ChatGPT Adoption and Academic Achievement: The Full Mediation Role of Critical Thinking

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Abstract: The rapid adoption of ChatGPT in higher education has transformed students' learning practices, yet its contribution to academic achievement remains inconclusive. This study investigates the direct and indirect effects of perceived usefulness, perceived ease of use, and digital literacy on academic achievement, with critical thinking serving as a mediating variable. A quantitative explanatory survey was conducted involving 214 students from the Office Administration Education Program at Universitas Negeri Semarang selected through proportionate stratified random sampling. Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The findings reveal that digital literacy directly improves academic achievement, whereas perceived usefulness and perceived ease of use show no significant direct effects. Critical thinking significantly predicts academic achievement and fully mediates the relationships between perceived usefulness and digital literacy with academic achievement, while no mediating effect is found for perceived ease of use. These findings extend the Technology Acceptance Model by highlighting critical thinking as the principal cognitive mechanism through which AI-supported learning enhances academic performance in higher education.

Abstrak: Pesatnya adopsi ChatGPT di pendidikan tinggi telah mengubah praktik belajar mahasiswa, namun kontribusinya terhadap prestasi akademik masih menunjukkan hasil yang beragam. Penelitian ini bertujuan menganalisis pengaruh langsung dan tidak langsung persepsi kegunaan, persepsi kemudahan penggunaan, dan literasi digital terhadap prestasi akademik dengan kemampuan berpikir kritis sebagai variabel mediasi. Penelitian menggunakan pendekatan survei kuantitatif eksplanatori terhadap 214 mahasiswa Program Studi Pendidikan Administrasi Perkantoran Universitas Negeri Semarang yang dipilih melalui teknik proportionate stratified random sampling. Analisis data dilakukan menggunakan Partial Least Squares Structural Equation Modeling (PLS-SEM). Hasil penelitian menunjukkan bahwa literasi digital berpengaruh langsung terhadap prestasi akademik, sedangkan persepsi kegunaan dan persepsi kemudahan penggunaan tidak berpengaruh secara langsung. Kemampuan berpikir kritis berpengaruh signifikan terhadap prestasi akademik serta memediasi secara penuh hubungan antara persepsi kegunaan dan literasi digital dengan prestasi akademik, tetapi tidak memediasi pengaruh persepsi kemudahan penggunaan. Temuan ini memperluas Technology Acceptance Model dengan menegaskan bahwa berpikir kritis merupakan mekanisme kognitif utama yang menghubungkan pemanfaatan AI dengan peningkatan prestasi akademik.

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A. Introduction

The rise of Society 5.0 has profoundly reshaped higher education, redefining universities from traditional knowledge repositories into dynamic ecosystems that cultivate graduates who are digitally capable, adaptable, and innovative. At its core, Society 5.0 envisions a technologically empowered, human-centered society in which cutting-edge innovations encompassing artificial intelligence (AI), the Internet of Things (IoT), and big data are harnessed to address complex societal challenges while enhancing human well-being (Mavrodieva & Shaw, 2020; Setiawan & Lenawati, 2020). Within this evolving paradigm, AI has transcended its original role as a technological instrument, emerging as an active cognitive collaborator that supports individualized learning, accelerates information processing, and streamlines educational decision-making. Consequently, academic institutions face mounting pressure to incorporate AI into pedagogical practice while simultaneously cultivating students' higher-order cognitive capacities.

Among the most prominent AI advances of recent years, ChatGPT has rapidly established itself as a leading generative AI tool in educational contexts. Since its public launch in late 2022, the platform attracted one million users within five days, marking it as one of the most explosive digital platform growths in modern history. Data from Statcounter (2026b) indicate that ChatGPT controlled approximately 80.49% of the global generative AI chatbot market as of early 2026. A comparable trend is evident in Indonesia, where ChatGPT captured roughly 80.6% of the domestic AI chatbot landscape, surpassing competing tools including Claude, Google Gemini, Microsoft Copilot, Perplexity AI, and DeepSeek (Statcounter, 2026a). These statistics confirm that generative AI has become integral to contemporary higher education, fundamentally transforming how students access knowledge, construct understanding, and accomplish academic tasks.

