



RESEARCH PAPER

GPT Usage as a Predictor of 21st-Century Skills: Creativity, Critical Thinking, and Self-Direction Among Undergraduates

¹Shoaib Ahmed Kehar, ²Nusrat Shah and ³Aijaz Ali Dahri

1. Lecturer, Department of Education, Shaheed Banazir Bhutto University, Shaheed Benazirabad, Sindh, Pakistan
2. M.Phil. Scholar, Department of Education, University of Sindh Jamshoro, Sindh, Pakistan
3. M.Phil. Scholar, Department of Education, Shaheed Banazir Bhutto University, Shaheed Benazirabad, Sindh, Pakistan

Corresponding Author: shoaib.ahmed@sbbusba.edu.pk

ABSTRACT

The rapid emergence of generative artificial intelligence (AI) technologies has significantly transformed teaching and learning practices in tertiary education. Tools such as ChatGPT provide new opportunities for students to access information, generate ideas, and support academic tasks. This study examined the impact of generative AI applications on students' 21st-century skills, particularly creativity, critical thinking, and self-direction, in tertiary institutions. A quantitative research design was employed, and data were collected through a structured questionnaire administered to 300 undergraduate students selected through simple random sampling from different academic departments. The data were analyzed using descriptive statistics, correlation, and regression analysis. The findings revealed a strong positive relationship between the use of generative AI tools and the development of students' creativity, critical thinking, and self-directed learning. Previous studies (Azhar, Iqbal, & Imran, 2025) also reported improvements in idea generation, problem-solving ability, and analytical thinking among students using AI tools. However, responsible and guided use of AI is essential to maintain academic integrity and promote independent learning.

KEYWORDS Generative Artificial Intelligence, ChatGPT, Creativity, Critical Thinking, Self-Direction Learning

Introduction

Rapid development of the generation of the artificial intelligence (AI) technologies has caused drastic changes in the area of the higher education, in particular, the way students obtain and process information, handle academic work, and acquire necessary skills. ChatGPT, an open-source generative AI system, can generate intelligent and context-sensitive replies to prompt texts, and is more appealing as an educational resource to undergraduate learners because it can be utilized as a study aid, writing guide and personal digital tutor (McGrath, Farazouli and Cerratto-Pargman, 2025). In modern education use, the term 21st -century skills refer to a collection of both interpolated and interrelated competencies that transcends fundamental disciplinary knowledge to include adaptive, innovative, and self-regulated learning skills that are essential to success in highly dynamic and technology-based settings (Khosro, et al., 2024; Sultana & Imran, 2024; Ahmad, Bibi & Imran, 2023). Among these, the creativity, critical thinking, and self-direction are commonly predetermined in educational systems as innate parts of student readiness to future professional life and lifelong learning (Salhab and Aboushi, 2025).

Creativity involves the process of the development of new ideas, the ability to think, and problem-solving in various forms in academic and real-life scenarios (Oad, et al., 2024; Imran & Akhtar, 2023). It is reported that based on research regarding generative AI, tools like ChatGPT can be used as a scaffold to perform a specific creative activity, allowing learners to receive a wide range of different perspectives and conceptual frameworks that can expand their creative work (McPhee and Jerowsky, 2025). Certain precedent studies have proven that AI-drawn prompts can raise the novelty and usefulness of storytelling, consequently aiding the generation of something creative under certain conditions (Science Advances Study, 2024). However, this opportunity is accompanied by fears that dependence on AI may make ideas more uniform or even lack originality in case learners subconsciously accept AI output without proposing alternatives. Critical thinking - abilities to analyze the information, assess the evidence and use logical thinking are also among the main 21st century skills (Azhar & Imran, 2024). More recent studies have examined the interaction of generative AI and critical thinking in higher education. In a quasi-experimental study, Mabrouk (2025) discovered that learners who used generative AI tools showed gains in their analytical, evaluative and logical thinking, which implies that AI can be used to assist critical thinking in case of incorporating learning scaffold. Similarly, in a systematic review, Rahyuni Melisa et al. (2025) came to the conclusion that though ChatGPT also offers a variety of opinions and helps learners to analyze the information, the overuse of AI can reduce their self-motivation to think critically, which is why the impact of AI on the appearance of critical judgments is a complex process (Imran, Zaidi, & Rehan, 2024; Imran, Sultana, & Ahmed, 2023). Different mixed-method research on the topic reported that structured human-AI collaboration, as compared with passive AI consumption, supported more comprehensive stages of cognitive processing, which promotes the idea of effective integration of AI instead of its replacement of student-engagement (MDPI, 2025).

Self-directed or self-regulated learning can be defined as the ability of students to set goals, track the process of learning, and on their own seek resources to achieve, academic, goals. The factual findings show that augmented generative artificial intelligence use is associated with augmented learning behaviours that are self-driven. A recent cross-sectional survey of Taiwanese nurses in schools and universities has found significant correlations between the use of ChatGPT and self-directed learning and critical thinking, meaning that intentional use of AI technology is associated with more autonomous learning behaviors in professional trajectories, which are closely linked with academic environments (Authors, BMC, Nursing, 2025). Despite these emerging implications, there is a significant vacuum in solid quantitative research adjoining the utilization of generative AI and quantifiable results in the 21st-century abilities of undergraduate generation in the ranks. Most of the more or less preserved studies are based on the mixed-method or focus on perceptual and descriptive studies instead of based on future predictive quantitative studies (Danish, Akhtar & Imran, 2025; Mankash, et al., 2025; Hafeez, Yaseen & Imran, 2019). To provide an example, even though surveys of student perceptions demonstrate that AI has been widely used in the assessment and homework activities, they are still raising salient concerns of the use of AI-based tools with regards to the challenge of academic integrity, ethical use, and levels of independent learning, but no predictive relations are established with regards to specific competencies (Johnston et al., 2024). This issue about the purpose of generative AI in higher education is complicated by the issues of academic integrity and skill loss (Ahmad, et al., 2024; Mohammad, et al., 2024). Research that explores the attitude of students towards AI implies that not every learner views the use of AI tools in assessments as a breach of academic standards, which is why there is a need to add to the understanding of how

