

Metacognitive Skill Development through AI Enhanced Educational Platforms: A Psychological Perspective

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ARTICLE INFO	ABSTRACT
Article History: Received: April 25, 2025 Revised: June 23, 2025 Accepted: July 07, 2025 Available Online: July 13, 2025	The research investigated psychological results, which focus on the impact of AI-based educational tools on training metacognition abilities in university students. The relationship between the use of AI-based tools and the planning, monitoring, and reflecting skills of students was tested with the help of a quantitative, cross-sectional, correlational research design. The sample of 250 undergraduate and postgraduate students was studied on the basis of simple random sampling at universities in the Punjab region of Pakistan. The research applied the Pearson correlation, simple linear regression, and independent samples t-test to evaluate the data with the SPSS software. Findings provided considerable positive findings between the application of AI-mortified learning systems and the metacognition capabilities. The regression analysis ensured that the AI-based personalized feedback was a major predictor of the level of metacognitive skills in the students. Furthermore, the students who applied the use of learning tools that were supported by artificial intelligence proved their metacognitive skills better than the ones who used traditional kinds of learning. The result supported the previous studies by pointing out the importance of AI in facilitating self-controlled learning and emotional health. The demographical analysis also showed that young students found it convenient to use AI-based platforms due to the customization they offer. This research paper proposes to include the AI tools in the curriculum and train the students to make the most of them in education. This paper presents the conclusion that an AI-assisted learning environment can be used to foster both cognitive growth and psychological health of the learner in a college or university environment.
Keywords: Artificial Intelligence, Metacognitive Skills, Personalized Feedback, Educational Psychology, Self-Regulated Learning, Higher Education, AI-Based Platforms, Academic Performance.	
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Introduction

The area of education has changed a lot in the present world of technology. Most educational sites are currently using artificial intelligence that increases student learning. One of the aspects in which AI can transform things is the formation of metacognitive skills. The concept of metacognition may be described as thinking about thinking. It involves planning, monitoring, and measuring the processes in his learning. Such abilities make the students more aware of their learning process and possibility to become better. Application of AI in educational platforms provides them with individual feedback, working tiers, and interactive life experience. Such features allow the learners to correct their objectives, track the progress, and consider what they understand. (Li et al.,2022) believe that AI-based systems and programs can help students develop self-regulatory and metacognitive skills due to their capacity to deliver sufficient prompts and take care of the learning processes.

The psychological view of metacognition describes the influence of mental functions, such as memory, attention, and reasoning, on learning. Being conscious of thought processes enables the students to make superior decisions concerning the mode of studying and resolving problems. Artificial intelligence can monitor tendencies in the studying of a student and recommend the solutions to enhance concentration, application of memory, and problem-solving. All this individualization helps in overcoming a cognitive overload and boosts the confidence in learning. It has been proven that not only do AI-based tools improve academic achievements, but they also provide students with additional motivation and engagement by stimulating reflection (Wang et al., 2024). These websites also have fun things such as quizzes, progress meters, and smart tutors that remind the students to consider and reflect on what they already know and what they have to learn at the next stage.

Metacognitive skills are of great essence in the world today when it comes to education since students have acquired tasks that are more complex in nature, demanding both critical thinking and decisions. Artificial-intelligence-differentiated education systems will provide a chance to incorporate the principles of psychology into education. That combination will allow students to find it easier to guide their learning process, maintain attainable objectives, and resist challenges. Psychologically, these AI tools have the potential of enhancing emotional regulation ability among learners, better handling stress related to academic pressure, and engaging good learning behavior among learners. As stressed by (Ahmed, N.R et al. 2025), AI-based learning environments can be very efficient at facilitating the development of metacognitive skills, as they allow one to offer students online, personalized feedback depending on their cognitive and emotional condition.

The latest discoveries in the field of machine intelligence allow the development of intelligent learning websites that adjust to the personal needs of the students. Such platforms use the data about the learning rate, preferences, and mistakes of a student and, based on this data, create an individual learning process. The systems are extremely efficient at demonstrating the metacognitive skills, as they help the students to realize their strengths and weaknesses. Learners can learn to be aware of their strengths and weaknesses, and this gives them reflections and feelings of being self-aware. (Kim et al.,2023) state that the AI-based learning environments facilitate metacognitive awareness of all learners by providing feedback during the learning process in real-time and guiding students through the problem-solving process. These platforms are usually marked with cues and draws that make the students have the feeling that they are never supposed to make any decision in learning that does not include taking time to reflect before making that particular decision, thus making them have increased abilities of planning and self-monitoring of their patterns of study.

Moreover, AI-powered learning technologies can provide good psychological help to the students when they are struggling with academic issues. There is a number of students who come with the experience of stress, lack of confidence, and inability to control their workload. Metacognitive skills equip students to manage these challenges by classifying the ability to master their own learning environment and supporting their emotions. AI systems are capable of noticing that a student is having problems and providing encouraging notes, easier material, or learning techniques to calm them and gain confidence. Psychologically, this support system has the potential to enhance the academic performance and the psychological status. According to the research carried out by (Zhao et al. 2021), adaptive feedback underpinned by AI enhanced the emotional status, motivation, and metacognitive behaviors of students who participated in learning sessions. That reveals that such AI platforms not only help to teach but also contribute to the development of essential psychological skills, which assist the students in becoming self-sufficient and self-knowledgeable learners.

