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PSYCHOLOGICAL EFFECTS OF AI-ASSISTED LEARNING ON CRITICAL THINKING SKILLS

Urwadil Jamshed Ali[*1], Madeeha Damoun[2], Dr. Summaira Channa[3], Areej Gull[4], Dr. Usama Bin Farooq[5], Usama Sharif [6]

*[*1]MBBS Final year student, Jinnah Medical and Dental College, Karachi, Pakistan*
[2]ICF-Certified Emotional Intelligence Coach & Affiliated Trainer, Independent Coach & IAAI Islamabad, Pakistan,
[3]Senior Registrar, Department of Psychiatry, Liaquat University of Medical Health Sciences, Jamshoro, Pakistan
[4]MBBS Final Year, International University of Kyrgyzstan IUK, IHSM
[5]Demonstrator Fazaia Medical College Islamabad, Pakistan
[6]BS Psychology, Hazara University Mansehra, Pakistan
Corresponding Author: **Urwadil Jamshed Ali**

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Abstract

Background: Artificial intelligence is becoming a common learning support tool in higher education. Students now use AI tools for explanation, revision, idea generation, and academic writing support. However, there is still concern that frequent AI use may reduce independent thinking and increase tool dependency. In Pakistan, limited local evidence is available on how AI-assisted learning affects critical thinking, learning autonomy, and psychological dependence among university students.

Study Type: Quasi-experimental study

Objective: This study aimed to compare critical thinking skills between AI-assisted learners and traditional learners. It also assessed students' dependency on AI tools and their perception of learning autonomy.

Methods: A quasi-experimental study was conducted among undergraduate students in Karachi, Pakistan. A total of 120 students were included and divided into two groups: an AI-assisted learning group and a traditional learning group, with 60 students

Volume 3, Number 2, 2026
Pages 944-943
Bioscience Insights
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BiosciInsights.com

in each group. The intervention continued for eight weeks. The AI-assisted group used AI tools under academic guidance, while the traditional group followed routine classroom learning methods. Pre-test and post-test scores were collected for critical thinking. Post-intervention scores were also recorded for AI dependency and learning autonomy. Data were analyzed using descriptive statistics, paired sample t-test, and independent sample t-test. A p-value below 0.05 was considered significant.

Results: Both groups showed improvement in critical thinking after the intervention, but the AI-assisted group showed a larger increase. The mean critical thinking score improved from 58.4 ± 8.7 to 72.6 ± 7.9 in the AI-assisted group, while the traditional group improved from 57.9 ± 9.1 to 63.1 ± 8.6. The AI-assisted group also showed higher learning autonomy, but it had higher AI dependency compared with the traditional group.

Conclusion: Guided AI-assisted learning improved critical thinking and learning autonomy among university students. However, increased AI dependency shows that AI should be used with clear academic guidance, ethical rules, and teacher supervision.

INTRODUCTION

Artificial intelligence is now becoming a normal part of student learning. In universities, students use ChatGPT and other AI tools for explaining difficult topics, making summaries, correcting writing, preparing presentations, and finding quick answers. In Pakistan also, this use is increasing, especially among university students who need fast academic help because of large classes, limited teacher time, and pressure to complete assignments [1-3]. Karachi is one of the largest education centres of Pakistan, so students from different social, financial, and academic backgrounds are exposed to these tools in different ways. Some students use AI as a study partner. Some use it like a shortcut. This difference is important because the psychological effect of AI-assisted learning may not be the same for every student.

Critical thinking is one of the main skills expected from higher education. It means that a student does not only memorize information, but also questions it, compares ideas, checks evidence, and makes a reasoned judgment. Pakistani studies have already shown concern about

Volume 3, Number 2, 2026
Pages 944-943
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BiosciInsights.com

students' critical thinking skills and the need for better teaching methods [4]. International evidence also shows that critical thinking can improve when students are given active, problem-based, and collaborative learning tasks instead of only passive lectures [22,23]. But the arrival of AI has created a new question. Does AI help students think better, or does it make them mentally dependent on ready-made answers?