Despite its accelerating adoption, the pedagogical impact of ChatGPT remains a subject of ongoing debate. Proponents underscore its capacity to provide immediate feedback, tailored explanations, rich learning resources, and flexible study experiences that elevate academic engagement and effectiveness (Gea et al., 2025). Critics, however, raise legitimate concerns about the accuracy of AI-generated content, threats to academic integrity, students' growing cognitive reliance on AI, and the tendency to accept AI outputs uncritically without adequate reflection or verification (Henukh et al., 2025). These contrasting perspectives reveal that ChatGPT's educational merit cannot be attributed solely to its availability or usage patterns. Its contribution to academic outcomes appears contingent on the depth of students' cognitive engagement with AI-generated content. The cognitive mechanisms through which AI adoption contributes to academic achievement therefore remain theoretically underspecified and empirically contested.

Academic achievement itself warrants a conceptualization that extends beyond cumulative grade point average (GPA). Contemporary higher education scholarship increasingly treats academic achievement as a multidimensional construct encompassing cognitive competence, communicative proficiency, interpersonal capacity, self-directed learning, and overall academic growth accumulated throughout the educational process

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(Tian & Sun, 2018). Yaxin & Noordin (2024) further differentiate academic achievement into objective achievement—capturing intellectual and scholarly accomplishments—and behavioral performance—representing active learning engagement, interpersonal competence, and sustained academic commitment. This broader perspective holds particular relevance within AI-supported learning environments, where technology shapes not only academic results but also students' cognitive engagement patterns and learning behaviors.

The Technology Acceptance Model (TAM), originally proposed by Davis (1989), has long served as a foundational framework for understanding how individuals adopt emerging technologies, particularly through the constructs of Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). Numerous prior studies report that students who view AI tools as useful and easy to operate tend to achieve superior academic outcomes, given that AI facilitates individualized learning experiences, expands access to educational resources, and enhances learning efficiency (Ahn, 2024; Crompton & Burke, 2023; Navarro et al., 2023). Liu et al (2025) similarly demonstrated that both perceived usefulness and perceived ease of use function as significant predictors of academic achievement in AI-assisted learning environments. Nevertheless, most of these studies have examined academic performance from a technology acceptance perspective while giving insufficient attention to the cognitive mechanisms through which technology adoption is translated into substantive learning outcomes.

In addition to technology acceptance, digital literacy has emerged as an indispensable competency within AI-driven educational settings. Broadly defined, digital literacy encompasses the capacity to access, critically evaluate, manage, create, and responsibly communicate information using digital technologies (Hammoda & Foli, 2024). Empirical evidence consistently demonstrates that learners with stronger digital literacy skills outperform their peers academically, as they are better equipped to assess information credibility, synthesize multiple sources, and address complex academic problems (Putri & Prakoso, 2024; Saputra et al., 2024; Wulandari et al., 2022). Nevertheless, digital literacy alone may not guarantee improved academic achievement if students remain unable to critically evaluate AI-generated content before incorporating it into their scholarly work (Darmawan et al., 2025).

Critical thinking has accordingly emerged as a fundamental cognitive competency in AI-assisted learning, enabling students to interpret, analyze, and evaluate information rather than passively accepting AI outputs as valid knowledge. While prior research broadly identifies a positive association between critical thinking and academic achievement (Hayati et al., 2019; Waruwu & Waruwu, 2024; Habibulloh et al., 2025), empirical findings remain inconsistent. Certain studies have found that critical thinking does not significantly predict academic achievement (Devitania et al., 2026; Duru & Obasi, 2023; Shirazi & Heidari, 2019). Furthermore, Jaramillo Gómez et al (2025) and Refaldi et al (2024) argue that excessive dependence on AI may erode students' inclination to question information critically, promote superficial learning habits, and ultimately undermine critical thinking capabilities

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over time. These divergent findings suggest that the role of critical thinking in AI-assisted learning remains insufficiently theorized and warrants further empirical investigation.

Although prior scholarship has contributed substantially to understanding AI adoption in education, several notable theoretical and empirical gaps persist. First, existing studies have predominantly examined TAM constructs, digital literacy, and critical thinking as isolated variables rather than integrating them into a unified explanatory model of academic achievement in AI-assisted learning. Second, evidence regarding the relationship between AI adoption and academic performance continues to yield inconsistent findings, with some studies identifying significant positive effects while others find weak or negligible relationships, suggesting that the cognitive mechanism through which AI contributes to academic success remains inadequately specified. Third, while critical thinking has frequently been conceptualized as either a predictor or an outcome, its potential function as a cognitive mediating mechanism bridging technology acceptance and digital competence to academic achievement remains largely underexplored, particularly within Indonesian higher education, where ChatGPT adoption has expanded rapidly while pedagogical integration continues to evolve.

