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The Nexus between Cognitive Absorption and AI Literacy of College Students as Moderated by Sex

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Article Information

ABSTRACT

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Keywords

Cognitive Absorption, AI Literacy, Moderation Analysis, SmartPLS, Philippines This study examines how Cognitive Absorption and AI Literacy are related among college students, specifically looking at how sex moderates this link. The study uses a quantitative research strategy and a non-experimental correlational approach. Data was collected through Google Forms utilizing modified questions designed for AI Literacy and cognitive absorption. G*Power 3.2 was used for power analysis to determine the necessary sample size for the investigation. 372 college students from different higher education institutions in Region XI were selected to take part in the study by stratified random sampling. Reliability and validity tests, including Cronbach's alpha, Average Variance Extracted (AVE), and Heterotrait-Monotrait Ratio (HTMT), were performed on the dataset before undertaking moderation analysis. Cognitive Absorption was identified as a key predictor of AI Literacy, showing a substantial impact size of 0.417. The moderating effect of sex, although statistically significant, had a minor effect size of 0.011. The corrected R-squared value of 0.378 indicates that the model, with all covariates, accounts for 37.8% of the variance in AI literacy.

INTRODUCTION

AI literacy is the essential talent of effectively engaging with and critically assessing AI technology in today's tech-centric society (Long & Magerko, 2020). It involves comprehending, utilizing, assessing, and dealing with ethical concerns associated with AI (Ng et al., 2021). Disparities exist in AI literacy across children from various socioeconomic and cultural backgrounds (Druga et al., 2019). Initiatives to improve understanding of AI involve a middle school program designed to educate kids on AI for them to become knowledgeable citizens and discerning users of AI (Lee et al., 2021), and the creation of an AI-robotics tool to advance AI literacy in underdeveloped nations (Eguchi, 2021). AI has the capacity to greatly improve communication abilities in English language learners, with a primary focus on writing, reading, and vocabulary development in language education.

Various studies have investigated the AI literacy of college students, yielding favorable results. Kong *et al.* (2021) and Lee *et al.* (2021) discovered that students from various backgrounds can gain a conceptual knowledge of AI. They also observed that AI literacy education can enhance students' ethical awareness of AI. Ng *et al.* (2022) and Lee *et al.* (2021) showed how pedagogical methods, including digital story writing, can enhance AI literacy in primary and middle school children. Juma (2021) discovered that although higher education students acknowledge the significance of AI in education, they possess little knowledge and understanding of it. These results emphasize the necessity of ongoing initiatives to improve AI literacy among college students.

Cognitive absorption, a high level of engagement with software, has been shown to strongly correlate with digital literacy in secondary school children (Canan Güngören et al., 2022). This is especially important in the realm of AI literacy, which is seen as a modern form of cognitive intelligence (Wang & Lu, 2023). Cognitive absorption's impact on establishing user trust and enhancing experience in human-machine interactions has been investigated by Balakrishnan & Dwivedi (2021). AI literacy is associated with metacognition and the capacity to predict an unpredictable future (Yi 2021). Literacy has a substantial correlation with cognitive performance in well-educated older adults, as shown by Barnes et al. (2004). Research has examined how cognitive absorption is influenced by computer playfulness and perceived quality in the context of fun-oriented information systems utilization (Weniger & Löbbecke, 2011). Perceived affective quality has been suggested as a precursor to cognitive absorption, significantly influencing it (Ping Zhang et al., 2006).

Several research have examined people's opinions and use of artificial intelligence (AI) (Obenza *et al.*, 2023a, 2023b). A notable deficiency in the existing research is the investigation of AI literacy in college students and the factors that may influence it. Current literature on AI literacy, namely on cognitive absorption, still has considerable inadequacies and restrictions despite the increasing study in this area. Long and Magerko (2020) and Ng (2021) have suggested competencies and design considerations for AI literacy, but they have not specifically addressed sex disparities. Therefore, there is a notable absence of focus on sex-specific patterns or issues in this area, highlighting the need for more research. Research

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must investigate sex discrepancies in the relationship between cognitive absorption and learning outcomes in AI literacy. The study aimed to examine how cognitive absorption and AI literacy of college students are related, with consideration to how this relationship may be influenced by their gender.

Theoretical Framework

Cognitive Absorption Theory (CAT) is a useful framework for examining the complex connection between cognitive absorption, AI literacy, and gender among college students. CAT, first introduced by Agarwal and Karahanna in 2000, explains the extreme involvement humans display when using technology, marked by strong concentration, altered perception of time, and profound immersion (Agarwal & Karahanna, 2000). The hypothesis suggests that cognitive absorption is a condition in which individuals are completely engrossed in technology-mediated activities, surpassing awareness of their surroundings and fostering a heightened sense of cognitive engagement (Agarwal & Karahanna, 2000).