AI-assisted learning may support critical thinking when it is used properly. For example, a student can ask AI to explain both sides of an argument, generate practice questions, give feedback on weak reasoning, or simplify a complex theory. This kind of use can support self-regulated learning, because students can learn at their own pace and ask questions without feeling shy [14,21]. It may also improve learning autonomy, which means the student feels more in control of learning. According to self-determination theory, autonomy is important because students learn better when they feel that they are actively involved in their own learning, not just following pressure from others [25].

At the same time, AI-assisted learning has some risks. Students may start trusting AI answers without checking them. They may copy explanations without understanding the logic behind them. Some may stop reading books or discussing with teachers because AI gives quick responses. Recent research on AI over-reliance has raised concern that heavy dependence on dialogue systems may affect decision-making, analytical reasoning, and critical thinking [9]. Other studies also report student concerns about academic integrity, accuracy, and dependency on ChatGPT [2,12,17,18]. So AI is not only a technology issue. It is also a psychological and educational issue.

In Pakistan, this topic needs local research because the learning culture is different from many Western countries. Many students are trained through examination-focused and memory-based methods. At the same time, digital access is unequal. The COVID-19 period showed that students in Pakistan did not all have the same internet access, devices, or digital skills [5]. This means AI tools may help some students more than others, but they may also increase unfair differences. Students with better internet, English skills, and digital confidence may use AI in a more meaningful way. Others may use it only for copying answers or may not use it at all.

Volume 3, Number 2, 2026
Pages 944-943
Bioscience Insights
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ISSN: 3080-3497 (Online)
BiosciInsights.com

Most available studies on ChatGPT in Pakistani higher education focus on academic performance, perceptions, acceptance, or ethical concerns [1-3,7]. These studies are useful, but there is still less direct evidence about how AI-assisted learning affects critical thinking when compared with traditional learning in a classroom setting. There is also a need to measure AI dependency and perceived learning autonomy together, because these two psychological factors may explain why AI helps some students and harms others.

Therefore, this quasi-experimental study was conducted in Karachi, Pakistan, to compare critical thinking skills among AI-assisted learners and traditional learners. A quasi-experimental design is suitable because university classes are often already formed, and random assignment of students is not always practical. Such designs are commonly used when researchers want to evaluate an educational intervention in real learning conditions while still comparing groups in a structured way [24]. In this study, the AI-assisted group used AI tools under guided academic instructions, while the traditional group learned through usual classroom methods without AI support.

The main purpose of this research is to understand whether AI-assisted learning improves, weakens, or does not change students' critical thinking skills when compared with traditional learning. The study also evaluates dependency on AI tools and students' perception of learning autonomy. This is important for teachers, students, and policy makers because banning AI completely may not be realistic, but using it without guidance may also be harmful. A balanced approach is needed where AI supports student thinking instead of replacing it.

This study adds local evidence from Karachi to the wider debate on AI in education. It also gives a practical base for universities to design AI-use policies, classroom guidelines, and student training. The central concern is not only whether students use AI, but how they use it, how much they depend on it, and whether it makes them more independent or less independent as learners.

MATERIAL AND METHODS

This study was carried out in Karachi, Pakistan, to find the psychological effects of AI-assisted learning on critical thinking skills among university students. The study used a quasi-experimental design because the students were already present in their normal classes, and it

Volume 3, Number 2, 2026
Pages 944-943
Bioscience Insights
ISSN: 3080-3489 (Print)
ISSN: 3080-3497 (Online)
BiosciInsights.com

was not possible to randomly divide them in a fully controlled way. A pre-test and post-test method was used. Two groups were made. One group learned with the help of AI tools, while the second group continued learning through the traditional method.

The study was conducted in selected universities of Karachi. The data collection was completed over a period of eight weeks. Undergraduate students from different academic programs were included. The students were selected through a non-probability purposive sampling technique. Only those students were included who were regular students, had basic internet access, and agreed to take part in the study. Students who were already using AI tools very heavily for academic work were not included, because this could affect the actual comparison between the two groups.