To bridge these identified gaps, this study advances an integrated cognitive framework that extends the Technology Acceptance Model by positioning Critical Thinking as the central mediating mechanism through which Perceived Usefulness, Perceived Ease of Use, and Digital Literacy influence Academic Achievement among ChatGPT users. Unlike prior investigations that primarily conceptualize critical thinking as an independent or dependent variable, the present study theorizes and empirically examines its role as a full mediating variable—elucidating how technology acceptance and digital competence are ultimately converted into meaningful academic gains. Furthermore, this study adopts a multidimensional conceptualization of academic achievement encompassing cognitive, interpersonal, and communicative competencies rather than relying solely on GPA, thus offering a more comprehensive perspective on learning outcomes in AI-assisted higher education.

Accordingly, this study examines the direct and indirect effects of Perceived Usefulness, Perceived Ease of Use, and Digital Literacy on Academic Achievement among ChatGPT users in the Office Administration Education Study Program, Universitas Negeri Semarang, with Critical Thinking serving as the mediating variable. Four specific research questions guide this investigation: (1) To what extent do perceive usefulness, perceived ease of use, and digital literacy directly shape students' academic achievement? (2) In what ways do perceive usefulness, perceived ease of use, and digital literacy influence students' critical thinking? (3) Does critical thinking significantly predict students' academic achievement? (4) Does critical thinking function as the cognitive conduit through which perceived usefulness, perceived ease of use, and digital literacy affect academic achievement?

The anticipated contributions of this study are both theoretical and practical. Theoretically, the study extends the Technology Acceptance Model by incorporating critical thinking as the cognitive mechanism that explains how AI adoption translates into academic

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performance gains. Practically, the findings offer empirical guidance for higher education institutions, educators, and policymakers seeking to design AI-supported learning environments that extend beyond mere technology adoption to encompass the deliberate development of digital literacy and critical thinking skills. Ultimately, the study supports the promotion of responsible, ethically grounded, and cognitively meaningful AI integration, thereby advancing sustainable higher education aligned with the objectives of Society 5.0.

B. Method

This study adopted a quantitative explanatory survey design to examine the causal relationships among perceived usefulness, perceived ease of use, digital literacy, critical thinking, and academic achievement in the context of ChatGPT-assisted learning. The explanatory approach was selected because it enables empirical testing of theorized causal relationships among latent constructs through systematically collected quantitative data (Kayyali, 2026). Data collection was conducted between March and April 2026 at the Office Administration Education Study Program, Universitas Negeri Semarang. To preserve internal validity and ensure participant homogeneity, the study was restricted to active undergraduate students from the 2022–2025 cohorts who had used ChatGPT at least once for academic purposes. This criterion ensured that all participants shared comparable academic backgrounds, institutional learning environments, and prior exposure to AI-assisted learning.

The target population comprised 458 students, and the minimum required sample size was established using the Slovin formula at a 5% margin of error—an approach well-suited for finite populations with relatively homogeneous characteristics (Sugiyono, 2016). This calculation yielded a minimum threshold of 214 respondents. Proportionate stratified random sampling was subsequently applied to achieve equitable representation across each academic cohort from 2022 to 2025. Primary data were gathered through an online questionnaire employing a four-point Likert scale, with options ranging from 1 (Strongly Disagree) to 4 (Strongly Agree). This four-point format was deliberately adopted to eliminate a neutral midpoint, thereby reducing acquiescence bias and encouraging respondents to express more definitive attitudinal positions toward each statement (Balaka, 2022).

The research framework presented in Figure 1 was constructed drawing on the Technology Acceptance Model (TAM) and contemporary scholarship on AI-facilitated learning. The model positions Perceived Usefulness (PU), Perceived Ease of Use (PEOU), and Digital Literacy (DL) as exogenous constructs that shape Academic Achievement (AA) through both direct pathways and indirect pathways mediated by Critical Thinking (CT). The underlying conceptual assumption is that students' academic success within AI-supported learning environments is shaped not solely by technology perceptions or digital competencies, but crucially by their capacity to critically interpret, appraise, and apply AI-generated content. In synthesizing technological, cognitive, and educational perspectives,

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the framework provides an integrated account of how ChatGPT engagement contributes to substantive academic outcomes.

