

# Empowering Minds: Transformative Effects of AI on Students' Critical Thinking and Problem-Solving Skills

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## ABSTRACT

**Aim of the study:** This study aimed to investigate the impact of the use of AI tools on academic engagement and critical thinking among university students in Karachi.

**Methodology:** The study used a preliminary exploratory mixed-methods design with a sample of 165 bachelor's students, selected through equal stratified randomization from seven public universities on University Road, Karachi, Pakistan. The study used a self-administered questionnaire with 36 closed-ended and 3 open-ended questions to collect data. The tool showed strong overall reliability, as indicated by Cronbach's alpha ( $\alpha = 0.753$ ).

**Findings:** Results revealed a significant but negative relationship between AI use and academic engagement ( $r = -.402$ ), and regression analysis demonstrated that AI use was associated with a 91.7% decrease in critical thinking ( $R^2 = .917$ ,  $\beta = -.958$ ). Moreover, academic engagement and critical thinking were positively related ( $r = .369$ ). Thematic analysis identified three themes: academic use of AI, benefits of AI, and challenges of AI, which fully corroborated the quantitative findings.

**Conclusion:** The study concludes that uncontrolled reliance on AI significantly weakens students' critical thinking and academic engagement; however, AI can be helpful and efficient for academic tasks, and excessive reliance on it could hinder the development of vital cognitive skills. The study suggests promoting balanced AI use, integrating research and inquiry into academic practice, and raising awareness of AI ethics education. Besides, there is an urgent need to make AI literacy obligatory in Pakistani university curricula and to provide formal training in the ethical use of AI to all faculty and students.

**Keywords:** Artificial Intelligence (AI), Critical Thinking, Problem-solving, Academic Engagement, AI Dependency, University Students.

## Article History

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# 1. INTRODUCTION

In the current era, the influence of Artificial Intelligence (AI) has spread from everyday tasks to decisions in important areas such as health, finance, and administration (Imran et al., 2025; Safdar et al., 2020). The rapid rise in AI's popularity is due to its unique ability to collect data, predict the future, and develop the best course of action. Despite skepticism from teachers and students, the integration of AI into the education system has been very rapid and widespread. A major question being raised regarding this technology is what impact AI tools are having on students' mental and intellectual development. Therefore, this study examines these real-world effects of AI so that policymakers, teachers, and parents may use it effectively while avoiding risks. However, given the limited empirical evidence on this topic, particularly in the regional context, the current study adopts a preliminary exploratory approach to generate initial insights that may enlighten upcoming large-scale surveys.

## 1.1 *AI in Education*

The incorporation of AI into education systems entails first training the tool to recognize students' cognitive patterns and preferred learning styles, and then planning the most suitable teaching methodology (Chu et al., 2022). AI's ability to perform both teaching and assessment tasks with equal skill is the main reason for its use in education. This means AI can handle both complex processes simultaneously with great speed and accuracy (Rehman & Sajjad, 2025a). This multi-purpose feature of AI makes it an indispensable tool for schools and colleges. This technological innovation is currently unable to bring about any major or radical change (overhaul) to the education system. Nevertheless, personalized learning and improved student outcomes indicate that we are moving in the right direction (Safdar et al., 2026; Safdar et al., 2026a; Malik et al., 2023). Instructional tools that analyze student behavior through algorithms have the potential to revolutionize pedagogy. This cutting-edge technology makes it extremely easy for students to learn more effectively and at a faster pace (Alhumaid et al., 2023; Saleem et al., 2025). However, the repertoire of AI tools used in education includes intelligent tutoring programs that provide individualized lessons tailored to each student's needs. This technology also includes simulated learning environments and more objective grading (Navarro et al., 2023). These intelligent learning aids take into account students' unique learning styles and specific learning methods and generate reports that provide valuable feedback to improve their performance and grades (Wang et al., 2022). They help students identify their academic weaknesses and provide highly personalized guidance to make their learning process more effective.

The use of simulated environments for training and education has long been around, but it has become more sophisticated than ever. Under AI supervision, these environments can now provide students with more effective responses and a more accurate imitation of the real world than in the past (Navarro et al., 2023). An intelligent environment not only guides the learning experience but also addresses its shortcomings by modifying the virtual world (Jain & Raghuram, 2024). Training runs, experiments, spatial exploration of complex concepts, and collaborating with peers in these simulations are heavily facilitated by AI (Malik et al., 2023). Furthermore, AI-powered student assessment tools are a relief for educators and students alike (Sánchez-Prieto et al., 2020). Where a pile of tests or papers used to mean hours upon hours of scrutiny on the evaluators' part, the same amount of work can now be taken over by a confident, intelligent computer program (Grájeda et al., 2024). AI can shorten the time frame for students to receive consistent, high-quality feedback (Alhumaid et al., 2023). Since AI is enabled by machine learning technology that allows it to build on itself, educators need only revise instructional plans before delivering them to students (Van den Berg & du Plessis, 2023). This revision and feedback from instructors and students are invaluable in helping AI evolve and become more valuable and resourceful than ever (Sánchez-Prieto et al., 2020). These developments are a beacon of hope for most of the pedagogical community, who expect it to lay the foundations for deeper engagement with course content and facilitate academic success and literacy for an increasing number of people (Van den Berg & du Plessis, 2023).

## ***1.2 Importance of Critical Thinking and Problem-Solving Skills***

Critical thinking and problem-solving skills are essential for the most basic operations of modern life. Together, these terms encompass an individual's ability to analyze information, evaluate evidence, and make informed decisions based on that evidence (Darwin et al., 2024; Exintaris et al., 2023). Not only do these attributes boost one's progress academically, professionally, and socially, but they also provide immense personal satisfaction (Sholihah & Lastariwati, 2020). Many of the world's problems, from the largest to the smallest, can be attributed to a lack of competent, intelligent, and strong leadership, in which both critical thinking and problem-solving skills are integral (Obidovna, 2024).