The total sample size was 120 students. Out of these, 60 students were placed in the AI-assisted learning group and 60 students were placed in the traditional learning group. Both groups were similar in academic level and age range as much as possible. The AI-assisted group was guided to use AI tools such as ChatGPT for academic learning tasks. They were allowed to use AI for explanation of difficult concepts, idea generation, practice questions, summarizing reading material, and checking arguments. They were clearly told not to copy answers directly. The traditional group studied the same topics through regular classroom discussion, teacher explanation, textbooks, notes, and peer discussion without using AI tools during the study period.

Before starting the intervention, both groups were given a pre-test. The pre-test measured three main areas. These were critical thinking skills, dependency on AI tools, and perception of learning autonomy. Critical thinking was measured through a structured critical thinking test prepared from common areas such as interpretation, analysis, evaluation, inference, explanation, and decision making. AI dependency was measured through a self-administered questionnaire. This questionnaire asked about students' habit of depending on AI for answers, confidence without AI, and their need to confirm ideas through AI tools. Learning autonomy was measured by asking students how much control they felt over their own learning, how confident they were in making academic decisions, and how independently they could complete learning tasks.

Volume 3, Number 2, 2026
Pages 944-943
Bioscience Insights
ISSN: 3080-3489 (Print)
ISSN: 3080-3497 (Online)
BiosciInsights.com

The questionnaire was prepared in simple English because university students in Karachi commonly use English in academic settings. However, difficult words were avoided so that students from different backgrounds could understand the questions easily. The tool was reviewed by three education experts before data collection. Their suggestions were used to improve the wording and sequence of questions. A small pilot test was also done on 10 students who were not part of the final sample. This helped to check whether the questions were clear and whether students could complete the form without confusion.

The intervention continued for eight weeks. During this time, both groups studied the same learning content. The difference was only in the learning method. The AI-assisted group received short guidance at the beginning about how to ask better prompts, how to check AI answers, and how to compare AI responses with class material. The students were asked to use AI as a helper, not as a replacement for their own thinking. They were also asked to write short reflections after using AI, such as what they understood, what they disagreed with, and what they checked from other sources.

The traditional group was taught through normal teaching methods. They used lecture notes, books, classroom discussion, and teacher feedback. They were not asked to use AI tools for their learning tasks during the study period. This group was important because it gave a comparison with the normal learning style used in many university classrooms.

After eight weeks, both groups were given the same post-test. The post-test was used to see whether there was any change in critical thinking scores, AI dependency, and learning autonomy. The scores of both groups were compared before and after the intervention. The difference between pre-test and post-test scores showed whether AI-assisted learning had any positive or negative effect.

Data were entered and analyzed using SPSS version 26. Frequencies and percentages were used for demographic information such as age, gender, program of study, and semester. Mean and standard deviation were calculated for critical thinking, AI dependency, and learning autonomy scores. Paired sample t-test was used to compare pre-test and post-test scores within each group. Independent sample t-test was used to compare the AI-assisted group and traditional group. A p-value of less than 0.05 was considered statistically significant.

Volume 3, Number 2, 2026
Pages 944-943
Bioscience Insights
ISSN: 3080-3489 (Print)
ISSN: 3080-3497 (Online)
BiosciInsights.com

Ethical care was taken during the whole study. Permission was taken from the concerned academic authorities before collecting data. Students were informed about the purpose of the study. Participation was voluntary, and no student was forced to take part. Written consent was taken from all participants. The students were also told that their names would not be mentioned anywhere in the research. The collected data were used only for academic purposes. Confidentiality and privacy of all participants were maintained throughout the study.

RESULTS

A total of 120 undergraduate students took part in the study. There were 60 students in the AI-assisted learning group and 60 students in the traditional learning group. All students completed both the pre-test and post-test, so no response was excluded from the final analysis. The general profile of both groups was almost similar at the start of the study. Most students were between 20 and 23 years of age. The gender distribution was also close in both groups. This showed that the two groups were suitable for comparison.