The operational definitions and measurement indicators for each construct are specified in Table 1. Perceived Usefulness was assessed through ten indicators adapted from Chin & Todd (1995), covering dimensions of performance enhancement, information accessibility, decision-making support, and productivity. Perceived Ease of Use was evaluated using eight indicators adapted from Venkatesh & Davis (2000), encompassing ease of learning, system controllability, operational flexibility, and usability. Digital Literacy was measured across eleven indicators reflecting four dimensions proposed by Hammoda & Foli (2024): digital skills, digital culture, digital ethics, and digital safety. Academic Achievement was operationalized following the multidimensional framework of Yaxin & Noordin (2024), which captures interpersonal facilitation, cognitive learning capacity, and communication proficiency. Critical Thinking was operationalized in accordance with Gerlich (2025) across six dimensions: interpretation, analysis, evaluation, inference, explanation, and self-regulation.

Measurement model assessment proceeded through convergent validity analysis utilizing outer loadings and Average Variance Extracted (AVE), with minimum acceptable thresholds set at 0.70 and 0.50, respectively (Hair et al., 2019). Internal consistency was assessed via Cronbach's Alpha, where values exceeding 0.70 were treated as indicative of satisfactory reliability (Hair et al., 2019). All structural relationships among constructs were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) implemented in SmartPLS version 4.1.1.8. PLS-SEM was selected because it accommodates complex mediation models, does not require multivariate normality assumptions, and delivers robust statistical power for studies involving moderate sample sizes (Hair et al., 2019; Sholihin & Ratmono, 2021). Respondents' participation was entirely voluntary, and completion of the questionnaire constituted implied informed consent. Formal institutional approval for data collection was granted by the Faculty of Economics and Business, Universitas Negeri Semarang. Based on the framework in Figure 1, ten hypotheses (H1–H10) were formulated to capture the theorized direct and indirect effects among all constructs.

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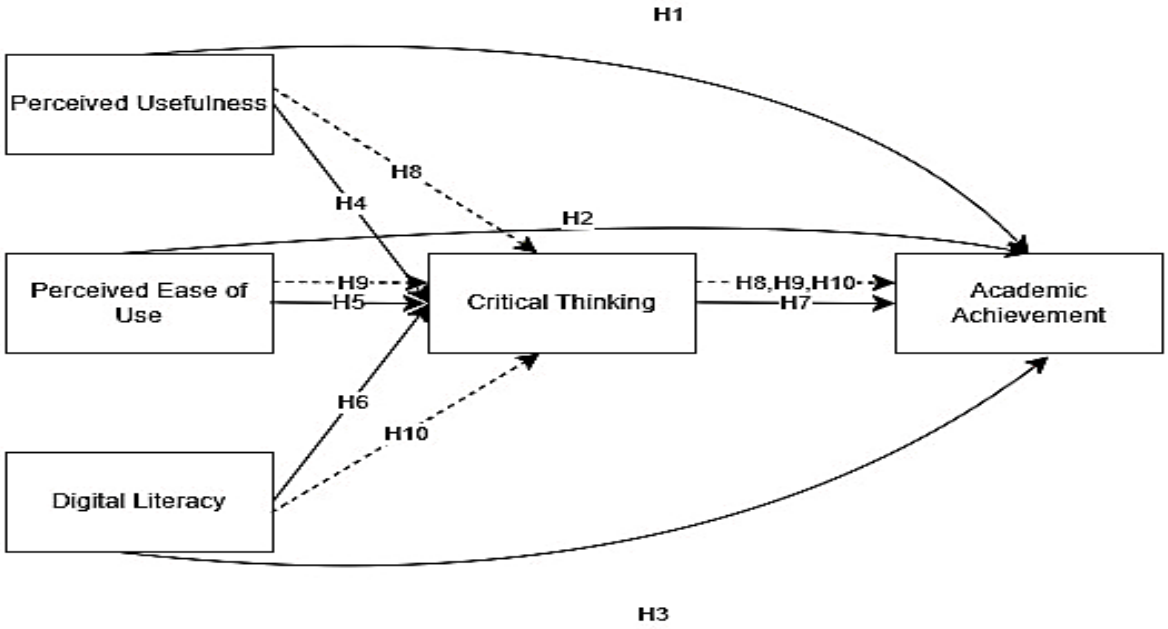

Figure 1. Research Framework

The proposed model delineates the causal relationships among three categories of variables. Specifically, Perceived Usefulness (X1), Perceived Ease of Use (X2), and Digital Literacy (X3) are identified as independent constructs shaping Academic Achievement (Y) through both direct pathways and indirect pathways channeled through Critical Thinking (Z) as a mediating variable. The framework's underlying logic is that students' academic outcomes are conditioned not only by their technology perceptions and digital competencies, but equally by their capacity for reflective and critical information processing within an AI-mediated learning environment.

