discussion

This paper sought to investigate the perceived usefulness of the AI tools in helping university students in Pakistan to achieve academic outcomes such as motivation, writing and self-directed learning. The results show that the overall student involvement in AI tools is high and the attitude towards their influence is positive in the academic and cognitive spheres. The reliability data (Table 1) indicates that the internal consistency is high in the subscales within the instrument and all the Cronbach alpha values are significantly more than and recommended 0.70 level (Nunnally and Bernstein, 1994). The average level of scale reliability 84 is an indication that the instrument employed to assess AI tool usage, perceived academic outcomes, self-directed learning and ethical concerns can be considered reliable and helpful to conduct further analysis. According to the demographic distribution (Table 2), the sample of the study is well-balanced and regarding gender, age, and GPA, subgroup comparisons are robust. Table 3 shows that younger students (18-22) used AI tools per day, which implies that they can become more flexible and are willing to adopt new technologies. This is in line with the existing literature that indicates that younger users tend to be more susceptible to new digital learning spaces (Pedro et al., 2019). An independent samples t-test based on gender (Table 4) showed that female students thought that AI tools were much more effective (M = 4.28) than their male colleagues (M = 4.10, p =.015). This can be an indication of more female students being willing to use AI to improve academic performance, especially in writing activities (as Table 9 also confirms, and 70 out of 100 female participants reported to have been helped with writing more than 61 out of 100 of their male counterparts).

Additional statistical analysis with one-way ANOVA showed statistically significant age group and GPA band differences in the perceived effectiveness of AI (Table 5 and Table 6). Those students between 21 and 23 years old showed the highest perceived effectiveness (M = 4.27) which could be attributed to the fact that they are at the transitional stage of their academic years and such tools become necessary to handle workloads. Students who mentioned that they benefited the most with the use of AI tools were those with a GPA over 3.5 (M =

4.35), and it is possible that students with an academic high performance can make more effective use of AI tools, perhaps to perfect their work or expand their learning abilities.

The high positive interrelation between the use of AI tools and self-directed learning ($r = 0.58$, $p < .001$; Table 7) indicates that there is a strong connection between the frequent exposure to AI and the independent academic interaction. This resonates with the studies of Gligorea et al. (2023) that AI can serve as a scaffolding of autonomous learning if it is properly adopted.

Table 8 confirms the hypothesis that students have a conclusive opinion about AI tools as being effective particularly in academic writing ($M = 4.35$), organization of ideas ($M = 4.25$), and confidence building ($M = 4.18$). Although motivation ($M = 4.12$) and reflective learning ($M = 4.01$) were also positively influenced, relatively low ratings were given to critical thinking ($M = 3.78$), which could indicate that AI tools might be more valuable with respect to facilitating surface-level academic activities, as opposed to a deeper intellectual experience. This observation is consistent with the claim of Costa (2023), who contended that although AI may be useful in academic production, it cannot be used to produce higher order thinking without instructional mediation.

Regarding the ethical issues (Table 10), KPK and Baluchistan students had greater concern levels regarding the use of AI, which possibly indicates the lack of digital literacy and access in the regions. These results emphasize that the necessity to mitigate trust cracks and ethical consciousness should be considered via specific digital policy programs.

Lastly, Table 11 is confirmation that student satisfaction is positively related to time spent on AI tools. The highest satisfaction was found in those who use AI more than 5 hours per week ($M = 4.4$), as opposed to those who use it less than 2 hours ($M = 3.1$). The suggested relationship is compatible with the idea of a reinforcing cycle, where the more engagement one has, the higher the perceived value, which encourages the use of the product/service even more often.

These results are further reinforced by qualitative answers. Themes of independence and personalized speed appeared as some of the major advantages, and students mentioned that AI enabled them to learn at their speed and feel more confident when participating in classes. It means that AI tools do not facilitate academic capabilities only but also the emotional security and learner agency elements of self-directed learning.

4. Conclusion

This research paper concludes that university students in Pakistan consider AI tools to be effective tools in improving the academic performance especially in writing, organization, and motivation. Also, the results indicate gender, age, and gender-based GPA disparities in AI perceptions and the strong association between AI use and self-directed learning. Nevertheless, the comparatively moderate effect on critical thinking and the higher levels of concern among the students in less digitally developed areas imply that AI integration strategies require a more inconclusive and comprehensive approach. These findings can be used by education

policymakers and university leaders to enhance equitable applications of AI, educate on ethical and critical engagement with AI, and support instructional structures to position AI as a tool to the continued intellectual development. The following studies must be longitudinal and should attempt to determine the impact or the advantages of AI in higher education through the lens of instruction design.

Recommendations

Based on the results, the following recommendations can be suggested:

1. To be more specific, universities should offer workshops and training to students and faculties to gain digital literacy with regards to AI.
2. Artificial intelligence gadgets should form an official curriculum alongside other learning tools rather than an extra-curricular activity amongst students.
3. To avoid AI abuse in education, institutions ought to devise clear guidelines on how AI ought to be applied in an ethical manner to inspire confidence.
4. It would need to invest in internet connection, online labs, and access to AI devices, especially in the less developed nations.
5. The disconnect between pedagogy and technology must be resolved through practical participation of faculty in the use of AI in teaching and assessment.

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