Importance of Metacognitive Skill Development

Metacognition is simply thinking of how we think and learn. It means staying conscious of our thoughts, actions, and learning strategies. As soon as students learn metacognitive skills, they will be more capable of managing their academic tasks and planning their studies. They involve forward planning of an activity before undertaking it, monitoring what is happening as one progresses with it, and evaluating the results after doing it. These skills are essential in the contemporary learning environment, whereby students have to cope with complicated information and demanding tasks that need independent decision-making (Teng, et al. 2024) claim that students assigned high metacognitive skills demonstrate better performance in their academic activities due to the ability to control their cognition process successfully. This assists them in being focused and prevents them from making mistakes in learning tasks and makes them feel more confident.

In addition to an increase in academic performance, metacognition also allows students to embrace emotional control and minimize academic pressure. When students spend time every now and then to reflect on their performance and work, then they have a good grasp of where they went wrong and how they can rectify the situation. This process of reflection reduces frustration and makes the students confident of their abilities. By learning to think about thinking, students feel more accountable for their learning process. The use of AI tools assisting with the process of metacognitive development also facilitates the work of students due to the simplification of the organization, task prioritization, and focus on key academic objectives. Focusing on incentives, the employment of AI feedback on self-reflection activities allows students to increase motivation and support the overcoming of learning challenges, as providing timely feedback, reminding them about the activity, and encouraging them raises the motivation to devote more time to the self-reflection process (Afzaal et al., 2024).

Nowadays, academic students are forced to cope with multiple tasks and handle much information simultaneously. They can also feel confused or overwhelmed with their studies in case they lack metacognitive abilities. By showing students how to plan, monitor, and evaluate their learning, it is possible to make them reserve the control of their studies and cope better with stress. These competencies also equip the learners with future academic and personal challenges. The use of AI in the educational process helps to train these skills through individually crafted learning experiences, instant feedback, and learning style recommendations. (McCarthy et al. 2018) analyzed the data provided by previous studies and demonstrated that metacognitive training with the help of AI apps not only improved the grades but also helped students feel more in control because it decreased the pressure due to cognitive overload.

In addition, metacognitive skills are not only beneficial to students when they are in school, but they are also critical to lifelong learning. Individuals require these skills in their personal activities, future workplaces, and careers to troubleshoot problems, acquire new knowledge, and make better decisions. By deliberating over their actions and learning practices, people can comprehend any situation better and enhance their problem-solving skills. The sphere of AI technologies is beneficial in this sort of process because it monitors the performance of a student and issues some recommendations to facilitate the time to perform some tasks in a more appropriate way. Such a process makes students consider their own thoughts and make more brilliant, effective learning decisions. According to the description by (Ahmad, N. R. et al 2025). AI systems also complement metacognitive awareness by providing constant feedback and directing the students undergoing self-assessment tasks. Moreover, practice and training of metacognitive knowledge also enhance the emotional states of the students since the students who develop metacognitive skills have less stress, more time management skills, and better emotional composure. What can also be identified is the use of AI platforms that promote metacognitive development in recognizing the learning state of students and becoming emotionally stressed and providing encouraging and supportive feedback. The article by (Chen et al., 2025) explains that the metacognitive tools with AI integration result in healthier learning applications as well as the emotional stability and better academic experiences of learners.

Role of AI-Enhanced Educational Platforms

Artificial Intelligence (AI) is transforming the learning behaviors of students in their respective schools, colleges, and universities all over the world. The AI-based learning systems provide students with the learning process that is tailored to their specific needs. These are websites which study the performance of students, their learning pace as well as their weak areas, in order to vary the lessons and activities. This makes learning more individual, structured and efficient to an individual student. It is not difficult to find weak spots and to bring a little bit of additional support, using AI systems. As an example, in case a student has difficulties with a specific topic, the system will be able to propose additional practice questions or video explanations on the topic. This consistent modification of the learning content facilitates the process of keeping students on track and making them feel that they are not lost in the middle of the tasks. The AI tools can also save the teachers and students time since it automates the mundane feedback as well as planning. This leads to easier and rapid learning by students. (Saleem et al. 2025) argue that the AI-based systems that modify the content in accordance with individual performance result in a better engagement of students, their ability to stay focused, and improved their overall academic performance.

The capacity of AI-supported educational platforms to provide students with real-time feedback can be listed among the most beneficial ones of this kind. With the on-the-spot suggestions or corrections given to students concerning their work, the on-the-spot suggestions or corrections on the work enable the students to note their mistakes immediately and improve them. The checking and correcting exercise assists the students in forming a habit of reflecting on personal learning mechanisms. It also enhances their ideas in the way they learn and what they should concentrate on. AI systems monitor the learning habits of the students quite attentively such as the time spent on a subject or frequency of error making. According to this information, the system sends reminders to stop, reflect and refine learning objectives. This has been consistent support that enables the students to develop strong metacognitive skills that include planning on how to approach the topic, monitoring on their progress and on assessing the outcome of their work. As (Kim et al., 2025) clarified, AI-created feedback contributes to the fact that learners acquire more

appropriate thinking patterns because it allows and stimulates regular self-reflection and self-monitoring, which are the crucial activities in academic improvement.