Critical thinking empowers individuals not only to navigate complex challenges and arrive at creative solutions but also to maintain healthy objectivity throughout the process (Darwin et al., 2024; Rehman & Sajjad, 2024). According to Lu and Xie (2024), critical thinking fosters a strong sense of curiosity and generates questions that catalyze individual and group growth. These individuals strive to identify root causes and flaws and to easily diagnose an uneven strategy or a misdirected project. Therefore, developing critical thinking is a crucial aspect of fairness in any field, as it enhances problem-solving and decision-making (Obidovna, 2024). These problem-solving skills involve identifying the problem, determining the root cause, generating a primary or alternative solution, and implementing strategies to address it (Okes, 2019). However, a healthy set of problem-solving skills must include extensive planning, flexibility in strategy use, resilience, resourcefulness, improvisation, and learning from trial and error (Maries & Singh, 2023). Various studies have shown that honing and polishing critical thinking and problem-solving skills in an increasingly interconnected and ever-changing world enables individuals, societies, and organizations to overcome hurdles and contribute more easily and meaningfully (Obidovna, 2024; Sajjad et al., 2019).

At any educational level, developing students' critical thinking and problem-solving skills is an essential focus for teachers and educational organizations (Yeung et al., 2023). Scholars Xu et al. (2023) stated that the continuous infusion of critical thinking and problem-solving skills into students is as important as instructing them on how to apply these skills effectively. Such students become enthusiastic learners capable of analyzing and articulating concepts and producing gold-standard arguments rooted in independent thought. To encourage these mental models, administrative educators are trained to nurture inquiry-based learning and to welcome alternative approaches proposed by students (Sajjad et al., 2019).

## ***1.3 The Role of AI in Enhancing Critical Thinking and Problem-Solving Skills***

Advocacy for AI technology hinges on its promise of faster, more innovative, and more accessible tools (Rehman et al., 2024). It is undeniable that AI brings a revolutionary impact wherever it is applied. In educational practice, AI is expected to similarly take a massive amount of labor off the hands of human professionals and students (Exintaris et al., 2023; Grájeda et al., 2024). AI may consistently produce high-quality work at superior speeds. Many core resources used by students and teachers may be replaced by AI, with highly desirable cost and time savings (Rehman & Sajjad, 2024). A standard AI model has no limitations in adapting to the needs of students and teachers (Galindo-Domínguez et al., 2024). This technology can design ideal learning experiences for each student and help them sort through vast amounts of information to find useful content. Commercial and analytical assessments of student performance provide teachers with actionable information to easily identify students' strengths and weaknesses (Hapsari & Wu, 2022; Rehman et al., 2023). Based on these results, teachers can better adapt their teaching methods and strategies to each student's intellectual needs.

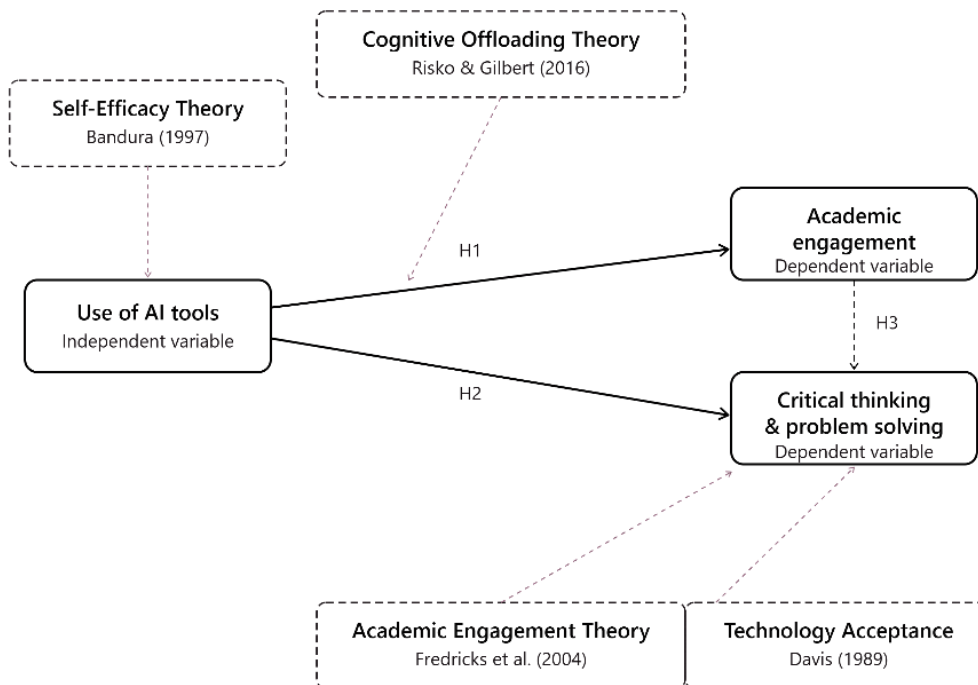
According to Exintaris et al. (2023), using AI-generated answers as prompts can improve students' metacognitive awareness, thereby changing the way students think and developing in-depth evaluation and critical thinking skills. This AI-generated content in educational environments not only enhances collaborative learning among students but also increases their interest in studying, which plays an important role in developing students' sophisticated problem-solving skills, enabling them to think at the micro level and solve difficult problems. Furthermore, this method serves as an excellent educational

support and guide, especially for incoming university students, helping them address initial learning difficulties and contributing to the development of sophisticated problem-solving skills, particularly through appropriate scaffolding. Also, literature shows that AI-generated materials and support, such as creating lesson plans and preparing assignments, play a significant role in enhancing critical thinking and problem-solving skills among teachers and students (Balouch et al., 2025; Liu et al., 2023; Van den Berg & du Plessis, 2023). Furthermore, Darwin et al. (2024) reported that AI-powered tools are more effective at improving language proficiency and enhancing critical thinking skills. These tools are widely used and significant in the field of education, especially in academic research, where we require more time to think critically and evaluate. These AI tools can analyze large volumes of text, expedite literature reviews by scrutinizing existing theories, detect themes, trends, and gaps, and aid in formulating research questions (Rehman & Sajjad, 2025b). Likewise, previous studies have highlighted that AI facilitates higher-order cognitive skills in the 21<sup>st</sup> century by providing a structured framework for leveraging technology to cultivate critical thinking and problem-solving (Darwin et al., 2024; Exintaris et al., 2023).