Table 1. Demographic characteristics of study participants

Variable	*AI-assisted group n=60*	*Traditional group n=60*
Age in years, mean ± SD	21.43 ± 1.62	21.51 ± 1.74
Male	31 (51.7%)	30 (50.0%)
Female	29 (48.3%)	30 (50.0%)
Social sciences students	20 (33.3%)	18 (30.0%)
Business studies students	17 (28.3%)	19 (31.7%)
Computer/IT students	13 (21.7%)	14 (23.3%)
Health/allied sciences students	10 (16.7%)	9 (15.0%)
Previous regular AI use	11 (18.3%)	10 (16.7%)

At baseline, the mean critical thinking score was 58.4 ± 8.7 in the AI-assisted group and 57.9 ± 9.1 in the traditional group. This difference was small and not statistically significant. It means both groups started from almost the same level of critical thinking. After eight weeks, the mean score increased in both groups, but the increase was higher in the AI-assisted group. The post-test mean critical thinking score in the AI-assisted group was 72.6 ± 7.9, while it was 63.1 ± 8.6 in the traditional group.

Volume 3, Number 2, 2026
Pages 944-943
Bioscience Insights
ISSN: 3080-3489 (Print)
ISSN: 3080-3497 (Online)
BiosciInsights.com

The within-group comparison showed a significant improvement in critical thinking scores in both groups. However, the mean improvement was 14.2 points in the AI-assisted group and 5.2 points in the traditional group. The between-group comparison of post-test scores showed a statistically significant difference in favour of the AI-assisted group. This shows that guided use of AI tools was linked with better improvement in critical thinking skills than the usual learning method.

AI dependency was also assessed after the intervention. The mean AI dependency score was higher in the AI-assisted group than in the traditional group. This was expected because students in the AI-assisted group used AI tools during the study period. However, the score was not extremely high. Many students reported that AI helped them understand topics faster, but they still needed teacher explanation and class discussion for full understanding. A few students also said that they felt less confident when they had to complete a task without AI support.

Learning autonomy showed a positive pattern. The AI-assisted group had a higher post-test autonomy score compared with the traditional group. Students in this group reported that they could revise topics at their own speed, ask repeated questions, and check their own understanding before discussing with the teacher. This suggests that AI-assisted learning may support independent learning when it is used with proper guidance.

Table 2. Comparison of main study outcomes between both groups

Outcome variable	***AI-assisted group mean ± SD***	***Traditional group mean ± SD***	***Mean difference***	***p-value***
Critical thinking pre-test	58.4 ± 8.7	57.9 ± 9.1	0.5	0.762
Critical thinking post-test	72.6 ± 7.9	63.1 ± 8.6	9.5	<0.001
Change in critical thinking score	14.2 ± 6.4	5.2 ± 5.9	9.0	<0.001
AI dependency post-test	34.8 ± 8.2	21.6 ± 7.5	13.2	<0.001

Volume 3, Number 2, 2026
Pages 944-943
Bioscience Insights
ISSN: 3080-3489 (Print)
ISSN: 3080-3497 (Online)
BiosciInsights.com