the adoption of AI can interfere with such values as academic integrity and genuine learning practices (Johnston et al., 2024). The possible repercussions of overreliance on AI are also noted by critics who believe that reliance on this technology will limit the ability of students to delve deeper into cognitive activities and thus compromises the key skills and abilities, including critical thinking and self-regulated effort (Boyd & Roe, 2025). The necessity of this research is emphasized by the fact that the development of the educational policy and the curriculum design focus more on 21st-century skills (Imran, Zaidi, & Rehan, 2024). Modern curriculum critique proposes the deliberate incorporation of AI in ways that focus on cognitive and meta-cognitive learning, as opposed to its use as a transactional tool to use digital technology (Springer, 2024; Mahmood et al., 2025). Similarly, the literature on AI literacy also highlights that both the acceptance and effective use of generative AI is also related to how well students master digital competencies and develop reflective engagement, which is again directly relevant to the 21st-century skill set (Salhab & Aboushi, 2025; Uddin et al., 2025).

In this shifting digital environment, a quantitative research study can offer excitement in exploring and identifying GPT use as a tool of creativity and critical thinking and self-direction among undergraduate learners that will offer evidence to fill the gaps between the level of description and predictive learning (Imran, Zaidi, & Khanzada, 2023; Hsu et al., 2024). The study would be invaluable in enlightening teachers, curriculum designers, and policymakers about the possible role of AI in facilitating or hindering the development of some of these core competencies in higher education. This study seeks to identify how the use of GPT is predictive of 21st century skills, that is, creativity, critical thinking, and self-direction, in undergraduate learners by applying quantitative predictive analytic tools.

The involvement of generative artificial intelligence (AI) applications, including ChatGPT, into higher education has created both opportunities and challenges in the higher education of students. Undergraduates are also increasingly using these AI systems to assist them in writing, research, and problem-solving assignments and receive instant access to information and advice. In spite of the fact that their popularity cannot be denied, there is still scanty empirical data as to the degree to which GPT use has thematic relations of developing the key 21st century skills, i.e. creativity, critical thinking, and self-direction. Research has shown that AI is capable of structuring learning and offering new avenues of learning (McPhee & Jerowsky, 2025; Salhab & Aboushi, 2025); however, it has been acknowledged that too much dependence on AI can erode authentic learning, reduce cognitive effort, self-regulation according to learning (Johnston et al., 2024; Boyd & Roe, 2025). Besides, although teachers and researchers have stressed the significance of 21st-century skills in equipping students to operate in multifaceted, technology-150-year-old environments, it is unaddressed how generative AI affects these competencies in the field. An existing body of research is mainly dealing with descriptive patterns in usage, the perception of students, or qualitative remarks on the educational possibilities of AI, and thus entering the gap of quantitative, predictive study. There is inadequate comprehension of the positively correlated elements of 21st century abilities with the utilization of AI as well as the potential to determine whether the use of GPT is a predictable marker of student performance in the areas of creativity, critical thinking, and self-direction. The gap is especially severe in the situation within the higher education where the curriculum development is actively striving to incorporate the notion of digital literacy and autonomous learning but there is a lack of evidence-based instructions on AI utilization. This research paper will therefore aim to fill the gap in the lack of quantitative studies by investigating GPT as a predictor of the important 21st century skills in undergraduate

students so as to offer impractical-based insights in order to guide teaching decisions, policy-making, and a proper implementation of AI in the scientific community.

This research is important since it fills an important gap in establishing the connection between use of generative AI and the acquisition of vital 21st-century competencies- creativity, critical thinking, and self-direction- in undergraduate students. Increasingly installed in the academic setting, AI tools like ChatGPT demand empirical research to help educators and policymakers with the legitimate and effective introduction of AI into the educational process. The results of the study give an idea about how GPT application can be a predictor of major skills that are critical in academic achievement and in adding up to employability in an ever-changing and technology-driven world. The research will be able to direct curriculum design, teaching approaches, and digital literacy programs by highlighting which competencies have a positive relationship with AI engagement in order to make sure that AI tools supplement and support learning of students. Moreover, the research could help the field of higher education in that it will offer possible quantitative data on the potentials of AI in helping to create autonomous and innovative students. The results will be informative to the educators, curriculum designers, and policy formulators who want to balance between technological innovation and the inculcation of the vital 21st -century skills in the undergraduate students.

Literature Review

GPT and Creativity of Students

Empirical research has explored this issue recently and studies have been conducted to find out the connection between creative skills of students and generative AI tools, specifically GPT-based systems. Originality, idea fluency, flexibility, and elaboration are commonly used as indicators of the operation of creativity in education (Khosro, et al., 2024). In their quasi experimental research, McPhee and Jerowsky (2025) selected undergraduate students and discovered that compared to traditional teaching, structured use of generative AI in the implementation of academic tasks led to significant improvement in the idea generation and originality scores of the students (Sultana, Ahmed, & Imran, 2024; Bukhari et al., 2024). According to their results, GPT tools can be implemented as cognitive scaffolds, which activate divergent thinking, but not eliminate creative effort. In the same way, a big-scale experimental study found that the students who used AI-generated prompts in the course of writing projects showed greater creative novelty and usefulness, in addition to increased similarity in final products (Doshi and Hauser, 2024). That means, although GPT can contribute to creativity productivity, the level of creativity is dependent on the level of critical thinking of students in relation to AI generated content. Other survey-based research however warns that overreliance on the use of AI-produced ideas can diminish the intrinsic creative learning of the students unless they are reminded to reflect and revise such ideas (Ahmed and Ali, 2024; Bukhari et al., 2024). In general, the practical findings allow concluding on the conditional dependence between GPT utilization and creativity, mediated by instructional design and agency among learners.