### 1.4 Theoretical Framework of the Study

The study was based on four cutting-edge theories: Cognitive Offloading Theory, Self-Efficacy Theory, Academic Engagement Theory, and Technology Acceptance Model (TAM), as shown in Figure 1. Cognitive Offloading Theory, proposed by Risko and Gilbert (2016), posits that when humans offload mental tasks to external resources, such as AI, their cognitive and critical-thinking abilities are impaired, a finding directly linked to the current study's hypothesis 2. Self-Efficacy Theory by Bandura (1997) posits that when students rely on AI, their self-confidence is weakened, affecting both academic engagement and critical thinking, thereby providing a theoretical basis for hypotheses 1 and 3. Whereas Academic Engagement Theory by Fredricks et al. (2004) suggests that students' behavioral, emotional, and cognitive engagement directly improves their critical thinking and academic performance, providing the theoretical basis for hypothesis 3. The last theoretical model, TAM (Davis, 1989), suggests that students accept AI tools because they find them convenient and useful, but that this acceptance can become a blind dependence that undermines academic engagement and critical thinking, providing theoretical context for all three hypotheses.

**Figure 1:** Theoretical Framework



## **1.5 Research Gap**

The current study is designed to examine in depth the impact of the growing use of AI in the educational process on students' independent research, classroom discussion habits, and critical thinking and problem-solving skills. This means that the research not only looks at the general use of technology but also examines whether AI is making it possible for students to become engrossed in independent research work and speak openly in class without hesitation, or to slow down their mental capabilities when working on their own. The literature mainly focuses on the benefits of AI in education (e.g., Khalilova et al., 2025), while some studies shed light on the practical uses of AI tools in educational environments (e.g., Qin & Wang, 2022). However, a significant gap remains in understanding its subtle effects on students' intellectual capabilities. Furthermore, previous research has only revealed educational facilitation (e.g., Stadler et al., 2024), without illuminating whether the technology refines students' minds or dampens their intellectual capabilities. As a consequence, this study examines the effect of overreliance on AI to determine the extent to which it is beneficial and the extent to which it begins to erode students' critical thinking and problem-solving. Besides, there was a dire need for an empirical study that validates the effects using data from real school environments, rather than just slogans.

## **1.6 Study Objectives**

1. To evaluate the nature and frequency of use of AI tools among students,
2. To examine the impact of the use of AI tools on students' academic engagement and independent research,
3. To explore the relationship between the use of AI tools and students' critical thinking and problem-solving skills,
4. To analyze the relationship between academic engagement and critical thinking,
5. To assess students' perceptions, benefits, and challenges regarding the use of AI for educational purposes.

## **2. METHODOLOGY**

This preliminary exploratory study used a mixed-methods (QUAN-Qual) research design, combining quantitative and qualitative analyses on a one-page basis to examine the impact of AI tools on students' academic engagement and critical thinking and problem-solving skills. The main purpose of adopting a mixed-methods design was to strengthen the validity of the findings through triangulation: themes derived from open-ended questions (academic use of AI, benefits, and challenges) were used to further confirm and interpret the quantitative findings.

### **2.1 Sampling**

The study population included all bachelor's-level students from seven major universities in Karachi, regardless of age and gender; these universities were: University of Karachi, NED University of Engineering & Technology, Sir Syed University, Federal Urdu University of Arts, Science, and Technology, Dow University of Health Sciences, Metropolitan University Karachi, and Al-Kawthar University. However, these universities were selected through convenience sampling because they are all located near the central educational hub of University Road in Karachi, Pakistan. These universities were selected because they are the largest and most well-known public and private educational institutions in Karachi, serving a diverse student population. Since this is a preliminary and exploratory study, it was considered necessary to limit the sample to a specific geographical area to maintain data quality and methodological consistency (Creswell & Creswell, 2018); However, future research should include more universities in Karachi.

However, these large universities comprise multiple faculties and departments, which made it practically difficult to collect uniform, fully representative data across all departments of each institution. Therefore,

the current sample was taken as a convenience-based cross-section rather than a complete department-wise representation of each university, and department-wise stratification should also be included in future research. Consequently, a sample of 175 university bachelor's students was selected using an equal stratified allocation method, with 25 students from each university, which constitutes 14.3% of the total sample. Thus, these universities were each represented equally at 14.3%, so no single institution had a dominant influence on the results (Cochran, 1977). The final selection of 25 students at each university was made through purposive sampling, including only students with a CGPA of 3.0 or above. Hence, the overall sampling strategy was stratified-cum-purposive rather than purely equal random stratified sampling; universities were selected on a convenience basis, while students within each university were selected on a purposive (CGPA-based) basis. The requirement of a  $CGPA \geq 3$  was imposed because such students are considered more academically engaged and more knowledgeable in using AI tools, and research shows that students with higher academic performance display more critical thinking and more knowledgeable interaction with technology (Wang, 2026; Xu et al., 2024). However, this requirement limits the sample's generalizability to students with lower CGPAs, a major limitation of this study. For the pilot testing, 10 of 175 students were randomly selected to avoid introducing bias in the selection of the final sample. Since including the pilot testing data in the final analysis could have compromised the methodology's purity, it was excluded from the final sample, resulting in a final sample of 165 students. This sample size is considered sufficient and appropriate for such preliminary and exploratory studies (Cochran, 1977).

## **2.2 Research Instrument**

A self-developed questionnaire was used to collect data in this study, which included both closed- and open-ended questions, and was based on the study's objectives, existing literature, and the conceptual framework. However, the first three sections (Sections I to III) of the questionnaire were quantitative, comprising 36 closed-ended questions. In contrast, three open-ended questions (Section IV) were included at the end as a qualitative component.

*Quantitative Part:* The questionnaire was divided into three main sections: Section I: use of AI tools; Section II: academic engagement and AI dependence; and Section III: critical thinking and problem-solving skills. It comprised 36 closed-ended questions and 3 detailed open-ended questions. Section I included eight items about the use of AI tools, which were answered on a three-point scale (yes, no, and to some extent) and were analyzed using descriptive statistics (e.g., frequencies and percentages). Section II included eight items on academic engagement and AI dependency, rated on a 5-point Likert scale from strongly disagree to strongly agree. Section III included 20 items on critical thinking and problem-solving skills, using a yes/no/to some extent scale. Section IV included three open-ended questions to explore students' experiences and perceptions of AI. In that way, it provided qualitative data consistent with the study's mixed-methods design (Creswell & Creswell, 2018).