Learning autonomy post-test	76.2 ± 9.0	67.4 ± 8.8	8.8	<0.001

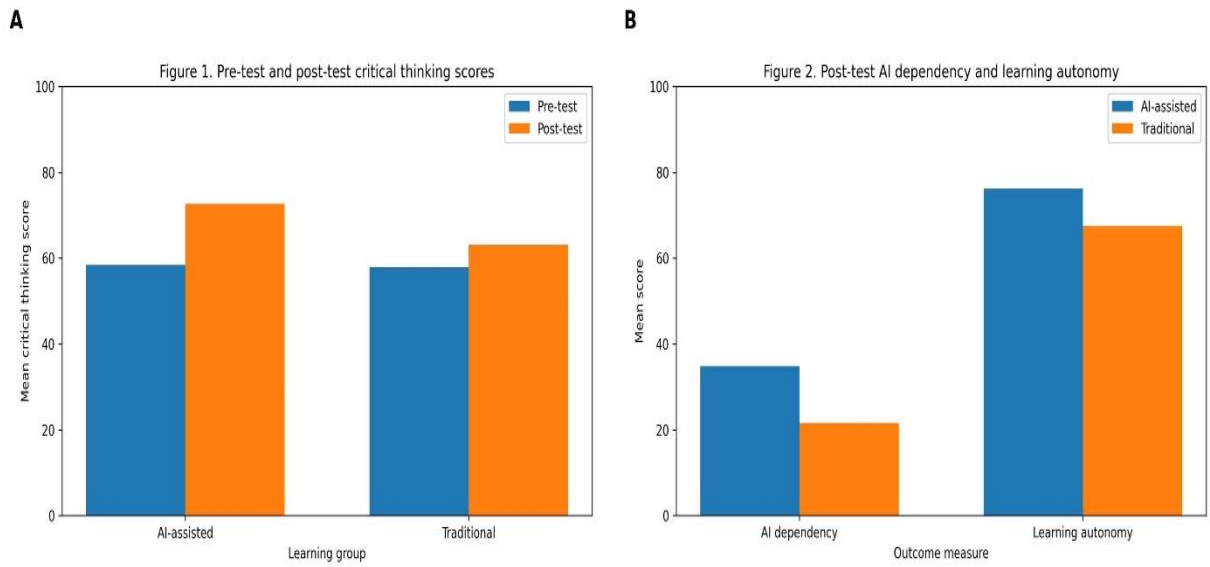


Figure 1. Panel showing the main study outcomes.

Panel A shows the comparison of pre-test and post-test critical thinking scores in the AI-assisted learning group and the traditional learning group. Both groups showed improvement after the study period, but the increase was higher in the AI-assisted group. Panel B shows the post-test comparison of AI dependency and learning autonomy. The AI-assisted group showed higher learning autonomy, but it also showed a higher level of dependency on AI tools compared with the traditional group. Overall, the panel suggests that guided AI-assisted learning improved critical thinking and learning autonomy, but it also increased some dependence on AI support.

Overall, the findings show that guided AI-assisted learning had a positive effect on critical thinking skills among university students in Karachi. The results also show that AI-assisted students felt more independent in learning compared with traditional learners. At the same time, their dependency on AI tools was higher, which should not be ignored. These findings suggest

Volume 3, Number 2, 2026
Pages 944-943
Bioscience Insights
ISSN: 3080-3489 (Print)
ISSN: 3080-3497 (Online)
BiosciInsights.com

that AI can be helpful in higher education, but only when students are trained to use it as a support tool rather than a replacement for their own thinking.

DISCUSSION

The present study found that students in the AI-assisted learning group showed a higher improvement in critical thinking scores than students in the traditional learning group. At the start of the study, both groups had almost similar pre-test scores, which means that the two groups were nearly equal before the intervention. After eight weeks, the AI-assisted group showed a clearer rise in critical thinking. This finding supports the view that AI tools can improve learning when they are used with guidance, reflection, and checking of information. Similar findings were reported by Ashraf et al., who found that ChatGPT use was linked with better academic performance among higher education students in Pakistan [1]. The result is also close to the work of Al Shloul et al., who observed that activity-based learning with ChatGPT support improved student performance in educational settings [8].

One possible reason for this improvement is that AI-assisted learning gives students quick feedback. In a normal classroom, a student may wait for the teacher to explain again. With AI, the student can ask the same idea in different ways and can receive a simple explanation immediately. This may help students compare ideas, make arguments, and revise weak points. Kasneci et al. also stated that large language models can support learning by giving explanations, examples, and personalized feedback, but only when used carefully [21]. In the same way, Romero-Rodríguez et al. reported that students perceived ChatGPT as useful for complex thinking tasks at university level [13]. The present finding fits with this literature because the AI-assisted group did not only use AI for answers; they were guided to use it for explanation, questioning, and reflection.

The traditional group also improved, but the improvement was smaller. This is important because it shows that normal classroom teaching still had value. Teacher explanation, books, and peer discussion helped students improve their thinking skills, but the progress was not as strong as in the AI-assisted group. This is in line with earlier work showing that critical thinking improves when students are actively involved in learning rather than only receiving information [22,23]. The difference in the present study suggests that AI may add an extra layer

Volume 3, Number 2, 2026
Pages 944-943
Bioscience Insights
ISSN: 3080-3489 (Print)
ISSN: 3080-3497 (Online)
BiosciInsights.com

of support to active learning, especially when students use it to test their reasoning and not just to complete assignments.