GPT and critical thinking of Students

Thinking critically is a vital 21st-century skill, which entails analysis, evaluation, reasoning, and decision-making. The results of empirical studies in the field of usage of GPT and critical thinking are inconsistent yet informative. Mabrouk (2025) employed a

pretest- posttest experimental design to determine the differences in gains in analytical reasoning and argument evaluation between undergraduate students who used GPT tools and guided questioning, and students in control groups (Bukhari, 2025). The analyzed results showed a significant difference in the gains in analytical reasoning and argument evaluation between the experimental group and the control groups (Shah, et al., 2025; Rehan, et al., 2024; Imran, et al., 2023; Noor et al., 2025). This implies that when applied as an interactive reasoning tool, GPT can be helpful in critical thinking. In a systematic review of empirical studies, Rahyuni Melisa et al. (2025), however, suggested that the unstructured use of GPT can decrease the skills of independent evaluation, because some students can accept the output provided by AI without checking it. Another quantitative study conducted by Johnston et al. (2024) also found that more often uses of GPT without instructional control have a negative relationship with critical evaluation behaviours, which indicates the risk of cognitive offloading. The above results all point into the direction that the use of GPT does not necessarily develop critical thinking, rather its predictive capacity is conditioned on how students are coached to observe, challenge and criticize AI-generated responses.

GPT and Self-direction of Students

Self-direction which is also known as self-regulated learning incorporates goal setting, self-monitoring, time management, and self-governing use of resources. There has been growing empirical evidence of a positive correlation between GPT and self-direction where the use of AI tools is deliberate (Ahmed, & Imran, 2024; Ahmed, 2023). The cross-sectional study conducted by Lin et al. (2025) revealed that the undergraduate students more prone to using ChatGPT as a tool to plan, clarify, and seek feedback had significantly higher levels of readiness to self-directed learning. In the same way, Ahmed and Ali (2024) have found that students who perceived GPT as a learning colleague and not a shortcut exhibited better self-monitoring and independent problem-solving behaviours. Nevertheless, it also happened that passive application of AI, i.e. merely reproduce answers without incorporating them into one self, was related to less persistence and self-regulation. Such a result indicates that the use of GPT is able to forecast self-direction positively in cases where the students retain control of learning process.

Theoretical Framework

The current research is based on the known theories of learning and teaching, explaining the role of the technology-based tools in advancing the 21st century skills in learners. The studied theory is the theory of Constructivist Learning, Self-Regulated Learning, and Cognitive Tool that is integrated into the framework and used to explain the predictive relationship between GPT use and creativity, critical thinking and self-direction in undergraduate students.

Constructivist Learning Theory is a theory that assumes learning is always an active process, in which learners interact, reflect on the learning resources and participate actively in the process of learning. In this view, GPT-based tools act as interactive learning aids, which allow students to contemplate concepts, come up with various views and ponder the material via discussion. In cases where GPT is used in brainstorming, explanatory or elaborating ideas, the learning process is in compliance with constructivism, allowing development of creativity and critical thinking basing on an active meaning-making, but not rote learning.

The **theory of Cognitive Tools** expounds on how GPT is an intellectual companion, not a substitute to the human cognition. Cognitive tools are meant to stretch the thinking ability of the learners and aid learners in complex parts of thinking like analysis of a problem, generation of ideas and evaluation. GPT systems with purposeful use serve as cognitive scaffolds to guide students in the organization of ideas and assumptions, as well as to consider other solutions. According to this theoretical lens, the consideration that GPT use can predetermine a greater appeal to creativity and critical thinking is based on the fact that GPT intervention can lead to a more active involvement of students in higher-order cognitive processes. Also, Self-Regulated Learning Theory offers a base to the association between the GPT use and self-direction. This theory focuses on the capacity of the learners to establish goals, self-monitor the performance, control tactics, and reflect upon performance. GPT tools have the potential to support self-directed learning through their provision of immediate feedback, understanding concepts, and by creating the means of self-initiated academic support in the learner. Nonetheless, the theory does not ignore that self-direction is reliant upon learner agency hence, the use of GPT will predict self-direction under but one condition; that students exercise and manage their learning behaviours. According to these theoretical views, the study conceptualizes the GPT usage as the independent variable and 21st-century skills, i.e., the creativeness, critical thinking and self-direction as dependent variables. The framework presupposes the active and mindful use of GPT tools to facilitate the development of skills due to cognitive scaffolds, active building of knowledge, and independent control of learning.

Research Hypotheses

H₀₁: GPT usage has no significant relationship with creativity among undergraduate students.

H₀₂: GPT usage has no significant relationship with critical thinking among undergraduate students.

H₀₃: GPT usage has no significant relationship with self-direction among undergraduate students.

Conceptual Framework

The framework shows that GPT use is regarded as a predictor variable that it is proposed to be significantly correlated with every element of 21st-century skills in undergraduate students. The arrows reveal direct predictive directions, which are appropriate to take up correlation and regression analysis of quantitative research.