To ensure the content validity of the research instrument, three experts in education and technology assessed the questionnaire. They provided advice on improvements, and the researcher made the necessary modifications to the language, structure, and content of the questions in light of their feedback. After review, to assess the tool's clarity and practical feasibility, pilot testing was conducted with 10 students, though no significant changes to the questionnaire were required. However, pilot-tested data were not included in the final analysis. Thus, data were recorded at the university by the researcher from 165 students; no responses were left unfilled. The absolute reliability (Cronbach's Alpha = 0.753) met acceptable standards for social research (Mela et al., 2023). However, the Academic Engagement and AI Dependency sections remained very high (Cronbach's Alpha = 0.952), indicating excellent reliability. Thus, the corrected item-total correlations for all 8 items ranged from 0.723 to 0.906 (see Table 1), which are significantly above the acceptable limit of 0.70 and demonstrate the internal consistency of all items.

**Table 1:** *The construct model, instrument*

| <b>Construct</b>                           | <b>Items</b> | <b>Reliability</b> |
|--------------------------------------------|--------------|--------------------|
| Use of AI                                  | 8            | .969               |
| Academic Engagements and AI Dependency     | 8            | .952               |
| Critical thinking & Problem-solving skills | 20           | .980               |
| Overall Reliability                        | 36           | .753               |

*Qualitative Part:* Section IV captures students' personal perceptions, experiences, and perspectives on the use of AI in their own words, which is integral to the study's overall QUAN-Qual design and is not limited by the quantitative questionnaire's closed-ended nature. Accordingly, three open-ended questions were added at the end of the questionnaire to gather in-depth evidence to further triangulate the quantitative results, thereby strengthening the utility of the study's mixed-methods design (Creswell & Creswell, 2018). These questions included:

1. How do you use AI tools for educational purposes, and to what extent do they impact your educational activities?
2. In your opinion, what are the benefits of AI in the educational field, and to what extent has it helped improve your academic performance?
3. In your opinion, what challenges or difficulties have you faced in using AI in the educational field, and what do you think about the future of this technology?

### **2.3 Data Collection Method and Analysis**

The data were collected using Google Forms; however, under the researcher's direct supervision, students completed the forms. The researcher guided the students to ensure the questionnaire was understood and completed correctly. Although the data were collected through an online Google Form, the researcher visited each university in person and manually selected and guided a predetermined number of students (25 per university); thus, the equal stratified allocation technique was implemented. First, the data were exported to an Excel sheet; then, after appropriate coding and data cleaning, the data were transferred to SPSS, where the required statistical techniques for quantitative analysis were applied. However, objectives 1 to 4 were examined quantitatively using descriptive statistics, Pearson correlation, and linear regression, while objective 5 was examined qualitatively through thematic analysis. Thematic data analysis was conducted using a manual coding scheme, in which respondents' responses were carefully read by hand, and initial codes were generated from common words, phrases, and ideas; similar codes were later combined into broader themes.

### **2.4 Ethical Considerations**

Participants' anonymity and confidentiality were strictly maintained throughout the research process. Informed consent was obtained from all participants at the start. Prior to conducting the study, the researcher informed all participants of their rights, confidentiality fears, and the right to withdraw from the study at any time.

## **3. FINDINGS**

The demographic characteristics of participants are reported in Table 2, where the majority of students were female (81.2%) and male (18.8%); however, the largest group was students aged 18 to 20 (68.5%).

**Table 2: Demographic Characteristics**

|        |         | N   | %    |
|--------|---------|-----|------|
| Gender | Female  | 134 | 81.2 |
|        | Male    | 31  | 18.8 |
| Age    | 18 - 20 | 113 | 68.5 |
|        | 21 - 23 | 43  | 26.1 |
|        | 24 - 26 | 9   | 5.5  |

### 3.1 Objective 1: Use of AI Tools Among Students

Table 3 presents descriptive statistics on students' use of AI tools in academic settings, with the majority of participants reporting frequent use of AI in academic tasks (Item 1: 61.2%). However, reliance on AI was associated with a lack of formal training (Item 4: 61.8%). The highest mean score was observed for Item 5 (M = 2.21, SD = 0.737), indicating partial use rather than full dependence. In total, 60% of students reported maintaining a balance between traditional methods and AI (Item 8, M = 1.68).

**Table 3: Descriptive Statistics of Use of AI Tools among Students**

|                                          | Yes         | No         | To Some Extent | M    | SD   |
|------------------------------------------|-------------|------------|----------------|------|------|
| Item 1: Frequent AI tool usage           | 101 (61.2%) | 9 (5.5%)   | 55 (33.3%)     | 1.72 | .934 |
| Item 2: Perceived AI academic impact     | 91 (55.2%)  | 31 (18.8%) | 43 (26.1%)     | 1.71 | .856 |
| Item 3: AI changed the learning approach | 70 (42.4%)  | 76 (46.1%) | 19 (11.5%)     | 1.69 | .668 |
| Item 4: Formal AI training received      | 102 (61.8%) | 9 (5.5%)   | 54 (32.7%)     | 1.71 | .931 |
| Item 5: AI reliance across tasks         | 31 (18.8%)  | 69 (41.8%) | 65 (39.4%)     | 2.21 | .737 |
| Item 6: AI content accuracy perception   | 72 (43.6%)  | 69 (41.8%) | 24 (14.5%)     | 1.71 | .707 |
| Item 7: AI skill development belief      | 91 (55.2%)  | 38 (23.0%) | 36 (21.8%)     | 1.67 | .814 |
| Item 8: AI vs traditional balance        | 99 (60.0%)  | 20 (12.1%) | 46 (27.9%)     | 1.68 | .883 |

### 3.2 Objective 2: Impact of The Use of AI Tools On Students' Academic Engagement and Independent Research

**Hypothesis 1 (H1):** There is a significant relationship between the use of AI tools and students' academic engagement.

Correlation analysis in Table 4 shows a significant negative relationship ( $r = -.402$ ) between the use of AI tools (M = 1.761, SD = 0.745) and academic engagement and AI dependency (M = 3.968, SD = 0.384). Bootstrap analysis further confirmed this relationship, as the 95% confidence interval  $[-.523, -.268]$  excludes zero, indicating the statistical robustness of the results. Based on these results, the research hypothesis H1 was accepted.