C. Result

Construct validity was examined through convergent validity analysis, establishing a minimum acceptable outer loading of 0.70 for all measurement indicators (Hair et al., 2019). Every item across all constructs exceeded this threshold, as detailed in Table 1, confirming that each indicator adequately captures its corresponding latent construct. Items PU5, PU6, PU8, PU9, AA7, and CT8 produced outer loading values in the 0.80 range, reflecting particularly strong convergent validity and confirming that these items account for more than 50% of their respective construct's variance. Based on these results, all indicators were retained in the final structural model.

Table 1. Convergent Validity Results – Outer Loading

Variable	Item	Outer Loading	Validity
Perceived Usefulness (X1)	PU1	0.711	Valid
	PU2	0.772	Valid
	PU3	0.782	Valid

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Variable	Item	Outer Loading	Validity
	PU4	0.717	Valid
	PU5	0.808	Valid
	PU6	0.812	Valid
	PU7	0.730	Valid
	PU8	0.813	Valid
	PU9	0.800	Valid
	PU10	0.790	Valid
Perceived Ease of Use (X2)	PEOU1	0.728	Valid
	PEOU2	0.752	Valid
	PEOU3	0.791	Valid
	PEOU4	0.793	Valid
	PEOU5	0.772	Valid
	PEOU6	0.794	Valid
	PEOU7	0.761	Valid
	PEOU8	0.723	Valid
Digital Literacy (X3)	DL1	0.772	Valid
	DL2	0.787	Valid
	DL3	0.706	Valid
	DL4	0.755	Valid
	DL5	0.772	Valid
	DL6	0.709	Valid
	DL7	0.746	Valid
	DL8	0.713	Valid
	DL9	0.720	Valid
	DL10	0.758	Valid
	DL11	0.769	Valid
Academic Achievement (Y)	AA1	0.731	Valid
	AA2	0.747	Valid
	AA3	0.708	Valid
	AA4	0.742	Valid
	AA5	0.745	Valid
	AA6	0.725	Valid
	AA7	0.802	Valid
Critical Thinking (Z)	CT1	0.711	Valid
	CT2	0.709	Valid
	CT3	0.719	Valid
	CT4	0.725	Valid
	CT5	0.775	Valid
	CT6	0.762	Valid
	CT7	0.743	Valid
	CT8	0.818	Valid
	CT9	0.709	Valid
	CT10	0.772	Valid
	CT11	0.721	Valid

Source: Questionnaire; data processed by the author using SmartPLS 4 (2026)

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Table 2. Convergent Validity Results – Average Variance Extracted (AVE)

Variable	Average Variance Extracted	Validity
Perceived Usefulness	0.600	Valid
Perceived Ease of Use	0.585	Valid
Digital Literacy	0.557	Valid
Academic Achievement	0.553	Valid
Critical Thinking	0.561	Valid

Source: Questionnaire, data processed by the author using SmartPLS 4 (2026)

As shown in Table 2, the AVE values for all five constructs exceed the minimum acceptable threshold of 0.50. This pattern indicates that each construct captures more explained variance across its own indicators than is attributable to measurement error. The highest AVE value—0.600 for Perceived Usefulness—alongside all remaining constructs surpassing the 0.50 threshold, collectively affirms that convergent validity has been satisfactorily established throughout the measurement model (Fornell & Larcker, 1981).

Table 3. Discriminant Validity Results – Heterotrait-Monotrait Ratio (HTMT)

	X1	X2	X3	Y	Z
X1					
X2	0.581				
X3	0.436	0.462			
Y	0.317	0.292	0.387		
Z	0.439	0.414	0.474	0.549	

Source: Questionnaire, data processed by the author using SmartPLS 4 (2026)

Discriminant validity was evaluated using the Heterotrait-Monotrait Ratio (HTMT) approach, with findings presented in Table 3. All HTMT coefficients fall below the conservative threshold of 0.85 (Henseler et al., 2015), with the highest observed value of 0.549 between Critical Thinking and Academic Achievement. These results confirm that all constructs are empirically distinguishable from one another, demonstrating adequate discriminant validity across the measurement model. The relatively modest inter-construct correlations further reduce concerns about multicollinearity distorting the structural path estimates.