The other greatest thing about the use of AI-based platforms is that they allow the student to have their target of learning based on their needs and preferences. The students can select the amount of the studies which they like per a day and the pace which they like studying. When the students include the specifications of their objectives, the automated system relates lessons and exercises to the specified preferences. This would make the students self-reliant as they would be allowed to regulate their time and their study pattern as they please. The systems also prescribe certain tactics which would help the students to master their memory, focus and problem-solving skills. This is because the students do not feel as though they have missed their studies and this makes the student feel he/she is in charge of his/her studies and it boosts the confidence and the motivation of such students. The AI platforms help the students to learn how to add realistic and achievable aims to them and have the chance of breaking down big objectives into small achievable ones which can be easily broken down. The study by (Zhao et al. 2025) determined that the websites designed to encourage goal-setting or independent learning promote metacognition and student performance. Through this personal care the students have been given greater responsibility on their studies and they are now in a position to manage themselves in education.

Research Objectives

1. To examine the relationship between the use of AI-enhanced educational platforms and the development of metacognitive skills among students.
2. To predict the influence of AI-based personalized feedback on students' metacognitive skill levels.
3. To compare metacognitive skill levels between students using AI-based platforms and those using traditional learning methods.

Problem statement

Although the use of Artificial Intelligence (AI) in education has become increasingly popular, the knowledge regarding the impact of AI-enhanced educational platforms on the acquisition of the metacognitive skills by the students remains scarce. Lack of learning planning, monitoring, and reflection places many learners at the risk of not managing their learning processes, emotions, and academic challenges. Although AI systems allow individualized feedback and flexible learning, few studies have been done to examine their immediate effects on the enhancement of metacognitive skills psychologically speaking. Moreover, it is not clear how different metacognitive abilities of students who learn through AI-based platforms and students who use traditional methods to learn are. The proposed research will fill this gap by gauging the links between the adoption of AI-based educational technologies and metacognitive skills promotion and forecasting the impact of AI feedback on the level of metacognitive skills and comparing the level of metacognitive skills in various learning conditions.

Significance of the study

The study is significant in the sense that it throws light on the way in which improved educational platforms through AI can aid students in gaining metacognitive skills which are vital in studying and the lifelong-learning process. AI tools can enhance their planning, monitoring, and reflection of learning by prioritizing such component as individual feedback, adaptive learning, and

emotional support. The results of the study will be useful to educators, policymakers and even technology designers on how to design learning systems that impart knowledge to the students and at the same time develop their thinking, decision-making and self-management capabilities. It will also address the research gap of investigating the psychological outcomes of the AI-based feedbacks on the metacognitive development and comparing the responses with the conventional method of learning. It can result in the more student-concerned and effective educational plans both online and in classrooms.

Literature Review

Metacognition is an important phenomenon of the current education. It means there is knowledge about personal thinking and learning, and there is knowledge on the decision-making process. The abilities allow the students to be able to plan, monitor, and evaluate learning. Challenging jobs will be easier to handle by good metacognitive students. They can be able to monitor their progress and to make corrections by themselves. The researchers have of late examined the possibilities of technology in enhancing the development of the skills. One of the concerns that is being given considerable attention by the researchers nowadays has to do with how artificial intelligence (AI) tools could be used to elevate the level of metacognitive awareness amongst the learners. Through AI platforms, students are provided with feedback and learning paths and recommendations to help them be organized and monitor the outcomes. They propose that learning metacognition outcomes are possible to be refined in students through the method of AI-aided learning (Paludo et al., 2024).

Artificial intelligence in education is a phenomenon growing rapidly within the past ten years. A lot of schools and universities utilize AI-powered platforms in order to make the students learn better. Such systems are able to determine strong and weak aspects of a learner and provide additional assistance where necessary. This simplifies the process of ensuring that students remain on track and have an idea of whether they are learning or not. The purpose of AI platforms is also to remind, give hints, and ask questions in order to make the students pause on what they learn. The metacognitive ability of these students gets enhanced by default. The studies revealed that AI platforms could enhance academic performance as well as problem-solving and decision-making. According to (Yang et al. 2023), students who apply AI-based learning environments also demonstrate their superiority to traditionally used learning tools in respect of planning, monitoring, and evaluation. Besides enhancing the learning process in academia, AI systems will enable students to manage their emotions and stress in the process of learning. A great number of students get anxious and frustrated in dealing with troublesome tasks.

AI tools will help to recognize the problem and help a student to pass through the difficult moment by sending encouraging messages, simplifying the questions, or giving advice on time-management skills. Such affirmative measures enhance the emotional dexterity of students, and that element forms a significant portion of metacognition. The students are more able to concentrate on the process of learning when they are relaxed and in a good mood. With the help of AI facilities, the students can contemplate their mood and academic results. This healthy learning environment helps the students to become more free and confident learners with ease. According to (Khotimah et al., 2024), an AI learning system enhances the cognitive and emotional dimensions of the student learning experience, in addition to the promotion of the metacognitive patterns of thinking. The second importance of AI-enhanced educational platforms is that these platforms facilitate lifelong learning. In modern dynamic life, individuals are required to acquire new skills all through their lives. The metacognitive skills also assist individuals to control the learning in other settings other than school or college. The AI systems that provide students with

constant feedback and tracking of their performances enable students to know about their learning behaviors. They will be able to find the issues in their study process and solve them themselves.