**Table 4: Correlational Analysis**

|                                           |                                   | Academic Engagement & AI Dependency<br>(M = 3.968, SD = .384) |
|-------------------------------------------|-----------------------------------|---------------------------------------------------------------|
| Use of AI Tools<br>(M = 1.761, SD = .745) | Pearson Correlation               | -.402**                                                       |
|                                           | Sig. (2-tailed)                   | .000                                                          |
|                                           | Sum of Squares and Cross-products | -18.831                                                       |
|                                           | Covariance                        | -.115                                                         |
|                                           | Bootstrap Bias                    | .002                                                          |
|                                           | Std. Error                        | .065                                                          |

|                 |       |
|-----------------|-------|
| 95% Conf. Lower | -.523 |
| Interval Upper  | -.268 |

\*\*Correlation is significant at the 0.01 level. Bootstraps are based on 1000 bootstrap samples.

### 3.3 Objective 3: Relationship between the use of AI tools and students' critical thinking and problem-solving skills

**Hypothesis 2 (H2):** There is a significant relationship between the use of AI tools and students' critical thinking and problem-solving skills, i.e., over-reliance on AI weakens students' critical thinking skills.

Table 5 presents the linear regression results for the relationship between the use of AI Tools and students' academic engagement and AI dependency. Regarding the model's explanatory power, the use of AI tools explained 91.7% of the variation in critical thinking ( $R^2 = .917$ ), indicating a very strong predictive ability. The ANOVA results proved the overall significance of the model ( $F(1, 163) = 1812.185$ ,  $p < .001$ ), while the coefficients indicated that the use of AI tools has a significant negative effect on critical thinking; therefore, research hypothesis (H2) was accepted.

**Table 5: Linear Regression**

|                                       | M     | SD    | R    | R <sup>2</sup> | Adj. R <sup>2</sup> | F        | B     | $\beta$ | t       | p    | 95% CI         |
|---------------------------------------|-------|-------|------|----------------|---------------------|----------|-------|---------|---------|------|----------------|
| Use of AI Tools                       | 1.761 | 0.745 | .958 | .917           | .917                | 1812.185 | -.907 | -.958   | -42.570 | .000 | [-.949, -.865] |
| Critical Thinking and Problem-Solving | 2.233 | 0.706 |      |                |                     |          | 3.831 |         | 94.037  | .000 | [3.751, 3.912] |

### 3.4 Objective 4: Relationship Between Academic Engagement and Critical Thinking

**Hypothesis 3 (H3):** There is a significant relationship between academic engagement and critical thinking.

The results of the Pearson correlation in Table 6 show a significant positive correlation between academic engagement and AI dependency, and between academic engagement and critical thinking and problem-solving skills ( $r = .369$ ,  $p < .001$ , 95% CI [.228, .493]), which was also confirmed by Bootstrap analysis (1000 samples) [.237, .491], thus accepting the research hypothesis (H3).

**Table 6: Correlation Analysis**

|                                                                        |                                   | Critical Thinking & Problem-Solving Skills<br>(M = 2.233, SD = .706) |       |
|------------------------------------------------------------------------|-----------------------------------|----------------------------------------------------------------------|-------|
| <b>Academic Engagement and AI Dependency</b><br>(M = 3.968, SD = .384) | Pearson Correlation               | .369**                                                               |       |
|                                                                        | Sig. (2-tailed)                   | .000                                                                 |       |
|                                                                        | Sum of Squares and Cross-products | 16.394                                                               |       |
|                                                                        | Covariance                        | .100                                                                 |       |
|                                                                        | N                                 | 165                                                                  |       |
|                                                                        | Bias                              | -.001                                                                |       |
|                                                                        | Std. Error                        | .065                                                                 |       |
|                                                                        | Bootstrap 95% Conf. Interval      | Lower                                                                | Upper |
|                                                                        |                                   | .237                                                                 | .491  |

\*\*Correlation is significant at the 0.01 level. Bootstraps are based on 1000 bootstrap samples.

### 3.5 Objective 5: Students' Perceptions, Benefits, and Challenges Regarding the Use of AI for Educational Purposes

Thematic analysis was conducted using Braun and Clarke's (2006) six-step framework, the most authoritative method for extracting meaningful patterns and themes from qualitative data. In the first step, responses to the three open-ended questions were read repeatedly to gain a deep understanding of the data, followed by initial coding, in which short labels were assigned to the main ideas of each response. In the second step, similar codes were combined to form initial themes: educational uses of AI, benefits of AI, and challenges of AI, which emerged as the three main themes. To ensure the validity of the themes, member checking was used, and participant quotes were included as evidence. Table 7 presents the coding scheme and themes derived from the open-ended responses of all 165 students, with only a few illustrative excerpts included for each theme and code.

**Table 7: Themes and Coding Scheme**

| Theme                  | Code                                      | Illustrative Excerpt                                                         | Respondents                                                        |
|------------------------|-------------------------------------------|------------------------------------------------------------------------------|--------------------------------------------------------------------|
| Use of AI in academics | Reliance on AI over traditional resources | No need for books, libraries, group discussions, and teachers.               | R1, R2, R11, R19, R34, R38, R65, R72, R88, R101, R119, R137, R150. |
|                        | AI as a centralized information source    | Lots of information in one place; no need to search on Google.               | R6, R7, R14, R33, R41, R64, R69, R77, R93, R108, R126, R141, R158. |
|                        | Convenience and time-saving               | Not time-consuming to make assignments effortlessly with AI.                 | R9, R16, R23, R29, R45, R58, R71, R84, R96, R113, R129, R144, R160 |
|                        | AI as a substitute teacher/guide          | I can say that AI is my teacher.                                             | R12, R21, R31, R47, R59, R75, R90, R104, R122, R135                |
| Perceived benefits     | Enhanced task efficiency                  | Gives you more options and suggestions... in a few seconds.                  | R3, R17, R26, R39, R52, R66, R79, R94, R110, R125, R148            |
|                        | Non-judgmental interaction                | Ask whatever I want without hesitating about being judged.                   | R5, R18, R30, R44, R57, R70, R85, R99, R116, R133                  |
|                        | Academic performance improvement          | My grades have improved significantly since using it.                        | R8, R20, R35, R49, R62, R76, R91, R105, R120, R138, R155           |
|                        | Structured, detailed output               | Provides structured information in detail.                                   | R13, R25, R37, R51, R63, R78, R92, R107, R123, R142                |
|                        | Meeting assignment requirements           | It provides the best result I could not have achieved on my own.             | R15, R28, R42, R55, R68, R82, R97, R111, R128, R146, R162          |
| Challenges             | Overdependence on AI                      | I do not feel that I need any human to guide me.                             | R4, R22, R36, R48, R61, R74, R89, R103, R121, R136, R153           |
|                        | Decline in critical thinking              | We cannot think critically for our assignments, as AI can.                   | R10, R24, R40, R53, R67, R81, R95, R109, R127, R143, R159          |
|                        | Inaccurate or outdated references         | References were outdated; cannot provide information with proper references. | R27, R43, R56, R73, R87, R102, R117, R134, R151                    |
|                        | Misuse beyond                             | Using it not only for academic purposes but also for                         | R32, R46, R60, R80, R98, R114,                                     |