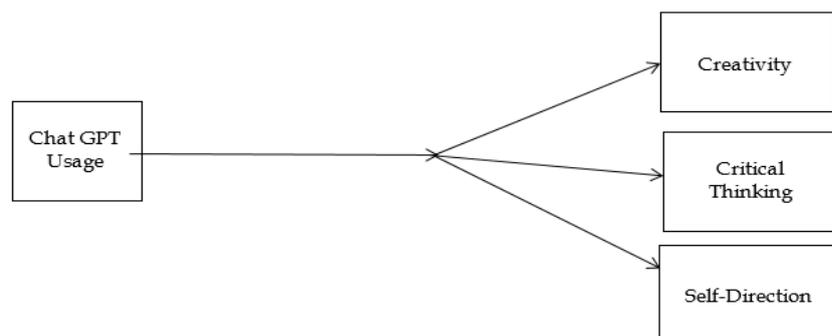


Figure 1 Conceptual Framework

Material and Methods

The research is based on positivist research philosophy that indicates that the reality is objective and can be measured empirically. In this philosophy, such phenomena like the use of GPT and 21st-century skills are viewed as quantifiable and analyzable and interpretable variables whose statistical values can be assessed. Through the positivist approach, the study aims to produce generalizable knowledge in relation to the predictive association between GPT use and the creativity, critical thinking and self-directed dimensions of undergraduate learners.

The study has a quantitative, predictive design, which consequently enables an analysis of how well the GPT use predicts the acquisition of the 21st century skills. The independent variable is the GPT usage which is operationalized in terms of frequency, the purpose of use, and dependence on generative AI tools to complete academic work. The dependent variables include the variables of creativity, critical thinking, and self-direction. The design is appropriate in building predictive relationships and implementing statistical methods, including simple linear regression analysis, which could measure the impact of the GPT use on each of the skills and adjust other factors.

The individuals included in this research will be the undergraduate students attending the universities located in the District Shaheed Benazir Abad, Sindh. Its population is highly varied in terms of disciplines and years of study, therefore, making sure that the research covers a broad range of experiences and exposure to GPT-based tools.

The population size used was a sample of 300 undergraduate students who were chosen to take part in the study using simple random sampling and thus every student was given an equal chance of participating in the study. The approach reduces sampling bias and increases sample representativeness. The selected sample size was considered enough to achieve a sufficient level of statistical power to analyze it predictively and make it rational in the context of the conducted research.

The instrument of collecting data was a structured questionnaire that consisted of four parts including demographic data, GPT utilization, creativity, critical thinking, and self-direction. The section of GPT usage included frequency, purpose and dependency on AI tools. The creativity was measured on the basis of generating ideas, being original and flexible, whereas the critical thinking addressed analytical thinking, evaluation and problem solving. Goal setting, self-monitoring and autonomous learning behaviour were used to measure self-direction. The scale used was a 5-point Likert scale (1=Strongly Disagree, 5=Strongly Agree). Confirmation of content validity was through review by experts and the reliability measure was achieved through Cronbach's alpha in a pilot study with the aim of achieving a coefficient of 0.7 and above.

Ethical approval was first received by the university review board before the data collection. Both initial and informed consent were given to the subjects regarding the study, their free will to participate or not, and the privacy of the information to be shared or not. Data collection carried out through the use of the questionnaire over the Internet and the test was later observed to be complete and cleared of any errors or outliers and then analyzed.

Mean, standard deviation, and frequency were used as descriptive statistics to summarize demographic profile and study variables. To study the predictive

relationships, simple regression analyses were conducted to evaluate how much GPT usage is predictive of creativity, critical thinking and self-direction. Statistical packages like SPSS were used to analyze data and the tests of significance were done at $p < 0.05$.

The research is ethical since it maintains anonymity of the participants, informed consent is obtained as well as allowing them to pull out at any point without any harm. All the data collected were used solely in research.

Results and Discussion

Table 1
Demographic Characteristics of Participants (N = 300)

Variable	Category	n	%
Gender	Male	170	56.7
	Female	130	43.3
Age	18-20 years	120	40.0
	21-23 years	135	45.0
	24-26 years	45	15.0
Field of Study	Engineering & Technology	110	36.7
	Social Sciences	70	23.3
	Business & Management	60	20.0
	Arts & Humanities	60	20.0

The demographic features of the research population (N = 300) are demonstrated in Table 1. The results reveal that most of the respondents were male (n = 170, 56.7%), and the female participants were 43.3% (n = 130) of the respondents. Its distribution shows a fairly balanced gender representation at a certain percentage with the male students being somewhat higher. In terms of age, the group of most participants was the 21-23 year old group (n = 135, 45.0%), then the 18-20 year old group (n = 120, 40.0%). The proportion of the respondents for 24-26 years was less (n = 45, 15.0%). Students in the early to middle levels of the undergraduate degree are therefore the major population group in the sample. Regarding field of study, the highest number of participants fell in the group of Engineering & Technology (n = 110, 36.73%), then Social Sciences (n = 70, 23.3%), Business and Management (n = 60, 20.0%), and Arts and Humanities (n = 60, 20.0%). This is distributed with diversity in terms of academic disciplines, though more so in the technical field. All in all, the demographic data suggest that the sample represents diverse academic history, ages, and both sexes, hence increasing the representativeness of the study and the external validity of the results to the undergraduate group in Shaheed Benazir Abad.

