



PERI-SUSTAINABLE PREFRONTAL TERTIARY OBLIGATIONS (PSPTO): STUDY ON AI TOOL DEPENDENCY AND DECLINE IN COGNITIVE ABILITIES AMONG YOUTH

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ABSTRACT

OBJECTIVE: To determine the association between AI tool dependency and self-reported deterioration of an analytical, creative, and systems thinking in higher education students, and suggests the Peri-Sustainable Prefrontal Tertiary Obligations (PSPTO) framework as an intervention approach.

METHODOLOGY: It was cross-sectional survey-based research on 400 participants (students aged 18-24) with varying academic backgrounds. The use of AI tools, apparent assistance, and possible negative effects as well as cognitive-behavioral effects were measured using a structured questionnaire. The analysis of data and contextualization of survey results with national and international studies were conducted using descriptive statistics, independent samples t-tests, and Exploratory Factor Analysis.

RESULTS: It was demonstrated that 86% of the interviewees used the AI tools in their daily life, and platform with the highest frequency was ChatGPT (71.3%). EFA established a three-factor measure of cognitive skills (analytical, creative, systems thinking). The high-dependency group was characterized by much higher perceived deteriorations in critical thinking ($t(398) = 5.72, p < 0.001, d = 0.62$) and problem-solving ($t(398) = 4.95, p < 0.001, d = 0.55$). Logistic regression results showed that daily users were more likely to report a significant loss in cognitive ability ($OR = 3.4, 95\% CI [1.9, 6.1], p < 0.001$).

CONCLUSION: The PSPTO model offers a well guided approach in integrating AI in education, by promoting digital literacy, equitable use of AI, and critical assessment of AI.

KEYWORDS: Artificial Intelligence, ChatGPT, Academic Integrity, Critical Thinking, PSPTO Framework, AI Dependency.

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INTRODUCTION: Artificial Intelligence is extensively taking over the world. In every aspect of fields like politics, healthcare, education, finances and media AI is being exploited. Professionals are using AI to accomplish their goals with more accuracy and consistency. The boom of generative Artificial Intelligence (AI) applications, especially ChatGPT, has triggered a paradigm shift in education and professional practice [1]. Although the technologies provide students with unprecedented efficiency, their widespread use among university learners who are at a crucial age of domain-specific cognitive schemas development can represent a threat to the developmental ability of intellectual skills [1]. The emergence of generative Artificial Intelligence (AI) applications, particularly ChatGPT, has created a paradigm shift in the educational field and in professional practice [2]. Technology, as efficient as they are, may pose a threat to the developmental capability of intellectual skills when used extensively among university students at the crucial age of domain-specific cognitive schemas formation [1]. The more cases of cheating are being reported by teachers and professors all across the social media that claims Academic dishonesty in the AI Era ChatGPT is bringing a plague of plagiarism [3] and reflecting upon AI in Pakistan [4]. Analytical, creative, and systems thinking are the three most desired cognitive skills in the future workforce defined by the World Economic Forum (WEF) [4]. The impact of AI dependency on these skills is an intense research question, therefore. There is emerging experimental evidence that the mode of AI integration is important. Research reveals that AI-assisted participants tend to have better results in terms of logical reasoning and problem definition but have deficiencies in the creation of new ideas and critical interpretation of the results provided by AI [5]. It means that the effect of AI is not uniform but preconditions human cognitive activities in certain ways, which can enhance the ability to analyze and reduce creative and integrative thinking [7, 8]. The threat posed by AI to higher order cognitive abilities is of concern in the Pakistani context where a greater number of people are enrolled in higher education in the country which currently stands at 1.8 million [6]. Past studies have already identified this problem of dependency and perceived decline [9], although in many cases this has not been accompanied by a solid theoretical framework and advanced statistical analysis that can be used to unravel these intricate associations [11]. This paper presents and frames Peri-Sustainable Prefrontal Tertiary Obligations (PSPTO) framework. This new construct holds the view that educational institutions must assume a duty (obligations) to provide a conducive learning (Peri) environment that

helps the sustainable growth of high (Tertiary) cognitive processes (Prefrontal), like complex decision-making and ethical thinking, in the age of AI. This research is an empirical investigation of the correlation between AI tool dependency and self-reported cognitive skills in university students, incorporating the WEF taxonomy of cognitive skills [5] and the methodological information in controlled experiments [10] to interpret the relationship and present a more detailed, quantitative study.