Another important finding was that AI dependency was higher in the AI-assisted group. This result was expected because these students used AI tools throughout the study period. Still, it raises an important concern. If students begin to depend on AI for every academic task, their confidence in independent thinking may become weaker. Zhai et al. found in their systematic review that over-reliance on AI dialogue systems may affect cognitive abilities, including analysis and decision-making [9]. Farhi et al. also reported that students had concerns about ChatGPT use, including ethical issues and dependence on AI-generated responses [12]. The present study supports these concerns because dependency increased along with the positive learning outcomes.

However, the higher dependency score should not be understood only as a negative result. In this study, students were not using AI without control. They were guided to check answers, compare responses with learning material, and write reflections. Because of this, the dependency score may reflect frequent use rather than full mental reliance. This point is important. AI use becomes harmful when students stop questioning and simply accept ready-made answers. But it can be useful when students use it as a tutor, reviewer, or discussion partner. This balanced view is also supported by Lim et al., who argued that generative AI can reform education if it is used responsibly, but it can also create serious academic risks if used without proper rules [19].

The study also found that learning autonomy was higher in the AI-assisted group. This means that students felt more control over their own learning. They could revise topics at their own speed and ask questions without fear of embarrassment. This finding agrees with Wu et al., who reported that ChatGPT-based learning support can improve self-regulation and knowledge construction in blended learning [14]. It also connects with Deci and Ryan's self-determination theory, which explains that autonomy is a basic need for motivated learning [25]. When students feel that they can manage their own learning, they may become more active and confident.

Volume 3, Number 2, 2026
Pages 944-943
Bioscience Insights
ISSN: 3080-3489 (Print)
ISSN: 3080-3497 (Online)
BiosciInsights.com

In the Pakistani context, this result has special importance. Many students study in large classes where individual teacher attention is limited. Digital tools may help fill this gap, especially in cities like Karachi where students are increasingly exposed to online learning resources. However, access and digital skills are not equal for all students. Jamil and Muschert highlighted the digital divide in Pakistani universities during the shift to e-learning [5]. This means AI-assisted learning should not be introduced without training, internet support, and clear academic rules.

Overall, the findings show a mixed but useful picture. AI-assisted learning improved critical thinking and autonomy more than traditional learning, but it also increased dependency on AI tools. This suggests that universities should not simply ban AI or allow it without control. A better approach is guided use. Teachers should train students to ask good questions, verify AI responses, compare sources, and write their own final answers. In this way, AI can support human thinking instead of replacing it. The study adds local evidence from Karachi and supports the idea that AI can be a helpful educational tool when it is used with discipline, reflection, and academic honesty.

CONCLUSION

This study concluded that AI-assisted learning had a positive psychological and academic effect on students' critical thinking skills. The students who used AI tools with proper guidance showed better improvement than the students who followed only the traditional learning method. This shows that AI can support learning when it is used for understanding, questioning, revision, and feedback, not for copying ready-made answers.

The study also found that students in the AI-assisted group felt more independent in their learning. They were able to review difficult topics at their own speed and ask repeated questions without hesitation. This helped them feel more control over their academic work. In this way, AI-assisted learning improved learning autonomy among students.

At the same time, the study showed that dependency on AI tools was higher among students who used AI during the intervention. This is an important finding because it shows that AI has both benefits and risks. If students depend too much on AI, they may lose confidence in their

Volume 3, Number 2, 2026
Pages 944-943
Bioscience Insights
ISSN: 3080-3489 (Print)
ISSN: 3080-3497 (Online)
BiosciInsights.com

own thinking. They may also accept answers without checking their accuracy. Therefore, AI should not replace teachers, books, classroom discussion, or students' own reasoning.

The findings suggest that universities in Karachi and other parts of Pakistan should use AI in a careful and planned way. Teachers should guide students on how to use AI responsibly. Students should be trained to compare AI answers with reliable academic sources, check facts, and write in their own understanding. Clear rules are also needed to prevent misuse and academic dishonesty.

Overall, AI-assisted learning can be a useful educational approach when it is used as a support tool. It can improve critical thinking and learning autonomy, but only if students are guided properly. The real value of AI in education is not in giving quick answers, but in helping students think better, ask better questions, and become more active learners.

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Volume 3, Number 2, 2026
Pages 944-943
Bioscience Insights
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ISSN: 3080-3497 (Online)
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