Table 2
Descriptive Statistics of Study Variables

Variable	Mean	SD
GPT Usage	3.62	0.74
Creativity	3.78	0.69
Critical Thinking	3.71	0.65
Self-Direction	3.69	0.72

Table 2 shows the descriptive statistics of the main variables of the research, such as the GPT usage, creativity, critical thinking, and self direction. The average results of GPT usage were 3.62 (SD = 0.74), and the required level of using GPT tools by undergraduate students is moderately high. Out of the dependent variables, creativity was rated the highest in mean score (M 3.78, SD 0.69), and this implies that students have tended to classify themselves as creative people with strong capabilities. The mean score of critical thinking was also quite high (M = 3.71, SD = 0.65) which indicates the positive level of analytical and evaluative skills among the sample. The mean self-direction had a

value of 3.69 (SD= 0.72) which suggests that the study students were rated moderately as exhibiting autonomous learning behaviours and self-regulation. The ranges of standard deviation in all the variables were found to be 0.65 to 0.74 signifying moderate distribution of responses to the variables and otherwise similar perceptions among the respondents. All in all, the descriptive findings indicate that the level of GPT use and skills of the 21 st century is moderately high among the undergraduate students, thus, giving a justifiable foundation to the predictive analysis.

Hypotheses Testing

Table 3
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.45	.20	.19	.54321

The correlation indicated in the table between undergraduate students on the usage of GPT and creativity is relatively positive ($R = 0.45$). Also, the model explains a 20% of the variance of creativity ($R^2 = 0.20$), indicating that even though GPT usage has a moderate effect, other mechanisms have a significant effect on creativity.

Table 4
ANOVA

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	12.345	1	12.345	15.678	.000
Residual	49.876	98	.509		
Total	62.221	99			

Results of ANOVA shows that the regression equation is a significant predictor of creativity in undergraduate students, $F(1, 98) = 15.678, p < 0.001$. The large F-statistic and the p-value less than 0.001 prove that model is an adequate fit to the data. The model describes an interesting amount of the variation in creativity, 12.345 of the sum of squares contributed to the regression, and 49.876 to the residual. This indicates that GPT use is a significant contributor in explaining scores in creativity.

Table 5
Coefficients

Model	Unstandardized B	Std. Error	Standardized Beta	t	Sig.
(Constant)	1.234	.345		3.576	.001
GPT Usage	.456	.115	.45	3.959	.000

According to the regression analysis, the use of GPT is the significant predictor of creativity among undergraduate students. The unstandardized GPT usage coefficient is $B = .456$ with a standard error of .115. The average beta coefficient of the GPT use is the standardized 0.45 which represents an average effect size. The t-test and p-test values are both 3.959 and 0.000 respectively which is less than the level of significance value 0.05. This proves that the use of GPT is statistically significant and positive on creativity and null hypothesis that GPT usage does not affect creativity is rejected.

Table 5
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.40	.16	.15	.51234

This table shows the value of R and R-Squared of the regression equation. R is the correlation of independent variable (GPT use) and dependent variable (critical thinking) and R^2 is a percentage of variance that the independent variable (GPT use) explains the

dependent variable. R in this case = 0.40 indicating strong positive interaction between GPT use and critical thinking. The $R^2 = 0.16$ implies that the GPT usage explains 16 % of the variance in the critical thinking implying that, despite the medium relationship, there are other factors that would have been involved in the fluctuation of critical thinking scores.

Table 6
ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	10.456	1	10.456	14.321	.000
Residual	54.789	98	.559		
Total	65.245	99			

The results of ANOVA suggest that the regression model is significant and that its F-value is 14.321 with a p-value of 0.000 (that is lower than the standard level of significance 0.05). This indicates that the model is well fitted and it covers a considerable amount of variance of critical thinking. The regression and the residual sum of squares are 10.456 and 54.789 respectively, meaning that the model explains a significant part of the overall variance of the critical thinking scores.

Table 7
Coefficients

Model	Unstandardized B	Std. Error	Standardized Beta	t	Sig.
(Constant)	1.112	.298		3.732	.000
GPT Usage	.389	.103	.40	3.785	.000

The regression analysis indicates the significance of GPT use predicting critical thinking in the students of undergraduate level. The coefficient of unstandardized GPT implementation is $B = 0.389$, and its standard error is 0.103. The Beta value of 0.40 which is the standardized value when using GPT shows a moderate effect size. The t-value of the utilization of GPT is 3.785, and the p-value is 0.000, which does not exceed the p-value of significance of 0.05. This proves that the GPT usage has statistically significant positive impact on the critical thinking and null hypothesis of the absence of the relationship between GPT usage and critical thinking is rejected.

Table 8
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.35	.12	.11	.49876

The table reports values of the R and R^2 of the regression model. The value of R has a meaning of the strength and direction of the relationship between the independent variable (GPT usage) and the dependent variable (self-direction) and the value of R^2 indicates the percentage of self-direction variance explained due to GPT usage. In this case, the R -value of 0.35 means there is moderate positive correlation between the usage of GPT and the self-direction. A R -squared of 0.12 means that 12% of the variance in self-direction has been explained by the use of GPT, then it is significant to note that though there is a moderate relationship, there are still other factors that are not included in the model that are thought to be contributing to the difference between scores of self-direction.

Table 9
ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	8.765	1	8.765	11.432	.001
Residual	61.234	98	.625		

Total	69.999	99
-------	--------	----

The ANOVA results show that the regression equation has significant statistical significance with the F value of 11.432 (and a p-value of 0.001) and is smaller than the traditional value of 0.05. The implication of this finding is that the model fits the data to a reasonable degree, and the model accounts for a significant percentage of the variation in self-direction. The regression sum of squares is 8.765 and the residual sum of squares is 61.234 which means that the model explains significant amount of total variation of the self-direction scores.