|                                       |                                       |                                                   |
|---------------------------------------|---------------------------------------|---------------------------------------------------|
| academic purposes                     | entertainment.                        | R130, R147, R163                                  |
| Difficulty for teachers or evaluation | Challenging for teachers, not for us. | R50, R54, R86, R100, R115, R131, R149, R164, R165 |

### **Theme 1: Use of AI in academics**

Most students in the sample reported using AI tools for academic purposes, primarily ChatGPT, Chatbots, and virtual assistants. All participants were using these AI tools to complete assignments, projects, and research proposals, and to write research papers in their academic settings. A majority stated that AI is a better guide than human teachers and other resources, as it can yield a significant amount of relevant information in a short period without bias. AI is believed to be a significant aid to students across subjects and fields. Some statements from the students are given below:

*“It is an invaluable tool in the field of education where we can find all information in one place; there is no need for books, libraries, group discussions, and teachers (in some instances, but not sure).” (R1)*

*“Yes, it has a scope in academics; students can get lots of information in one place, and there is no need to search on Google or other websites. AI provides information with just one click, tailored to your specific needs. It is an exciting tool. I need to give it the command that I need and what my basic requirement of information is, even if I mention the number of required words, and it provides me with all relevant information in a few seconds.” (R6)*

*“It is easy to use and accessible for us, so we use it where we need it. Moreover, we mostly use it for making assignments. It helps me a lot because it is not time-consuming to make assignments effortlessly with AI. Now I do not bother searching for material from the internet, books, or teachers’ notes.” (R9)*

*Obviously, we use AI in academics; it assists with our research, assignments, and related projects. Sometimes I feel I am unable to understand teachers’ points of view on any topic, and I get stuck, lacking the confidence to ask them for clarification. Then, instantly, I ask AI, and it provides me with simple information and guidelines. That is very helpful for me. I can say that AI is my teacher.” (R12)*

### **Theme 2: Perceived benefits of AI in academic settings**

A majority of the students perceived AI as mostly beneficial, particularly when used for academic purposes such as preparing assignments, designing research projects, preparing for exams, and assisting with other tasks assigned by teachers. Some participants also stated that they utilize AI in their everyday lives for problem-solving. Statements of the participants are given below:

*“AI in academics is challenging because it gives you more options and suggestions for your academic-related tasks within a few seconds. Remarkably, it is a great invention that can replace teachers, books, and other search engines to find the answer to your question.” (R3)*

*“Just one click gives you lots of information as per my needs. I can ask whatever I want without hesitating about being judged for it, even if it gives me information that I cannot ask others.” (R5)*

*“I am using an AI tool for assignments and exam preparations. It is an invaluable tool that enhances my capability to increase my GPA. My grades have improved significantly since using it, and I have achieved 90% in all subjects, Alhamdulillah. Moreover, my*

*teachers have no issue, as they do not have software to check for plagiarism; it is my luck. Even all my classmates are using it.” (R8)*

*“AI-related platforms are a helpful integration for students, especially in making assignments, projects, or even research proposals, when writing a paper without any further guidance. It provides structured information in detail. I do not know whether the information it provides is reliable, but it can satisfy you by presenting relevant information logically.” (R13)*

*“Yes, AI has many benefits in academics, as it helps students create assignments and projects as per their teacher’s requirements. I found that I had given myself instructions to complete this approximately 3,000-word assignment, which required specific details per my teacher’s requirements. Amazingly, it provided me with the best result that I could not have achieved in a few seconds. I just rephrased it to avoid AI plagiarism and submitted it to my teacher, and I received great feedback.” (R15)*

### **Theme 3: Challenges associated with the integration of AI**

The prevailing view among the study population commends AI for its ease of use, 24/7 availability, essentially free cost, and minimal technical expertise. Additionally, some participants expressed concern that AI may replace teachers and other human educators, highlighting a significant risk and deterring many students from placing their full confidence in AI. Some participants’ statements are given below:

*“I cannot do my task as perfectly as AI can in a short period. I use it continuously for my university assignments, projects, research, and daily problem-solving. I ask AI for guidance on various situations, and it provides the necessary direction. So I cannot feel that I need any human body to guide me.” (R4)*

*“AI is challenging our minds; we cannot think critically for our assignments, as AI can. So, we are going to rely on it too much instead of doing it in our minds.” (R10)*

*“I asked the AI to provide references for the materials as per my teacher’s requirements, but it was unable to do so, which confused me. Furthermore, the provided references were outdated, as the AI cannot provide information with proper references (new).” (R27)*

*“All of us are now misusing AI, like we are using it not only for academic purposes but for entertaining ourselves, too. No training has been given to us, as it is available on websites, so everyone can easily access and use it as needed.” (R32)*

*“It can be challenging for teachers, not for us, as students using AI platforms have different logical information for assignments that some teachers feel energetic about checking, while others need their kind of work. Though there is software that detects AI plagiarism, students cannot simply copy and paste the material.” (R86)*

## **4. DISCUSSION**

The findings of the current study showed that the majority of students reported frequent use of AI tools for their academic purposes, reflecting AI in education as a growing global development. These findings are consistent with Strzelecki’s (2024) findings that AI tools (e.g., ChatGPT) are becoming increasingly popular among students because they provide structured, relevant, and instant information. However, the majority (61.8%) of students did not receive any formal training in using AI, which was the key finding of the current study and is consistent with Bala et al. (2025), who stated that the lack of AI training is a serious challenge in developing countries. Additionally, the study further revealed a tendency for students to maintain a balance between AI and traditional educational methods; Selwyn and Cumbo (2024) posited that students use AI as an auxiliary tool rather than a complete replacement. These findings clearly

illustrate that the lack of formal training and guidance is leading to ineffective and sometimes unethical use of AI among students, despite the increase in AI use in Pakistani universities.