Table 4. Reliability Results – Cronbach's Alpha

Variable	Cronbach's Alpha	Reliability
Perceived Usefulness	0.926	Reliable
Perceived Ease of Use	0.899	Reliable
Digital Literacy	0.920	Reliable
Academic Achievement	0.865	Reliable
Critical Thinking	0.921	Reliable

Source: Questionnaire, data processed by the author using SmartPLS 4 (2026)

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Internal consistency across all constructs was assessed through Cronbach's Alpha, with results reported in Table 4. All five constructs exceeded the minimum threshold of 0.70, with values ranging from 0.865 for Academic Achievement to 0.926 for Perceived Usefulness. The notably high alpha values for Perceived Usefulness (α = 0.926), Digital Literacy (α = 0.920), and Critical Thinking (α = 0.921) reflect strong item homogeneity within each construct, confirming that the measurement instrument demonstrates satisfactory reliability for structural analysis (Hair et al., 2019).

Table 5. Model Fit Results – SRMR and NFI

Variable	Saturated Model	Estimated Model
SRMR	0.062	0.062
d_ULS	4.377	4.377
d_G	1.846	1.846
Chi-square	2.190.106	2.190.106
NFI	0.728	0.728

Source: Questionnaire, data processed by the author using SmartPLS 4 (2026)

The model fit evaluation summarized in Table 5 reveals that the SRMR value of 0.062 falls within the recommended threshold of 0.08, confirming that the proposed model achieves an acceptable level of correspondence between the implied and observed covariance structures. However, the NFI value of 0.728 falls short of the conventional benchmark of 0.90, reflecting a moderate degree of model fit. This outcome may be attributable to the relatively high number of indicators included in the model and is considered acceptable within the PLS-SEM framework, where the NFI statistic is known to be sensitive to model complexity and sample characteristics.

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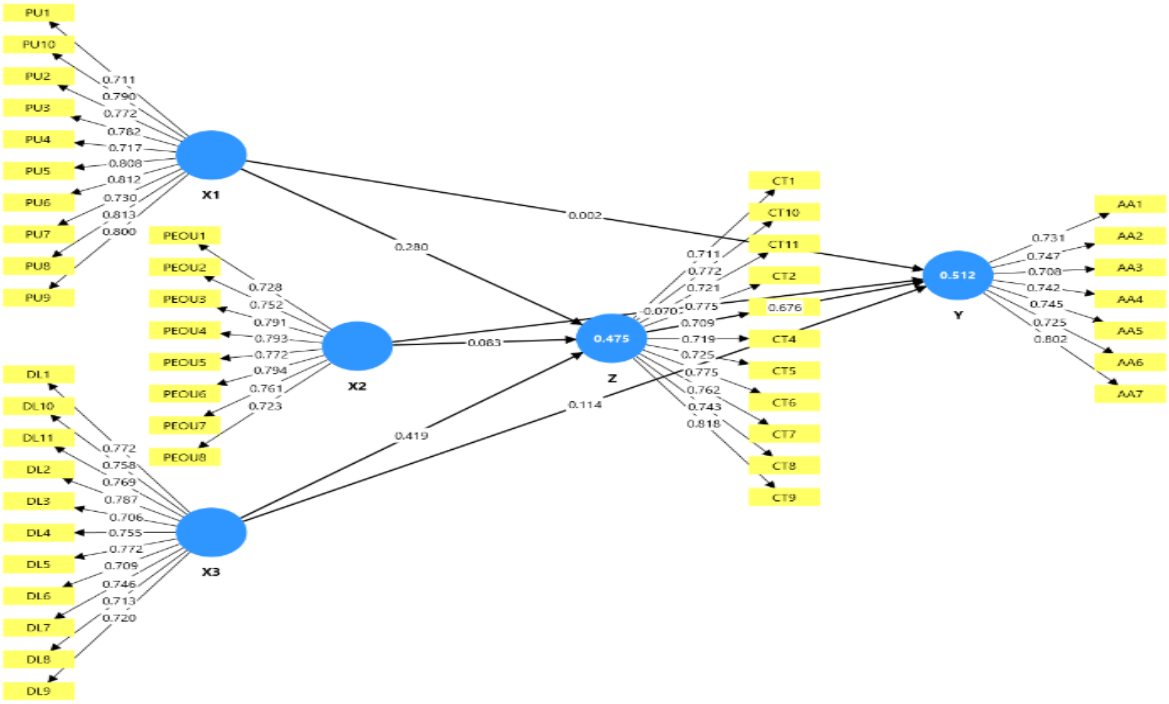

Figure 2. Outer Model Path Diagram

Figure 2 illustrates the outer model path diagram derived from PLS estimation. The diagram depicts the relationship between each latent construct and its corresponding measurement indicators, represented by the outer loading values of each item. All indicators across all constructs demonstrate high outer loading values, indicating that each item effectively captures the latent construct it is intended to measure.