METHODOLOGY: The study design used was quantitative and cross-sectional. Four hundred students were chosen through a stratified convenience sampling tool among Sindh public and private universities in Pakistan to be diverse in terms of students who were studying different subjects. The inclusion criteria included that the participants must be enrolled in graduation or higher, aged between 18 to 24 years and have used an AI tool in their academics. An online questionnaire was created, which is a self-administered questionnaire, consisting of four sections:

1. Demographics.
2. AI Usage Patterns.
3. AI Dependency Scale: Ten-item, five-point Likert scale (Cronbach's α : 0.84) of perceived dependency.
4. Perceived Cognitive Impact Scale (PCIS): This study is enriched with a great addition. The PCIS was designed based on the three main cognitive skills, based on sub-skills of the experimental rubric of Musazade et al. [5] adjusted to a self-report form. It included 29 questions (e.g., I produce new ideas to complete assignments, I look at issues in different ways) that were measured on a 5-point Likert scale (1=Strongly Disagree to 5=Strongly Agree). The PCIS was subjected to Exploratory Factor Analysis (EFA) to validate theoretical three-factor structure. A Kaiser-Meyer-Olkin measure confirmed that the sampling adequacy (KMO =0.87) was satisfactory and Bartlett test of sphericity was significant ($\chi^2(406) = 4521.3, p < 0.001$). On Principal Axis Factoring with a Promax rotation, it developed a distinct three-factor solution, which explains 68.4% of the variance to Analytical, Creative, and Systems Thinking. Each factor has high internal consistency (Cronbach's α : 0.89, 0.85, and 0.87, respectively). Microsoft Excel and IBM SPSS statistics (Version 26) were used to analyze the data. The analysis included: Descriptive Statistics, Inferential Statistics (Binary Logistic Regression, and Independent-samples t-test), and Exploratory Factor Analysis (EFA) to justify the models.

RESULTS: The study sample was comprised of 400 students (58% females and 42% males) whose mean age was 20.7 years (SD = 1.8). It was reported that 86.5% (n=346) use AI on a daily basis, with ChatGPT being the most frequently used tool (71.3%, n=285). The EFA results confirmed that the three-factor structure of the PCIS had been proven valid and that the constructs of Analytical, Creative, and Systems Thinking are being measured in a distinct and reliable manner.

Concepts of AI as portrayed by students show a conflict between utility and dependency as it is depicted in Figure I. Though the majority (75.9%) of them appreciated AI due to its efficiency in saving time, a higher percentage (82.8%) reported problems with a lack of AI, which indicates that the same tool which is expected to contribute to the ability to work independently should also decrease the ability to solve a problem independently.

The average score of the AI Dependency Scale was 3.45 (SD = 0.89). Survey respondents were divided into high-dependency (n=214) and low-dependency (n=186) groups.

The independent sample t-test showed that the high dependence group scored significantly lower on all the three cognitive factors, which led to an increased perceived decline (Table 1).

The findings of the independent samples t-tests between the high and the low AI dependency groups regarding the three cognitive skill factors are tabulated in table 1. The high-dependency group also had considerably lower scores in each of the three cognitive domains than the low-dependency group. The variations were also significant with significant effect sizes of Cohen's $d = 0.84$ to Analytical Thinking and $d = 0.92$ to Creative Thinking (all $p < .001$). This tendency indicates that the increased AI dependency is linked with significantly weaker self-reported cognitive functioning, and creativity seems to be especially at risk.

Binary logistic regression was conducted to determine whether an AI usage pattern was significantly associated with substantial cognitive decline. Table 2 indicates that high dependency scores and increased use of AI per day were both important independent predictors. Daily users were 3.74 times more likely to report significant cognitive decline than non-daily users (95% CI [2.07, 6.76]) and an increase in the AI Dependency Scale by one point doubled the odds (OR = 2.03, 95% CI [1.48, 2.78]). The model accounted for about 17.6% of the reported cognitive decline (R^2).