CAT emphasizes that cognitive absorption is evident in different aspects, including absorption, attention, control, and immersion (Agarwal & Karahanna, 2000). Absorption refers to how deeply individuals engage in a specific task, while focus indicates the level of concentration directed towards the activity. Control refers to the sense of control individuals have over the technological interface, while immersion indicates the degree of temporal distortion and detachment from the immediate world (Agarwal & Karahanna, 2000).

Cognitive absorption is especially important in the realm of AI literacy for college students. When people interact with AI technologies, their level of cognitive absorption can greatly impact how they learn and understand AIrelated information and abilities. CAT provides a detailed framework for comprehending the cognitive processes involved in the advancement of AI literacy. It explains how individuals' thorough interaction with AI interfaces influences their cognitive schemas and knowledge structures (Agarwal & Karahanna, 2000).

Moreover, the influence of gender as a moderator should be taken into account in the context of CAT. Recent findings indicate that there may be gender differences in how cognitive absorption is experienced and its outcomes, with research showing varying levels of technological involvement and immersion between men and women (Agarwal & Karahanna, 2000). This study aims to investigate how gender, as a moderating variable, affects the relationship between cognitive absorption and AI literacy in college students. It tries to uncover potential gender-related distinctions in technology adoption, engagement, and proficiency.

Cognitive Absorption Theory offers a strong theoretical basis for studying the relationship between cognitive absorption, AI literacy, and gender in college students. CAT provides valuable insights into how individuals acquire and internalize AI-related knowledge by explaining the cognitive mechanisms involved in technology engagement and immersion. This enriches our understanding of the interaction between cognition, technology, and gender.

METHODS AND MATERIALS

The study utilized a quantitative research strategy, specifically a non-experimental correlational approach, to investigate how sex influences the connection between cognitive absorption and AI literacy. Quantitative research, according to Creswell & Creswell (2022), is a methodical examination of factual concepts through the analysis of variable relationships. This method allows for the measurement of variables using instruments, making it easier to apply statistical tools for data analysis.

Ramayah *et al.* (2017) used a moderating variable (MV) to explain how the predictor's effect is impacted by the criterion. This factor is crucial for thoroughly examining the relationship between the predictor and criteria variables. The MV does not directly affect the predictor, but it can influence the intensity and direction of the association between the basic components.

The AI Literacy scale, a 5-point scale with 12 items, was modified from Wang *et al*'s research in 2022 to measure people's daily interaction with, understanding of, and assessment of AI technology. The study used the Cognitive Absorption scale, a 7-point scale with 20 items created by Agarwal and Karahanna in 2000. The survey was conducted online. The participants were college students from Region 11 who were chosen using stratified random sampling.

A power analysis was performed using G*Power 3.1.9.6 (Faul *et al.*, 2007) before data collection. It was found that a sample size of N = 89 was needed to obtain 80% power for detecting a medium effect (f2 = 0.15) at a significance level of $\alpha = 0.05$. The sample size of N = 372 exceeded the minimum requirement, which strengthened the study's ability to investigate the complex interactions between the variables.

Various strategies were used to guarantee the validity and reliability of the measurement models. The measurements used were Average Variance Extracted (AVE) for assessing convergent validity, Heterotrait-Monotrait Ratio (HTMT) for evaluating discriminant validity, and Cronbach's alpha for determining internal consistency. Descriptive statistics, including standard deviation and mean, were computed using Jamovi software version 2.0 to describe AI literacy and cognitive absorption. The bootstrapping standardized algorithm was used using SmarPLS 4.0 software to assess the postulated moderation model. The study aims to thoroughly investigate how sex moderates the link between cognitive absorption and AI literacy among college students using rigorous approaches.

Hypothesis

Sex has a significant moderating effect on the relationship between Cognitive Absorption and AI Literacy of college students.



RESULTS AND DISCUSSION

Establishing the validity and reliability of the measurement model is paramount when conducting research utilizing moderating analysis, as emphasized by Hair *et al.* (2019). Prior to evaluation, potential gaps in some items were addressed to ensure the robustness of the research instrument. Table 1 presents the assessment of reliability and validity, conducted through the utilization of Cronbach's alpha, a widely accepted measure of internal consistency for questionnaires (Mashingaidze *et al.*, 2021). The obtained Cronbach's alpha values for AI Literacy (0.898) and Cognitive Absorption (0.942) exceeded the benchmark of 0.7, indicating strong internal consistency and validity of the questionnaires (Taber, 2017).