Click or tap here to enter text.The direction of arrows connecting each construct to its indicators reflects the reflective measurement approach adopted in this study, whereby latent variables are theorized to causally influence their observed indicators. Higher outer loading values signal greater representational accuracy between an indicator and its construct. These results corroborate the convergent validity findings and confirm that all indicators satisfy the criteria recommended for SEM-PLS analysis (Sholihin & Ratmono, 2021).

Table 6. R-Square-Inner Model

	R-square	Adjusted R-Square	
Academic Achievement	0.512	0.504	Moderate
Critical Thinking	0.475	0.468	Moderate

Source: Questionnaire, data processed by the author using SmartPLS 4 (2026)

Click or tap here to enter text.The R-square values in Table 6 indicate that the predictor variables collectively account for a moderate proportion of variance in both endogenous constructs. Specifically, the model explains 51.2% of the variance in Academic Achievement (R^2 = 0.512) and 47.5% in Critical Thinking (R^2 = 0.475), both classified as

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moderate according to Hair et al (2019). While Perceived Usefulness, Perceived Ease of Use, and Digital Literacy together constitute meaningful predictors of student outcomes, the substantial unexplained variance points to the potential influence of individual and contextual factors not captured in the current model.

Table 7. F-Square-Inner Model

	Academic Achievement	Critical Thinking
Perceived Usefulness	0.000	0.059
Perceived Ease of Use	0.004	0.005
Digital Literacy	0.013	0.198
Critical Thinking	0.492	

Source: Questionnaire, data processed by the author using SmartPLS 4 (2026)

Effect size analysis (f^2) displayed in Table 7 reveals a markedly uneven pattern of predictor contributions (Cohen, 2013) . Perceived Usefulness and Perceived Ease of Use each demonstrate negligible effects on both Academic Achievement and Critical Thinking ($f^2 \leq 0.059$), indicating that their practical influence on student outcomes is minimal even when statistically significant. By contrast, Digital Literacy exhibits a moderate effect on Critical Thinking ($f^2 = 0.198$), suggesting that stronger digital competence is substantively—not merely statistically—linked to deeper cognitive engagement. Most notably, Critical Thinking exerts a large effect on Academic Achievement ($f^2 = 0.492$), underscoring its primacy as the key proximal predictor of academic performance, consistent with effect size benchmarks proposed by Cohen (2013): 0.02 (small), 0.15 (moderate), and 0.35 (large).

Table 8. Hypothesis Testing Results (Direct-Indirect)

Hypothesis	T-Statistic	P-value	Interpretation
X1→Y	0.024	0.490	H_1 rejected
X2→Y	0.840	0.200	H_2 rejected
X3→Y	1.832	0.034	H_3 accepted
X1→Z	3.086	0.001	H_4 accepted
X2→Z	0.928	0.177	H_5 rejected
X3→Z	5.543	0.000	H_6 accepted
Z→Y	11.426	0.000	H_7 accepted
X1→Z→Y	2.808	0.003	H_8 accepted
X2→Z→Y	0.921	0.178	H_9 rejected
X3→Z→Y	5.161	0.000	H_{10} accepted

Source: Questionnaire, data processed by the author using SmartPLS 4 (2026)

A p-value threshold of 0.05 was applied to assess statistical significance in all hypothesis testing procedures. A T-statistic threshold of 1.645 was used to determine significance at the 5% level under one-tailed hypothesis testing. This approach was employed to evaluate all formulated hypotheses based on both direct and indirect correlation paths, with complete results presented in Table 8.