In addition, the present study displayed a significant negative relationship between the use of AI tools and academic engagement and AI dependency, meaning that overreliance on AI significantly reduces students' independent research and classroom participation. Similarly, a study demonstrated that the continuous use of AI tools significantly reduces students' classroom discussions and direct interaction with teachers and peers (Fitria, 2023). As well, Lopulalan et al. (2026) demonstrated a clear, significant association between AI dependence and decreased academic independence. However, Popenici and Kerr (2017) took a different side, declaring that AI tools can increase academic engagement when used with appropriate guidance and training. This inconsistency shows that the effects of AI depend on the mode of use. Therefore, these findings confirm that unrestrained dependence on AI tools negatively affects students' academic engagement.

The current study's findings showed that the use of AI tools negatively impacts critical thinking and problem-solving skills. These findings are supported by Suryanto et al. (2025), who demonstrated that AI tools, such as ChatGPT, weaken students' critical thinking and problem-solving skills by leading them to rely on ready-made answers rather than think critically. However, Szmyd and Mitera (2024) argued the opposite: that when AI tools are used for analytical and logical tasks, they can enhance critical thinking. Conversely, the current study's results do not support this point; this may be due to a lack of formal training in the use of AI in education. In addition, open-ended replies confirmed these findings, as one respondent stated that "AI is challenging our ability to think," which aligns with Cognitive Offloading Theory and posits that dependence on AI controls students' brain activity (Risko & Gilbert, 2016). Therefore, these results clearly indicate that the unregulated use of AI in Pakistani universities is weakening students' cognitive abilities, and urgent measures are necessary to remedy this.

Moreover, the study shows a significant positive relationship between academic engagement and AI dependency, as well as between academic engagement and critical thinking and problem-solving skills ( $r = .369$ ). This is consistent with the findings of Kim et al. (2020), who demonstrated that academic engagement directly improves students' higher-order thinking. However, the study shows that AI dependency reduces academic engagement, which also has an indirect negative impact on critical thinking, a cascading effect consistent with Bandura's (1997) Self-Efficacy Theory and the findings of Suryanto et al. (2025). These results therefore confirm that ensuring students' active classroom participation with balanced use of AI is essential for the development of critical thinking.

However, the three themes of the qualitative analysis- educational use of AI, benefits of AI, and challenges of AI- fully confirmed the quantitative findings and showed coherence with the findings of Baidoo-Anu et al. (2024), who demonstrated that students use AI primarily for assignment and exam preparation. However, students' calling AI "their teacher" and the issue of misquotes reflect the concerns of Zimmerman et al. (2024) that AI can weaken human academic relationships and that the accuracy of information is a serious challenge.

The results of the current study provide strong theoretical support for Cognitive Offloading Theory (Risko & Gilbert, 2016) and Self-Efficacy Theory (Bandura, 1997), as increased reliance on AI appeared to weaken students' self-esteem and critical thinking skills. This is consistent with the basic assumptions of both theories that mental reliance on external sources affects human cognitive abilities. Similarly, the positive relationship found between academic engagement and critical thinking confirmed Academic Engagement Theory (Fredricks et al., 2004). While the acceptance of AI tools is driven by convenience and utility, it may later lead to an unbalanced dependence, consistent with the Technology Acceptance Model (Davis, 1989), in which initial acceptance may gradually turn into blind dependence, which is detrimental to both academic engagement and critical thinking.

Even as AI improves the educational environment, it remains vital for the academic community to closely and continually monitor its impact on those involved in educational progress. Hence, Pakistani

universities urgently need to formulate a clear policy and training program accordingly for the ethical use of AI, as indicated by the current study's findings.

## **5. CONCLUSION**

The study concludes that students are using AI tools extensively for their academic purposes. The negative influence of AI use on students' academic engagement, critical thinking, and problem-solving clearly indicates that excessive dependence on AI seriously damages students' academic understanding; however, the balanced use of AI, combined with formal training, may support students' academic abilities and development. In addition, thematic analysis revealed that students are aware of AI's limitations and advantages in education, which highlights the need for responsible and accountable use of AI; for this, in Pakistani universities, making AI literacy an essential part of the curriculum is important. Furthermore, raising students' awareness of the ethical use of AI are the most urgent priorities.

## **6. LIMITATIONS**

A fixed university population and a small student sample limit this study, potentially affecting the generalizability of the findings. Moreover, self-reporting and social prestige biases may affect the precision of replies.

## **7. RECOMMENDATIONS**

It is recommended that educationists, policymakers, and educational technology developers balance and moderate the incorporation of AI in educational environments to augment, rather than hinder, students' cognitive growth. Furthermore, the sole means to ensure a healthy and safe future for AI in the educational process is sound policymaking and teacher training, so that the use of these tools can be regularly monitored and controlled. Thus, for the education system, it is essential to clearly identify the specific stages in the teaching process where the use of AI is counterproductive rather than beneficial. Moreover, the alarm that teachers' roles will be reduced or eliminated with the advent of AI is completely unfounded; on the contrary, their responsibility has now increased more than ever to promote independent thought and innovation among students. Providing legal protection for the role of these professional teachers against the threats posed by AI alternatives is the need of the hour for the long-term survival of education. Furthermore, educational institutions should conduct steady awareness programs, workshops, and training for students and teachers on the ethical use (data privacy and algorithmic bias) of AI in education. Additionally, in place of traditional methods, active learning strategies should be adopted to foster critical thinking and problem-solving skills among students and to reduce AI's negative impact on education.