As per the recommendations established by Diamantopoulos *et al.* (2001) and Drolet and Morrison (2001), Cronbach's alpha values of 0.60 to 0.70 are considered acceptable, while values between 0.70 and 0.90 are deemed tolerable to good. Both factors had

values exceeding 0.70, confirming the instrument's dependability in measuring the constructs of interest. The Cronbach's alpha values did not surpass 0.95, suggesting that redundancy within the factors was not a problem. Convergent validity was evaluated by calculating the Average Variance Extracted (AVE). The average values for AI Literacy (0.586) and Cognitive Absorption (0.575) above the recommended threshold of 0.5, as proposed by Fornell and Larcker (1981) and Hair et al. (2019). AVE scores of 0.50 or higher suggest that the construct explains 50% or more of the variability in its components, which supports the validity of the measurement model. Discriminant validity, a critical component of validating measurements, was assessed by Heterotrait-Monotrait (HTMT) ratios. The paired ratios varied between 0.011 and 0.696, showing good discriminant validity as none surpassed the threshold of 0.85 suggested by Henseler et al. (2015). The results confirm that the instrument used is valid and trustworthy for evaluating the constructs being studied.

Variables	Cronbach's alpha	Average variance extracted (AVE)			
AI Literacy	0.898	0.586			
Cognitive Absorption	0.942	0.575			
Discriminant Validity - Heterotrait-monotrait ratio (HTMT)					
AI Literacy <-> Cognitive Absorption	0.648				
AI Literacy <-> Sex	0.104				
AI Literacy <-> Sex x Cognitive Absorption	0.350				
Sex <-> Cognitive Absorption	0.070				
Sex <-> Sex x Cognitive Absorption	0.011				
Cognitive Absorption <-> Sex x Cognitive Absorption	0.696				

 Table 1: Construct Validity and Reliability

Analyzed data from 372 respondents provided significant insights into the degrees of AI literacy and cognitive absorption among college students, as detailed in Table 2. The average AI literacy score was 3.43, suggesting a high degree of AI literacy among students from different universities. This discovery aligns with prior research conducted by Kong *et al.* (2022) and Kong *et al.* (2021), indicating elevated levels of AI literacy in students attending universities in Hong Kong. Nevertheless, the results also bring to mind the concerns highlighted by Anderson and Anderson (2006) regarding security, privacy, and biases linked to advanced AI knowledge.

AI literacy was evaluated based on four subfactors: Awareness, Usage, Evaluation, and Ethics. The subfactors, as outlined by Wang *et al.* (2022), explain many aspects of AI literacy. The average values for each subfactor were: Awareness (3.27), Usage (3.40), Evaluation (3.64), and Ethics (3.41). The results indicate a considerable level of skill in all subcategories, consistent with Kong *et al.*'s (2022) research on ethics, accessibility, and expertise in AI literacy among university students.

The study found that Cognitive Absorption had a mean

value of 5.04, suggesting a moderate to high level of cognitive absorption in college students. The components of Cognitive Absorption, such as Temporal Dissociation, Focused Immersion, Heightened Enjoyment, Control, and Curiosity, showed average values between 4.73 and 5.52. The results support prior research conducted by Balakrishnan and Dwivedi (2021), emphasizing the connections among cognitive absorption, trust, and experience in interactions between humans and machines. College students' proficiency in AI literacy and cognitive absorption varies. Research conducted by Yang et al. (2022) and Banele (2023) emphasizes the importance of increasing awareness and implementation of mobile learning, along with enhancing evaluation tools for information literacy and individualized learning suggestions. Dergunova et al. (2022) highlighted the importance of addressing authenticity concerns, cognitive anxieties, and the necessity for specific interventions to improve AI literacy and cognitive absorption. Zastudil et al. (2023) highlighted concerns regarding excessive dependence on AI and the possible negative consequences.



Variables	Mean	SD	Description
Cognitive Absorption	5.04	0.94	Moderately High
Temporal Dissociation	5.52	1.24	High
Focused Immersion	4.90	1.02	Moderately High
Heightened Enjoyment	4.82	0.95	Moderately High
Control	4.73	1.09	Moderately High
Curiosity	5.22	1.37	Moderately High
AI Literacy	3.43	0.54	High
Awareness	3.27	0.62	Moderate
Usage	3.40	0.63	Moderate
Evaluation	3.64	0.77	High
Ethics	3.41	0.66	High