AI-based systems have the possibility to suggest more useful learning plans where the performance information of individual learners is involved. According to (Mazari et al. (2025), AI tools that enable metacognitive learning are accurate when used to be able to generate self-regulated learners who are able to succeed in school, at work, and in everyday life. Furthermore, some research studies have evidently demonstrated that the AI tools enhance better and proper planning of the learning activities of students. Such platforms make students have a clear objective in the study process, make appropriate decisions regarding learning aids, and allocate time to each subject. This planning habit facilitates metacognitive skill development since the students attain the ability to think ahead and anticipate obstacles. The AI systems also teach learners how to simplify hard tasks by dividing them into small, achievable ones. This helps students to be less stressed and more assured that they are handling their studies. In accordance with (Jin et al.,2023) learning platforms powered by AI that encourage goal-setting and planning the tasks can enhance the performance of the students in the learning process and make them responsible for their academic progress.

AI-Based Feedback and Learning Personalization

The use of artificial intelligence (AI) in the academic domain has made the process of learning in the school, college, and university environment change, as learning is basically offered a personal touch. AI will be able to base on the learning habits of a student and track the errors and inform him/her on how to learn. Such systems find it easy to know where a student may be struggling and immediately offer him/her extra help. This sort of real-time feedback can come in handy when encouraging students to be aware of their progress and remedy their errors so as to improve the learning experience. Due to the ability to receive an endless stream of personal feedback, the AI platform can help students be more focused, manage their performance, and believe in their abilities more. According to the results of the study made by (Li et al. 2024), the use of AI feedback machines rather than other forms of feedback creation results in the increased level of student engagement and academic achievement because the users receive guidance and motivation during the studying process. One of the best traits of these AI learning platforms is personal feedback and learning materials. With personal learning styles and the fact that the students have different times of learning, lessons are adapted with the use of AI tools, according to their needs.

When a student is having difficulties, then the system will give easier tasks, and when a student is doing well, then the system also ups the stakes by giving more difficult tasks to the student. This will see easy, enjoyable, and encouraging learning. Personalized instructional plans boost the confidence of learners as they are made to feel that the teachings are biased towards them. According to (Ahmed et al. 2023), AI-driven electronic learning tools, based on the adaptive feedback and the modification of lessons, provide a higher result in academic performance and meet the needs of students to expand the level of metacognition as they get an opportunity to reflect on the process of learning and adapt to achieve higher academic performance. AI-based feedback also aids in building positive study habits and decision-making by highlighting the mistakes and reasoning as to how one can avoid them in the future. There are a lot of mistakes that students repeat and do not even notice them, and AI tools make them obvious and provide some hints to improve them. The process increases the awareness of learning preferences and thinking styles of students. The system could advise the student to adjust his/her study methods or suggest additional practice in trouble spots so that he/she can improve.

(Chang et al.,2023), have discovered that AI feedback systems that give clear and actionable feedback positively impact how much students plan and monitor learning, which are two of the most crucial elements of metacognitive learning. Moreover, the AI tools will be based on data about past learning achievements of a student to recommend individualized learning plans, i.e., the system will choose what is to be learned, practices, and tests based on what the student should perfect the most. That will enable students to spend more time on challenging topics and avoid previously covered ones, simplifying their lives and decreasing academic pressure. It is more efficient and makes students motivated, as they get a feeling their studying plan is worthwhile and actual. The system just keeps track of progress and makes changes whenever the need arises. AI-based adaptive learning systems help students to feel more confident and motivated because they allow them to personalize their goals and the scope of academic work by following their expectations and convenience.

Psychological Perspective on Metacognitive Development

Metacognition contributes a lot in the way students think, learn and also perform well in their studies. The metacognition process in the psychological terms refers to the consciousness of thinking and managing the habits of learning. Those students, who have good metacognitive skills, understand how to plan their activity, monitor their progress and reflect on their performance. This consciousness can be used to enhance memory, concentration, as well as decision making capabilities. It also assists the students dealing with heavy tasks or exams in ways that help to take care of stress and emotions. Psychology is of the opinion that, once students get to know how to think about their thinking, they cope with learning issues stronger and make wiser decisions. (Paris et al. 2013) indicate that students who possess high skills in metacognition do better when confronted with challenging academic assignments since they have learned how to facilitate their learning in addition to adopting suitable responses in various situations. Psychology on the other hand explains that the students who fail to develop metacognitive skills tend to underperform in their studies.. Such students may lose focus and get demoralized. Educating children on how to reflect upon their methods of learning will enable them to not only raise their academic performance, but also have a better mental condition.

The AI systems might be significant in this domain as they can aid students in realizing that they made mistakes and should consider alternative methods of studying and analyze their emotions during the learning process. (Zong et al. 2023) clarified how AI-based learning systems developed on the psychological principles could augment the metacognitive awareness and emotional well-being levels of students by giving them constant feedback, updates on their progress, and positive messages throughout their learning experience. Besides monitoring the academic performance of students, AI system can recognize emotional variations as students go through a study. Most of the students get nervous, fatigued or even frustrated with difficult subjects. The repeated error, decreased response rate, or unfinished work will draw attention to AI tools and might indicate the pressure or loss of motivation. When it occurs, the AI systems will be able to suggest pieces of advice like taking a short break, providing less challenging tasks, or encouraging messages sending to make the student feel better. Such emotional provision helps the students to feel less lonely and more motivated in studying. (Drigas et al.,202) emphasized that educational platforms based on AI with emotional surveillance and support enhance the confidence of students, their focus, motivation, and metacognitive awareness level, giving them control over their thoughts and emotions when struggling to solve challenging academic problems.