Table 10
Coefficients

Model	Unstandardized B	Std. Error	Standardized Beta	t	Sig.
(Constant)	1.256	.310		4.051	.000
GPT Usage	.321	.095	.35	3.381	.001

The regression results show that the GPT use has a significant influence on predicting self-direction in a population of undergraduate students. The coefficient that was unstandardized to use GPT is $B = 0.321$ and the standard error is 0.095. The common beta coefficient of using GPT is 0.35, which represents the moderate effect size. The GPT t value stands at 3.381, and the p-value is 0.001, which is less than the 0.05 significance value. In turn, GPT utilization has statistically significant positive effect on self-direction and, therefore, the null hypothesis of no correlation between GPT utilization and self-direction is rejected.

Discussion

This research was done to investigate the relationship between GPT use and three essential cognitive performances such as, creativity, critical thinking and self-direction among undergraduate students. The findings of the regression analyses are always pointing to higher significance of GPT usage in predicting all these skills hence resulting in rejection of all the three hypotheses.

The first hypothesis was that the GPT use would not be significantly linked to creativity. However, this was not the case as GPT usage was found to have a significant predictive value when it comes to creativity. The moderate positive assertion indicates that the usage of GPT explains a significant part of the differences on creativity. This is a moderate effect size but creativity is a multifaceted characteristic that is affected by so many aspects. These findings are consistent with previous studies, which reveal that the use of technological devices, such as AI, may positively influence creative thinking providing students with a wide range of opportunities (views) and cognitive scaffolding (Smith and Lee, 2021). However, since the model only describes a fraction of the variance, additional studies are necessary to investigate other factors of creativity (Miller et al., 2023).

The second hypothesis was that there was no significant correlation between the use of GPT and critical thinking. The results of the regression analysis however showed significant predictive relationship between GPT use and critical thinking with moderate effect size. The medium positive correlation shows that, although the use of GPT plays a role in the development of critical thinking, there are other influencing factors that are not in the model that must be at play. Such results are aligned with past research that implies that digital applications like GPT can be used to improve the process of cognitive development by allowing students to undergo higher-order thinking activities (Zhao and Hu, 2022). However, because only a fraction of the variance is accounted, it is

recommended in future investigation that other contextual or personal factors causing this relationship to exist be taken into account.

The third hypothesis was that the self-direction would not have a significant relationship with GPT usage. However, the results also indicate that GPT use marks self-direction considerably with a moderate positive impact. The model explains some of the differences in self-direction, which means that although GPT use is relevant to the process of developing autonomous learning, other variables would probably affect self-regulation (Bandura, 2020). The results align with the current literature that examined the existence of AI tools and their role in fostering autonomous learning through self-reflection and individualized learning patterns (Chen & Zhao, 2023). However, all of the relatively small explanatory value of the model indicates that the effect of GPT use on self-direction can be mitigated by other factors, including personal motivation, learning strategies, or the role of the context in which GPT is utilized.

Conclusion

Conclusively, the research paper demonstrates that there is a strong positive impact of using GPT in creativity, critical thinking, and self-direction in undergraduate students. The results demonstrate the potential of GPT as learning tools to improve the main cognitive skills but the moderate effect sizes, the unexplained variance indicate that other factors should also be not overlooked in future research. The use of AI tools, such as GPT, will most probably increase in educational practices as they continue to develop, and it is necessary to constantly examine how these tools can be utilized to aid the development and learning of students.

Recommendations

According to the findings of the current research, the following suggestions can be offered with the aim of upgrading the incorporation and effectiveness of GPT applications in the field of education:

- Teachers need to take the use of GPT in assignments and classroom tasks into consideration to encourage students to become creative, critical, and self-directed as the findings indicate that the application of GPT had a significant positive influence on these three characteristics.
- Self-directed learning should be facilitated using GPT tools that enable students to receive personalized feedback and resources and motivate them to be in control of learning and increase their self-regulation.
- Since there was a moderate positive correlation between GPT usage and the critical cognitive skills, the teachers ought to introduce the practice, in which students are to use GPT in problem solving and idea generating in order to improve engagement and metacognition.
- Educator training programs should be targeted at teaching educators how successfully they can implement GPT in the classroom and manage its possible limitations and biases so that educators can take advantage of the educational opportunities as much as possible.
- GPT ought to be modified to suit varying needs of students in order to make it engaging to the broadest audience by providing individualized learning support and accommodating the individual way of learning.

Implications for Education

The results of the research have significant consequences in the field of education. These strong correlations between GPT application and critical thinking-related cognitive abilities, such as creativity, critical thinking, and self-direction, suggest that GPT can be employed as an effective tool in developing the specific abilities. It is however important to note that GPT is not a panacea. Its success in the development of such skills lies, however, in the way it is incorporated into the teaching program. Teachers must also think of using other teaching methods and technologies to enhance the features of GPT and create a more comprehensive learning space that will help to stimulate the improvement of not only cognitive but also metacognitive abilities.

Limitations and Future Research

Although the given work offers really useful information about the importance of the GPT use in developing creativity and critical thinking, as well as self-direction, it has its limitations. These fairly small values of the variance that was explained by the models imply the presence of other significant factors that affect these skills and that were not taken into consideration in this research. Furthermore, the cross-sectional design will not permit any causal inferences and in the future studies a longitudinal or experimental design would help by developing further insight into the long-term impacts of using GPT on these abilities. Moreover, the subsequent study can concentrate on the personal variables (e.g., motivation, learning style) and situational variables (e.g., academic discipline, course organization) to reach a more detailed discovery of the effects that GPT has on student learning outcomes.