Table 2: Status of college students' AI Literacy and Cognitive Absorption

Cognitive absorption, a state of deep involvement with technology, has been found to be influenced by human-to-machine interaction (Balakrishnan & Dwivedi, 2021). This absorption is crucial in the development of AI literacy, which is considered a form of cognitive intelligence (Wang & Lu, 2023). AI literacy, in turn, is linked to metacognition and the ability to anticipate the future (Yi & Park, 2021). The predictive ability of cognitive skills, including working memory, is also important in literacy (Alloway & Gregory, 2013). Figure 1 shows the link between Cognitive Absorption and AI Literacy of College Students as Moderated by Sex. The path from Cognitive Absorption to AI Literacy is strong and positive (0.691) and highly significant (p < 0.001). This indicates a robust direct effect of Cognitive Absorption on AI Literacy, meaning that as college students' cognitive absorption increases, their AI literacy also tends to increase.

The path from the interaction term (Sex x Cognitive Absorption) to AI Literacy is negative (-0.201) and significant (p = 0.049). This suggests that sex does moderate the relationship between cognitive absorption and AI literacy, but it has a small effect, meaning that the increase in AI literacy associated with cognitive absorption is less pronounced for female compared to male.



Figure 1: Moderation Analysis Results from SmartPLS

The results indicate that the interaction effect of sex and cognitive absorption on AI literacy is significant, with a path coefficient of -0.201 and a p-value of 0.049, supporting

hypothesis 1. This suggests that sex moderates the relationship between cognitive absorption and AI literacy among college students, albeit with a small effect size ($f^2 =$

0.016). AI literacy's R-square value is 0.378, indicating that the model explains approximately 37.8% of the variance in AI literacy, with cognitive absorption having a substantial effect size ($f^2 = 0.417$) on AI literacy compared to the

minimal effect of sex alone ($f^2 = 0.011$). This is a moderate level of explanatory power, suggesting other factors also play a role in determining AI literacy levels.

The interaction plot shows the relationship between

Hypothesis	Path	Sample	Standard	Т	Р	Remark	
	Coefficient	Mean	deviation	statistics	value		
	(B)		(STDEV)				
Sex x Cognitive Absorption -> AI Literacy	-0.201	-0.205	0.102	1.97	0.049	H ₁ is	
						supported	
	R-square	R-square adjusted					
AI Literacy	0.378	0.373					
Effect Sizes (f ²)							
Cognitive Absorption -> AI Literacy	0.417						
Sex -> AI Literacy	0.011						
Sex x Cognitive Absorption -> AI Literacy	0.016						

 Table 3: Moderating Effect, R-square values, and effect sizes

cognitive absorption and AI literacy, differentiated by sex. The red line represents male respondents, and the green line represents female respondents. The lines are not parallel, which indicates that there is indeed a moderating effect of sex on the relationship between cognitive absorption and AI literacy.

The positive slope of both lines suggests that as cognitive absorption increases, so does AI literacy for both sexes. However, the red line is steeper, indicating a stronger relationship between cognitive absorption and AI literacy for the group represented by males. This corroborates the findings of Shashaani (1997), Shashaani and Khalili (2001), Dzandu *et al.* (2016), and Nouraldeen (2022) who explored the attitudes and adoption of college students towards AI and other related technology revealed intriguing dynamics, with sex playing a significant role. They have found that male students exhibit a more positive attitude or adoption towards AI/technology, spending more time on computer and mobile devices and demonstrating greater technological experience, knowledge, and awareness.



Figure 2: Simple Slope Analysis (0=Male and 1=Female)

CONCLUSION

The research results emphasize the importance of cognitive absorption in developing AI literacy among college students, influenced by gender. The notion of cognitive absorption suggests that intense involvement in an activity results in improved learning outcomes, as seen by the significant correlation between cognitive absorption and AI literacy. The association between cognitive absorption and AI literacy is influenced by sex, as shown by a substantial interaction effect, indicating that the impact of cognitive absorption on AI literacy differs between males and females. The model explains around 37.8% of the variation in AI literacy, emphasizing the significant impact of cognitive absorption. It also suggests the existence of additional components not covered in this study. The results show that educational tactics in AI should be customized to reflect both cognitive engagement and the moderating effect of sex. Though studying cognitive absorption and AI literacy among college students provides important information, some issues need to be addressed in future studies.

some issues need to be addressed in future studies. To begin with, this research focuses mainly on sex as a moderator, leaving out possible influences such as culture, education, and social status. An intersectional analysis including these factors would probably give a deeper explanation for the complex forces causing AI literacy and cognitive immersion among university students. Furthermore, the use of Google Forms for data collection may result in a digital literacy bias that excludes those who lack internet prowess. Further studies can be done on how the students see AI and look at some risks and morality issues that accompany this technology in education.

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