In addition, psychologically, education platforms facilitated by AI would support self-regulated learning proximate to meta-cognition. Self-regulated students are conversant with their capabilities and their limitations. They are on how to coordinate their studies, track their own work and assess themselves. The AI systems promote this through offering specific advancement dashboards, learning targets, reminders, and self-diagnostic tests. These instruments make the students aware of their progress and change when required. This is a habit that enhances problem solving and decision making. (Kamelia et al. 2023) also ensured that AI-Assisted learning environments enhance the skills and capacity of the students to establish their own goals, handle their progress, and transform their learning patterns through self-regulated and metacognitive activities. Psychology also alludes to the affirmative emotions which enable students to learn with ease such as confidence and curiosity. The fact that the AI platforms promote the development of metacognition also makes the students feel good about learning. Students become motivated and achieve better performance when they are in control and when they also receive useful feedback. (Shahzad et al., 2023) suggest that AI-enhanced systems assisting academic and emotional well-being contribute to making students responsible, independent, and thoughtful learners and result in sustainable academic achievements and mental health results.

Research Hypotheses

1. There is a significant relationship between the use of AI-enhanced educational platforms and the development of metacognitive skills among students.
2. There is a significant predictive influence of AI-based personalized feedback on students' metacognitive skill levels.
3. There is a significant difference in metacognitive skill levels between students using AI-based platforms and those using traditional learning methods.

Methodology

Research Design

The research design of the study was a quantitative, cross section correlational study design. It was selected because this design was more suitable in research of the correlation between the utilization of the AI-enhanced education platform with the development of the metacognitive skills in the students. Correlation design was considered to suit the purpose because the objective was to find out whether there was any significant correlation existing between the variables of the research or otherwise without any manipulation effect. It was also a cross-sectional study because the researchers managed to collect data at a given point in time. This data were to be collected during a specific academic period and no follow-ups were involved. This pattern assisted in providing accurate and current account of the current situation of use of AI tools within educative institution. It was also useful during the finding out of the effects of these tools on the metacognitive ability of the students at the course of the study. The quantitative research method was featured because it operated according to the gathering of numeric data and its analysis through the application of such statistical tests as correlation, regression and t-tests or ANOVA.

Population

This study used the population of undergraduate and postgraduate students who enroll at universities and higher education facilities in Punjab, Pakistan. This was based on the fact that such students included the selection of students who were viewed as suitable participants in this

research. This was because the students participated actively in AI assisted and traditional learning environment as part of their academic programs. The importance of population was that they were a group of learners who were conversant with artificial intelligence-based learning systems and were supposed to have varying degrees of metacognitive experiences due to their learning backgrounds. This group of people was deemed to provide some important information on how students were being affected in their thinking and learning and solving problems due to the presence of the AI tools. It was presumed that this sample would assume representation of the range of metacognitive abilities in contemporary university scholars. A carefully established population was selected; in which students of various public and private universities were used to make the study more diverse. It was also established to consider both male and female students studying various study programs in order to have the results of the research generalizable and balanced.

Sample Size

This study was designed as a population of 250 students. It was neither too large to the extent that it was not possible to manage with the time check and available resources available. The sample chosen here was supposed to be a good representation of the whole university student group in Punjab. The sample size was determined following a review of some other similar research studies and as stipulated by the statistical demands of the proposed research. It was noted that sample sizes of between 200 to 300 students were used in other forms of analysis, similar to those of the field of educational technology and psychology in the stage of research processes. This was the number chosen because it was to guarantee the validity and soundness of the study. Also, the sample size to be selected so as to minimize the sampling errors plus enhance the generalizability of the study findings was to be decided.

Sampling Technique

This study applied a simple random sampling technique. The latter was chosen as it was not biased and all students in the target population had equal probability of being recruited into the study sample. Simple random sampling was significant in decreasing selection bias and enhancing fairness and objects of the study findings. With assistance of university administrations, a list of potential students who can be considered was prepared. Out of this list, the students were randomly picked without considering any special consideration of a particular group or individual. This method was adopted since it was straightforward to handle and was appropriate in education research involving students in other schools. The random selection was conducted through a list of random numbers developed by a computer that made the entire process impartial. This was done to make sure that the chosen students is an equal and representative sample of the entire student body in Punjab. It was concluded to apply this method in order to provide a possibility of students having different backgrounds, level of studies, and university equal opportunity to participate in the study.

Ethical Considerations

This research was very ethical; that is, it made sure that no activities interfered with the safety, rights and comfort of every participant. They also formally allowed the concerned university authorities and the academic departments, to start the process of data collection, and then moved on to the collection of data. All the participants were greatly informed on the aim of the researchers and what they would expect them to do during the research process. All the students who volunteered to take part in the research signed a consent. They informed that it is not a

requirement that they have to be included in the study and could defy at any time without any penalty or implication. It was also set out to students that they will not encounter any risk of pain, stress or discomfort during the process of study. The confidentiality of the personal data of every participant (name, phone number, e-mail addresses and answers) was strictly followed and none of the names or the personal identity was discussed in the study results, reports or papers. The information received was extremely safeguarded and used in scholarly studies only. The information had been inaccessible to other individuals, except the research team.