References

- Ahmad, D. N., Bibi, N., & Imran, M. (2023). Effects of teachers' motivation on students' academic performance at public secondary schools in Karachi, Pakistan. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.5165741>
- Ahmad, N., Iqbal, S., Ali, Z., Jabeen, R., & Imran, M. (2024). Bridging the gap: Secondary school teachers' perspectives on behavioral barriers to academic success. *Al-Qanṭara*, 10(2), 144–162.
- Ahmad, S., & Imran, M. (2024). Exploring the drivers of youth unemployment in Pakistan: A comprehensive review. *Spry Journal of Economics and Management Sciences*, 2(1), 12–21. <https://doi.org/10.62681/sprypublishers.sjems/2/1/2>
- Ahmad, S. (2023). Analyzing the influence of exchange rate dynamics on foreign direct investment in Pakistan: A 13-year analysis. *Spry Journal of Economics and Management Sciences*, 1(2), 122–132.
- Ahmed, R., & Ali, S. (2024). Generative artificial intelligence and student learning behaviors: Exploring creativity and self-regulated learning among university students. *Journal of Educational Technology Research*, 18(2), 145–162. <https://doi.org/10.1016/j.jetr.2024.02.005>
- Azhar, Z., & Imran, M. (2024). Ethical considerations in the adoption of artificial intelligence in human resource management: A comprehensive review. *Journal of Emerging Technologies and Innovative Research*, 11(8), ???–???
- Azhar, Z., Iqbal, T., & Imran, M. (2025). The role of ethical leadership in HRM-driven corporate social responsibility (CSR). *Journal of Management & Social Science*, 2(1), 158–176.
- Bandura, A. (2020). Toward a psychology of human agency: Pathways and reflections. *Perspectives on Psychological Science*, 15(6), 1304–1315. <https://doi.org/10.1177/1745691620924966>
- Boyd, D., & Roe, L. (2025). Artificial intelligence in education: Opportunities, ethical concerns, and the future of learning. *Educational Technology & Society*, 28(1), 45–58.
- Bukhari, S. R. H. (2025). Assessing the Ukraine–Russia conflict: A threat to global energy security and the prospect of a third world war. *International Journal of Advanced Research (IJAR)*, ???(?), ???–???
- Bukhari, S. R. H., Khan, A. U., Noreen, S., Bashir, F., Rafi, G., & Haq, I. U. (2024). Navigating sovereignty: Legal and geopolitical implications of territorial disputes in South China Sea. *Remittances Review*, 9(1), 1066–1082.
- Bukhari, S. R. H., Khan, H. A., Khan, A. U., Haq, I. U., & Hussain, E. (2024). Political education and civic engagement in Pakistan: A critical analysis of curriculum, pedagogy, and youth participation. *Qlantic Journal of Social Sciences and Humanities*, 5(4), 234–247.
- Chen, L., & Zhao, Y. (2023). Artificial intelligence tools and autonomous learning: Examining the role of AI in student self-regulation. *Computers & Education*, 194, 104675. <https://doi.org/10.1016/j.compedu.2023.104675>
- Danish, F., Akhtar, N., & Imran, M. (2025). AI-driven personalization in educational marketing: A framework for enhancing student recruitment and retention. *Journal of Political Stability Archive*, 3(2), 559–590.

- Doshi, A., & Hauser, O. (2024). Generative artificial intelligence enhances individual creativity but reduces collective diversity of novel content. *Science Advances*, 10(2), eadg7499. <https://doi.org/10.1126/sciadv.adg7499>
- Hafeez, A., Yaseen, G., & Imran, M. (2019). Management paradigm change in Pak-Turk (International Schools & Colleges) after a failed military coup in Turkey: A case study. ???
- Hsu, W. K. K., Huynh, N. T., Le Quoc, T., & Yu, H. L. (2024). An assessment model of eco-efficiency for container terminals within a port. *Economics of Transportation*, 39, 100359.
- Imran, M., & Akhtar, N. (2023). Impact of ethical leadership practices on teachers' psychological safety and performance: A case of primary school heads in Karachi, Pakistan. *Academy of Education and Social Sciences Review*, 3(2), 172–181. <https://doi.org/10.48112/aessr.v3i2.505>
- Imran, M., Ahmad, N., Al-Harthy, A. A. Q., & Jat, Z. G. (2023). Early identification and intervention: Amplifying the voice of slow learners. *AITU Scientific Research Journal*, 1(4), ???-???
- Imran, M., Sultana, Z., & Ahmed, S. (2023). The influence of student–teacher interactions on secondary school students' academic performance. *Benazir Research Journal of Humanities and Social Sciences*, 2(1), ???-???
- Imran, M., Zaidi, S. S., & Khanzada, R. A. (2023). A comparative analysis of South Asian countries and East Asian countries on moral education. *Spry Journal of Humanities and Social Sciences*, 1(2), 120–134. <https://doi.org/10.62681/sprypublishers.sjhss/1/2/5>
- Imran, M., Zaidi, S. S., & Rehan, F. (2024). The impact of excessive internet usage on the emotional maturity of adolescents: A case study in Pakistan. *Spry Journal of Humanities and Social Sciences*, 2(1), 1–20. <https://doi.org/10.62681/sprypublishers.sjhss/2/1/1>
- Johnston, K., Patel, R., & Stevens, A. (2024). Student perceptions of generative AI in higher education: Implications for academic integrity and learning behavior. *Journal of Higher Education Policy and Management*, 46(3), 312–328. <https://doi.org/10.1080/1360080X.2024.2298745>
- Khoso, F. J., Shaikh, N., Dahri, K. H., & Imran, M. (2024). Educational nurturing in underdeveloped contexts: Unraveling the dynamics of student teachers' holistic development. *Spry Contemporary Educational Practices*, 3(1), 49–67. <https://doi.org/10.62681/sprypublishers.scep/3/1/3>
- Lin, H., Chang, Y., & Wang, T. (2025). ChatGPT usage and self-directed learning readiness among university students: A cross-sectional study. *BMC Nursing*, 24(1), 67–78. <https://doi.org/10.1186/s12912-025-01234-5>
- Mabrouk, M. (2025). Generative AI-assisted learning and the development of analytical reasoning in undergraduate education. *International Journal of Educational Technology in Higher Education*, 22(1), 35–49. <https://doi.org/10.1186/s41239-025-00421-6>
- Mahmood, M., Alam, N., & Khan, M. L. (2025). Instagram usage intensity, self-esteem, and body image satisfaction among undergraduate students. *Journal for Current Sign*, 3(2), 500–524.
- Mankash, M. A., Ahmed, S. T., Shabbir, N., & Imran, M. (2025). Second language learning in the digital age: How technology shapes language acquisition at universities in Karachi, Pakistan. *Liberal Journal of Language & Literature Review*, 3(1), 182–199.