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## **Authors Contribution**

Dr. Fouzia Rehman led and contributed to the study design. Dr. Saira Saleem and Sumreen Zahid helped draft and revise the manuscript. Areeba Rehman and Mahnoor Irshad helped collect data from participants. Prof. Dr. Shahida Sajjad proofread and supervised the research work. All authors read and approved the final manuscript.

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## Data Availability Statement

The survey data generated and analyzed for this study are not publicly available and will not be deposited in any repository to protect participants' confidentiality and anonymity; participants were assured that no identifying information would be shared beyond the research team. The quantitative data set in this paper may be made available by the corresponding author upon reasonable request.

## Ethical Approval

The study was conducted in accordance with current ethical guidelines and international research standards for human participants. We confirm that the study was conducted in line with the ethical standards of the Declaration of Helsinki and all participants took part voluntarily after being informed about the purpose of the research, their right to withdraw, and the confidentiality measures in place. No identifying details have been included in the manuscript.

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## APPENDIX: RESEARCH INSTRUMENT

| Section I: Use of AI                                                                                                                      | Yes | No | To Some Extent |   |
|-------------------------------------------------------------------------------------------------------------------------------------------|-----|----|----------------|---|
| 1. Do you use AI-powered tools frequently (such as virtual assistants, chatbots, or online databases) to assist with your academic tasks? |     |    |                |   |
| 2. Do you perceive AI's impact on your academic performance?                                                                              |     |    |                |   |
| 3. Do you believe that the use of AI for academic tasks has changed the way you approach learning and studying?                           |     |    |                |   |
| 4. Have you received any formal training or guidance on how to use AI-powered tools for your academic tasks?                              |     |    |                |   |
| 5. Do you rely on AI-powered tools for different types of academic tasks? (e.g., research, writing, problem-solving)                      |     |    |                |   |
| 6. Do you perceive the accuracy and reliability of AI-generated content or recommendations for your academic tasks?                       |     |    |                |   |
| 7. Do you believe that AI-powered tools have helped you develop new skills or improve existing ones related to your academic tasks?       |     |    |                |   |
| 8. Do you balance the use of AI-powered tools with traditional academic methods (e.g., textbooks, library research)?                      |     |    |                |   |
| Section II: Academic Engagement and AI Dependency                                                                                         | SD  | D  | N              | A |
| 9. Use of AI has made it easier for me to find relevant information for my academic assignments.                                          |     |    |                |   |
| 10. AI platforms have reduced the amount of time I spend on independent research and reading.                                             |     |    |                |   |
| 11. I feel less motivated to engage in independent research and reading since relying on AI for academic tasks.                           |     |    |                |   |

|                                                                                                                                                 |     |    |                |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------|-----|----|----------------|--|
| 12. I feel more confident in completing academic tasks efficiently when using AI-powered tools.                                                 |     |    |                |  |
| 13. My teachers do not allow me to use AI for help. Teachers check for AI plagiarism.                                                           |     |    |                |  |
| 14. AI technology has impacted my participation in class discussions and group study sessions because I rely on AI instead of group discussion. |     |    |                |  |
| 15. I believe that discussions with peers or professors are an essential aspect of my learning experience, regardless of AI use.                |     |    |                |  |
| 16. While using AI platforms in your assignments or research, do you try to rephrase the AI-given information or use it as it is?               |     |    |                |  |
| <b>Section III: Critical Thinking Skills</b>                                                                                                    | Yes | No | To Some Extent |  |
| 17. I feel confident in my ability to analyze information and evaluate evidence critically.                                                     | .   |    |                |  |
| 18. Overall, I believe that my critical thinking skills have improved as a result of using them.                                                |     |    |                |  |
| 19. Use of AI has challenged me to approach academic tasks with a more critical and analytical mindset.                                         |     |    |                |  |
| 20. I have become more adept at identifying biases and evaluating the credibility of sources since using AI for academic tasks.                 |     |    |                |  |
| 21. The use of AI has broadened my perspective and encouraged me to consider alternative viewpoints in my academic work.                        |     |    |                |  |
| 22. I feel better equipped to apply critical thinking skills learned through AI-assisted tasks to real-world situations outside of academia.    |     |    |                |  |
| 23. Do you think that you are completely relying on AI, which affects your mental abilities, like critical thinking and problem-solving skills? |     |    |                |  |
| 24. On your own, can you list three key details about any topic effortlessly?                                                                   |     |    |                |  |
| 25. Do you easily recognize or distinguish previously learned information, or do you really need to evoke it from AI?                           |     |    |                |  |
| 26. Can you apply knowledge and principles to solve daily or academic problems?                                                                 |     |    |                |  |
| 27. Have you ever taken part in a conversation that compares and contrasts different viewpoints or perspectives?                                |     |    |                |  |
| 28. Do you easily judge the value or significance of ideas or solutions?                                                                        |     |    |                |  |
| 29. Do you try to identify the strengths and weaknesses of the information, proposal, or task?                                                  |     |    |                |  |
| 30. Do you always try to generate new ideas, solutions, or products?                                                                            |     |    |                |  |
| 31. Do you design a project/solution to address a specific issue/problem?                                                                       |     |    |                |  |
| 32. Have you ever tried to propose a new approach to a challenge?                                                                               |     |    |                |  |

|                                                                                                                                                                      |  |  |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|
| 33. Do you try to combine ideas or elements to form a new whole?                                                                                                     |  |  |  |
| 34. Do you try to integrate concepts to create an outcome?                                                                                                           |  |  |  |
| 35. Do you try to develop a plan that incorporates a strategy/method to achieve a goal?                                                                              |  |  |  |
| 36. Do you synthesize the findings of academic tasks or research studies to identify common themes?                                                                  |  |  |  |
| <b>Section IV: Open-ended (please give your answer in detail)</b>                                                                                                    |  |  |  |
| 37. How do you use AI tools for educational purposes, and to what extent do they impact your educational activities?                                                 |  |  |  |
| 38. In your opinion, what are the benefits of AI in the educational field, and to what extent has it helped improve your academic performance?                       |  |  |  |
| 39. In your opinion, what challenges or difficulties have you faced in using AI in the educational field, and what do you think about the future of this technology? |  |  |  |