Data Analysis

The data was coded and checked on the Statistical Package of the Social Sciences (SPSS) software version 26 and analyzed once it was collected. General characteristics of the subjects were reported using descriptive statistics, e.g., frequencies, percentages, means, and standard deviations. To check the interrelation between the use of AI-enhanced platforms in education and the development of metacognitive skills, the Pearson correlation analysis was applied. To predict the influence of customized AI-based feedback on the level of metacognitive faculty of the students, a simple linear regression analysis was conducted. Lastly, the comparison of the difference in levels held on the metacognitive skills of the AI-based platform and traditionally trained students has been carried out using an independent t-test. With the number of groups other than the two, a one-way ANOVA test was used to compute the difference between the mean scores of two or more groups. All the statistical tests were made significant at 0.05. The results were given in the form of tables and figures, and the results were interpreted and explained by relating them to the objective of the research.

Table 1: Demographic Characteristics of the Respondents (N = 250)

Demographic Variables	Categories	Frequency (n)	Percentage (%)
Gender	Male	120	48.0%
	Female	130	52.0%
Age Group	18–20 years	90	36.0%
	21–23 years	110	44.0%
	24 years and above	50	20.0%
Education Level	Undergraduate	150	60.0%
	Postgraduate	100	40.0%
Type of Learning Platform Used	AI-Enhanced Platform	130	52.0%
	Traditional Learning	120	48.0%

The table above indicates the demographic profile of the participants that took part in the study. The student sample included 250 students 48 percent (n = 120) males and 52 percent (n = 130) females meaning that there represents a balanced gender ratio in the sample. In respect to age, a larger proportion of the students (44%) were in 21-23 years bracket (n = 110), 36 percent in 18-20 years group (n = 90) and 20 percent aged 24 years and over (n = 50). The respondents were 60 percent undergraduate students (n = 150) and 40 percent postgraduate students (n = 100) in relation to education level. Of the students who were surveyed (n = 250), 52 (n = 130) said that they prefer learning through AI-enhanced educational platform and 48 (n = 120) students indicated that they will use the traditional learning method. These findings indicate a broadly and equitable sample based on gender, age, the level of education and the use of learning platforms.

Figure 1:

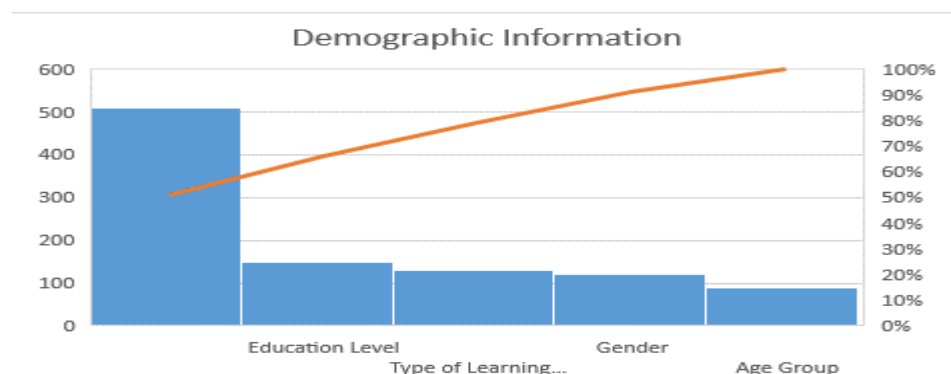


Table 2: Pearson Correlation Analysis

Variables	Mean	SD	1	2
1. Use of AI-Enhanced Educational Platforms	3.85	0.64	1	
2. Metacognitive Skills	3.90	0.70	.472**	1

The results of Pearson correlation test in regards to the use of the AI-augmented learning platforms and metacognitive skills. According to the results, the association between the two variables was positive and that the two values were moderate ($r = .472$, $p < 0.01$). It means that just as the use of AI-based education tools increases, the metacognitive capacities of individuals will get improved as well. Such positive correlation is statistically significant implying that such association is not accidental. It can therefore be concluded that the learners who frequent the use of the AI-enhanced learning environments would tend to come up with a better level of planning, monitoring and reflection into their learning progress.

Figure 2:

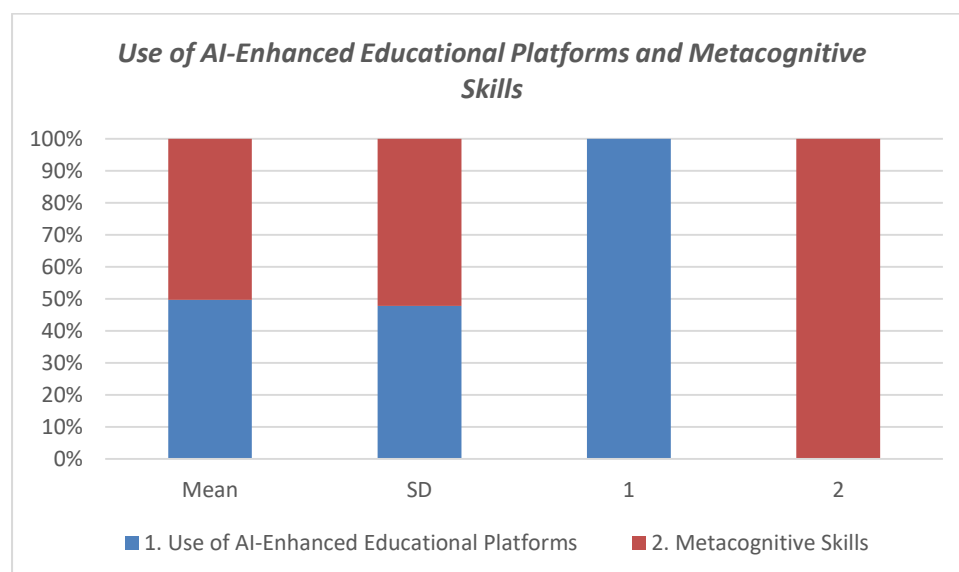


Table 3: Simple Linear Regression

Model	B	SE	β	t	p
(Constant)	2.10	0.23	—	9.13	0.000
AI-Based Feedback	0.48	0.06	0.512	7.94	0.000

The outcomes of a simple linear regression test run on the predictive role of AI-given personalized feedback to the development of metacognition in students. The results indicate that, AI feedback is a large positive predictor of metacognitive skills with a B value of 0.48 and standardized beta (β) of 0.512. It means that with a one-unit rise in AI-based personalized feedback, the metacognitive skills rise by 0.48 units. The correlation coefficient has a level of statistics that are significant ($p = 0.000$), which implies being not by chance. Constant 2.10 means the expected value of metacognitive skills in the cases there is no AI-based feedback. These findings indicate that the more personalized feedback students get via AI education programs, the better likelihood that they will have improved metacognitive skills, would know how to plan and monitor their learning abilities in addition to reflecting.

Figure 3:

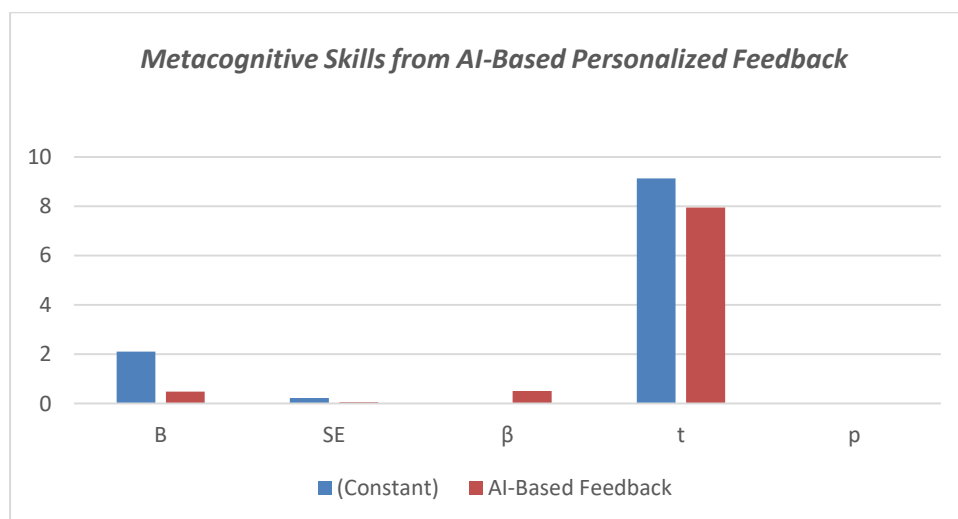
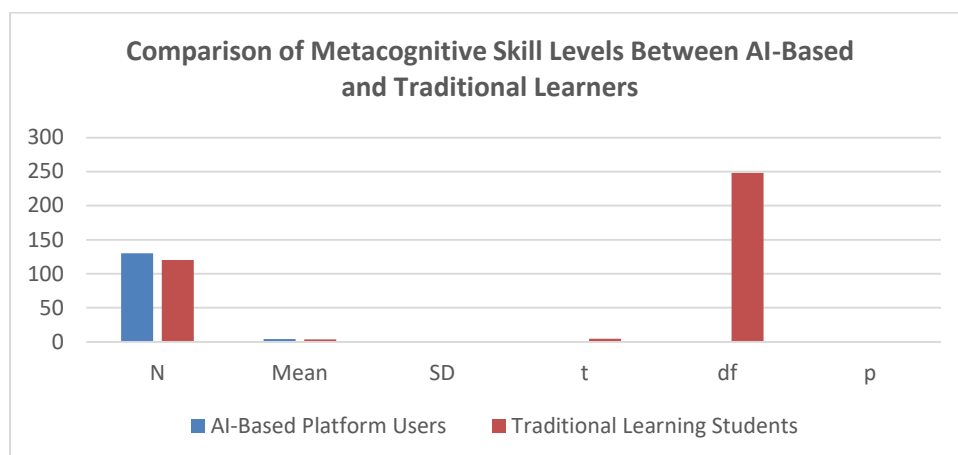


Table 4: Independent Samples t-Test

Group	N	Mean	SD	t	df	p
AI-Based Platform Users	130	4.05	0.58			
Traditional Learning Students	120	3.70	0.65	4.61	248	0.000

The findings of an independent samples t-test of the level of metacognitive skills in the group of students taught on AI-based educational platforms versus the traditional learning methods. The results indicate that there is a considerable variation between the two groups since the AI-based platform users gave a high mean score ($M = 4.05$, $SD = 0.58$) compared to traditional learners ($M = 3.70$, $SD = 0.65$). The t-test obtained a significant result: $t(248) = 4.61$, $p = 0.000$, which means that in the student group that used AI-based instructional tools, the level of metacognition was significantly higher than in the group of students who studied according to the traditional method. This finding indicates that learning environments associated with AI have a positive impact on the capacity of students to plan, monitor, and reflect the learning processes.