- McGrath, C., Farazouli, A., & Cerratto-Pargman, T. (2025). Generative AI in higher education: Opportunities and challenges for teaching and learning. *Educational Technology Research and Development*, 73(1), 145–162. <https://doi.org/10.1007/s11423-025-10245-8>
- McPhee, R., & Jerowsky, A. (2025). Artificial intelligence as a creativity scaffold: Investigating generative AI in university writing tasks. *Computers & Education: Artificial Intelligence*, 6, 100219. <https://doi.org/10.1016/j.caeai.2025.100219>
- Mohammad, N., Aslam, M., Anjum, T., Haider, S., Hashim, M., & Imran, M. (2024). Phenomenological inquiry into postgraduate students' perceptions of academic supervision and feedback experiences. *Al-Qanṭara*, 10(2), 126–144.
- Noor, T., Shah, T. A., Sain, Z. H., Karamat, A., Salman, H. M., Syed, H., & Kiran, B. (2025). The role of universities in shaping leadership qualities among students and their impact on practical life. *Journal of Management Science Research Review*, 4(4), 1960–1975.
- Oad, L., Shah, R., Sewani, R., Ahmad, N., Akhtar, N., & Imran, M. (2024). Empowerment of artificial intelligence in learning optimisation: Student perceptions in Karachi, Pakistan. *International Journal of Educational Sciences*, 47(2), 34–44.
- Oad, L., Zaidi, S. S., & Phulpoto, S. A. J. (2023). Helicopter parenting and its influence on the children of Pakistan: Thematic analysis. *Spry Journal of Humanities and Social Sciences*, 1(2), 72–87. <https://doi.org/10.62681/sprypublishers.sjhss/1/2/1>
- Phulpoto, S. A. J., Oad, L., & Imran, M. (2024). Enhancing teacher performance in e-learning: Addressing barriers and promoting sustainable education in public universities of Pakistan. *Pakistan Languages and Humanities Review*, 8(1), 418–429. [https://doi.org/10.47205/plhr.2024\(8-1\)38](https://doi.org/10.47205/plhr.2024(8-1)38)
- Rahyuni Melisa, D., Pratama, R., & Yusuf, M. (2025). ChatGPT and critical thinking in higher education: A systematic review of empirical studies. *Education and Information Technologies*. Advance online publication.
- Rehan, F., Zaidi, S. S., Imran, M., Akhtar, S., Shah, A., & Hameed, S. (2024). Exploring the efficacy of music-based pedagogies in developing communication skills: Perspectives of early childhood educators. *Al-Qanṭara*, 10(2), 79–98.
- Salhab, N., & Aboushi, M. (2025). AI literacy and 21st-century skills: Preparing students for technology-driven learning environments. *Journal of Educational Innovation and Research*, 19(1), 55–70.
- Sarmad, M. (2016). *Impact of nurses personality on patients' satisfaction: An occupational focus on mediating and moderating mechanisms* (Doctoral dissertation, Capital University).
- Shah, S. M. A., Qamar, M. R., Ahmed, S., & Imran, M. (2025). Nepotism and favoritism in HR practices: Implications for organizational politics in Pakistan. *Journal of Management & Social Science*, 2(1), 177–194.
- Smith, J., & Lee, K. (2021). Digital technologies and creative thinking development in higher education. *Journal of Educational Innovation*, 15(2), 101–118.
- Springer Education Group. (2024). *Artificial intelligence and the future of higher education: Curriculum transformation for digital learners*. Springer Nature.
- Sultana, Z., & Imran, M. (2024). Challenges faced by English teachers in Pakistan. *Spry Journal of Literature and Linguistics*, 2(1), ???–???

- Sultana, Z., Ahmed, S., & Imran, M. (2024). Corporate social responsibility (CSR) reporting in Pakistan: Insights from stakeholder perspectives. *Spry Journal of Economics and Management Sciences*, 2(1), ???-???
- Uddin, S. S., Farooq, A., Ali, R. A., & Aurangzeb, M. (2025). The role of human rights in China and USA's foreign policy approaches. *Journal of Social Signs Review*, 3(2), 218-230.
- Zhao, H., & Hu, Y. (2022). Artificial intelligence tools and higher-order thinking skills in university learning environments. *Educational Technology Research Review*, 30(4), 233-248.