FIGURE. I CONTRAST BETWEEN PERCEIVED BENEFITS AND AI USAGE DRAWBACKS

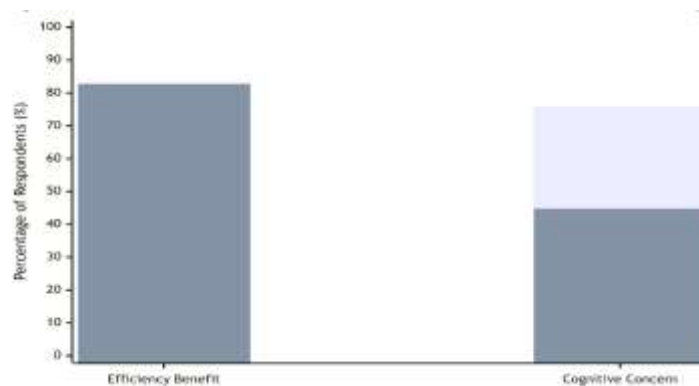


TABLE-I: INDEPENDENT-SAMPLES T-TEST COMPARISON BY DEPENDENCY GROUP

Cognitive Factor	High-Dependency Group (214) Mean (SD)	Low-Dependency Group (186) Mean (SD)	t (398)	p-value	Cohen's d
Analytical Thinking	2.91 (0.71)	3.48 (0.66)	8.14	< .001	0.84
Creative Thinking	2.65 (0.68)	3.30 (0.72)	8.92	< .001	0.92
Systems Thinking	2.78 (0.74)	3.40 (0.69)	8.58	< .001	0.87

TABLE. II BINARY LOGISTIC REGRESSION PREDICTING SIGNIFICANT COGNITIVE DECLINE

Predictor	B (SE)	Wald	p-value	Odds Ratio (OR)	CI (95%)
Daily AI Use (Yes vs. No)	1.32 (0.30)	19.36	< .001	3.74	[2.07, 6.76]
AI Dependency Score	0.71 (0.16)	19.69	< .001	2.03	[1.48, 2.78]
Constant	-4.25 (1.18)	12.96	< .001	0.014	

Model Fit: $\chi^2 (2) = 44.1$, $p < .001$, $R^2 = .176$, Classification Accuracy = 72.0%.

DISCUSSION: The present study offers strong evidence that reliance on AI tools is closely linked with self-reported deteriorations of analytical, creative, and systems thinking in university students. The results are consistent with experimental studies which point to the fact that the use of AI produces a cognitive restructuring in which the use of AI to perform structured tasks might result in the substitution of more complex, generative cognition processes [4, 5].

The validation of the three-factor model by the EFA intensifies the validity of the application of the WEF taxonomy in survey research. The negative, high correlations between AI dependency and all three cognitive abilities are disturbing. Creative thinking ($d = 0.92$) had the highest effect size, which is why AI dependency can have the most drastic impact on the ability to produce and synthesize new ideas. This is similar to the result of Musazade et al. [4], who found that novel idea generation and Multidisciplinary integration, which are the pillars of creativity and systems thinking, are weak among AI-assisted participants.

The logistic regression model also emphasizes a point that frequency of use (daily use) and the psychological condition of dependency are independent and significant predictors of cognitive decline. This implies that good users are not immune to the exposure to its possible negative consequences as long as they continue to use it in a manner that develops dependency.

The results are quite convincing and show the reason why the suggested PSPTO does need to be in place. Academia is supposed to exceed the capability to simply access AI in order to attain sustainable intellectual progress. The findings reveal that it is crucial to foster the implementation of the use of AI in a collaborative, rather than a passive form. This is analogous to the behavior analysis in Musazade et al. [4], where collaborators who simply engaged with AI outperformed copy-pasters across many sub-skills. Practical implications involve:

Pedagogical Design: AI has to be integrated into the curriculum to help students in activities like data collection and preliminary organization, but the students must think critically, synthesize and present their arguments in novel forms that AI cannot.

AI Literacy Training: Training and workshops about AI usage and applications must be organized as users may learn efficient use of AI instead of fully depending on it.

The cross-sectional nature of this research does not facilitate any causal inference. Self-reported information is likely to be biased with perception. Future study should adopt longitudinal designs and objective measurements and similar experimental tasks as Musazade et al. [5] would be triangulated to further support the findings. Also, a qualitative study can be conducted in respect of the nuances of the implementation of collaborative AI in diverse cultural and scholarly contexts.

CONCLUSION: The research confirms the presence of the close and threatening connection between the dependency on AI tools and the apparent loss of the essential cognitive functions, and creativity appears to be at the greatest risk. The cost of mental autonomy and creative ability should not be lost to the benefits of efficiency that AI is bound to bring. The PSPTO framework as an informed solution rooted in the worldwide knowledge of cognitive skills development provides a positive roadmap that will allow developing an academic environment where AI will be used as a tool to assist but not to substitute critical, creative, and systems thinking. By promoting digital literacy and ethical interplay, the students could be mentored to become the masters of the technology, not the slaves, and therefore be able to attain tertiary roles of higher education in the 21st century.

Ethical considerations Approved by the Ethical Review Committee of LUMHS, Jamshoro (Approval ID: LUMHS/REC/-1015). Informed consent was gained from all participants before inclusion.

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Authors Contribution

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Concept and design
Acquisition of data