Figure 4:



Discussion

The results of the current research indicated that there is a significant and positive correlation between the application of AI-augmented learning environments and the acquisition of metacognitive abilities of college students. Pearson correlation analysis revealed that there is a moderate positive correlation between the two variables, hence, students who would be keenly adopting AI-aided learning tools would have better skills in learning planning, monitoring, and reflecting. The finding is also consistent with the study by (Ismaili, et al. (2024) according to which AI-driven adaptive learning systems have demonstrated their ability to assist students in advancing self-awareness and academic decision-making due to the provision of individualized learning content and constant feedback. The simple linear study also confirmed that the AI-based personalized feedback is an important indicator of the extent of metacognitive skills of the students. It became clear that the level of metacognition of students increases with the consumption of AI feedback tools, which proved the assumption that AI could be applied to advise learners by identifying errors, providing solutions, and mapping the ways to enhance the study process better.

AI-based platforms facilitate the necessary growth of metacognitive awareness in learners because such platforms provide their feedback about their performance as soon as they complete an academic task, and this promotes the need to reflect and work on their abilities. The subject of tracing performance and updating the learning recommendations according to the progress achieved by the student belongs to the core of the role which AI holds in the development of these skills. Moreover, the difference between the level of metacognitive skills of students who utilize AI-based platforms and those who use traditional learning approaches was significant as determined using the independent samples t-test. The students who received assistance of AI-supported tool performed better on metacognitive ability which proves that AI platforms are more effective in fostering skills such as goal setting, progress monitoring and personal reflection of filled training than traditional classroom studies. This finding is consistent with the study of (Kinshuk, et al 201), who found that the use of AI learning environment gives students more time to think and practice new ways of learning independently than the conventional instruction methodology, making them more accountable to their own academic development.

The demographic analysis also revealed that most of the students who took part in the sample preferred AI improved platforms to the traditional learning process with a very high percentage between 21-23 years. This fact shows that it is easier to engage young students in universities through technology-based learning and make them use AI tools to facilitate their academic achievements. Essentially the same trends were outlined by (Sajja, et al. 2024) who have observed that students of higher educational establishments turn more to AI systems when approaching academic assignments, managing their time and solving problems because they are convenient and capable of providing personalized learning environments.

Conclusion

The present research examined how the metacognitive skills would change when using AI-enhanced educational platforms, as an intervention, through the lens of psychology. These findings verified the fact that AI-based learning technology bears a substantial positive connection with the capability of students to plan, track, and reflect on their process of learning. The use of AI-based personalized feedback was seen as an effective predictor of metacognitive skills, who motivate students to be more self-aware and take charge of their studies. Moreover, students working on AI platforms showed better skills of metacognition than those students, working with common methods of learning. The results assume that an AI-based system has academic superiority in terms of providing individualized feedback, performance monitoring, as well as the enhancement of self-regulatory learning behaviors. The demographic outcomes also demonstrated that younger students of universities are willing to use AI-enhanced platforms due to their flexibility and personal assistance. Such results are in line with previous studies and support the psychological and educational value of the implementation of AI in higher education.

Recommendations

1. Universities need to incorporate AI-supercharged learning systems in their normal education as a way of developing their metacognition and student learning outcomes.
2. Instructors ought to train students how to utilize the AI-based personalized feedback tools in the implementation of effective academic planning, monitoring and reflection.
3. Learning institutions would be advised to invest in AI systems that have the ability to provide emotional support options as well as academic counseling capabilities to decrease the stress levels of the students and enhance their emotional proficiency.
4. To encourage self-regulated and reflective learning habit, the AI platforms must be arranged with the means of constant progress monitoring and self-evaluation opportunities.
5. The problem of future curriculum development should pay attention to integrating AI tools into the traditional teaching approach to structure customized, flexible, and balanced learning.
6. Awareness and workshops are to be conducted among the faculty and students to improve awareness of the advantages of AI in teaching metacognitive and self-management skills.
7. Future studies ought to determine how AI-aided learning tools impact the cognitive, emotional, and academic developments of students in the long run.
8. Manufacturers of an AI tool ought to work with educational psychologists to create AI systems that match psychological requirements and learning styles of students.

Future Implications

The results of the present research represent significant future implications to educational institutions as well as technology developers. With the further development of the AI augmented learning systems, they are likely to become increasingly important in the process of enhancing the

metacognition of students and their emotional state. In the future, academic curriculums must incorporate AI technology that helps students assess themselves, provide emotional growth and personalized feedback on their academic achievements. Furthermore, it is possible to personalize AI systems by considering wider psychological and cognitive needs so as to generate more flexible and student-centred learning opportunities. Universities can also discuss the possibility of additional special training programs of students and faculty to take the most out of AI-facilitated learning. The future of the study should consider how AI-based education systems may affect a student in the long-term regarding academic performance, his/her emotional well-being, and skills to engage in lifelong learning through high workability in different educational settings.

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