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Structural path testing results, summarized in Table 8, reveal a differentiated significance pattern across the hypothesized relationships. Among the direct paths, Digital Literacy significantly predicts Academic Achievement ($T = 1.832$, $p = 0.034$), whereas neither Perceived Usefulness nor Perceived Ease of Use demonstrates statistically significant direct effects ($p > 0.05$), leading to the rejection of H1 and H2. Regarding the antecedents of Critical Thinking, both Perceived Usefulness ($T = 3.086$, $p = 0.001$) and Digital Literacy ($T = 5.543$, $p < 0.001$) exert significant positive effects, while Perceived Ease of Use exerts no meaningful influence, resulting in the rejection of H5. Critical Thinking emerges as the strongest predictor of Academic Achievement ($T = 11.426$, $p < 0.001$), supported by a large effect size ($f^2 = 0.492$). For the indirect effects, Critical Thinking significantly mediates the relationship between Perceived Usefulness and Academic Achievement (H8; $T = 2.808$, $p = 0.003$), and between Digital Literacy and Academic Achievement (H10; $T = 5.161$, $p < 0.001$). No significant mediation is detected for Perceived Ease of Use and Academic Achievement, resulting in the rejection of H9. Collectively, these findings indicate that the influence of technology acceptance and digital competence on academic achievement operates primarily through the cultivation of students' critical thinking capacity.

D. Discussion

The results of this study reveal that the connection between ChatGPT adoption and academic achievement is substantially more nuanced than a straightforward technology-outcome association. The structural model demonstrates that Perceived Ease of Use exerts no meaningful effect on Academic Achievement through either direct or mediated pathways, while Critical Thinking fully mediates the effects of both Perceived Usefulness and Digital Literacy on Academic Achievement. These patterns collectively suggest that students' academic success in AI-supported environments depends less on the accessibility features of the technology and more on the extent to which learners critically engage with AI-generated content.

The finding that Perceived Usefulness does not directly predict Academic Achievement (H1 rejected; $p = 0.490$) merits careful attention. Although students may recognize ChatGPT as beneficial for academic tasks, such perceptions alone appear insufficient to generate meaningful learning gains. A plausible explanation is that students primarily deploy ChatGPT to maximize task efficiency rather than deepen conceptual understanding, fostering cognitive offloading whereby learners delegate analytical processes to AI rather than actively constructing knowledge. Technology thus operates as a productivity mechanism rather than a catalyst for substantive academic learning. This aligns with foundational TAM premises, which assert that perceived usefulness primarily drives technology adoption behavior rather than guaranteeing educational effectiveness (Davis, 1989). These results also reflect the Indonesian higher education context, where rapid ChatGPT uptake has outpaced pedagogical reforms promoting reflective AI use (Nugroho et al., 2018). In contrast to studies documenting significant direct effects of perceived usefulness on academic achievement (Badr et al., 2024; Hasanein & Al-Romeedy, 2026;

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Risparyanto & Fitriyanto, 2023; Simarmata et al., 2024; Togaibayeva et al., 2022), the present findings suggest that usefulness perceptions alone do not translate into improved academic performance without concurrent cognitive engagement. Accordingly, this finding extends prior literature by establishing that ChatGPT's educational value is contingent on students' higher-order cognitive engagement rather than technology acceptance per se.

An analogous pattern characterizes Perceived Ease of Use, which fails to yield significant effects on either Academic Achievement or Critical Thinking (H2 and H5 rejected). While ChatGPT is broadly perceived as intuitive and user-friendly, ease of interaction alone does not stimulate analytical reasoning or deeper cognitive processing. On the contrary, excessive convenience may inadvertently encourage passive learning behaviors, allowing students to accept AI-generated responses without evaluating their accuracy or validity. Such passive consumption suppresses metacognitive activity and reduces opportunities for higher-order thinking development. This finding aligns theoretically with TAM, which frames perceived ease of use as a facilitator of technology adoption rather than a predictor of educational benefit (Davis, 1989). It also corroborates Lakus (2025), who argues that technological ease may cultivate dependency rather than foster independent academic growth. The results diverge, however, from Shahraniza & Abubaker (2025), who identified significant effects when learning motivation was introduced as a mediating variable, suggesting that cognitive and motivational factors—rather than usability characteristics—ultimately determine whether AI adoption yields academically meaningful outcomes.

A distinct pattern characterizes the relationships involving Perceived Usefulness and Digital Literacy with Critical Thinking, both of which prove to be significant positive predictors (H4 and H6 accepted). Students who view ChatGPT as academically valuable and who command stronger digital literacy skills appear better positioned to interrogate, compare, and thoughtfully integrate AI-generated content before applying it to academic tasks. This outcome is consistent with constructivist learning principles; wherein substantive learning emerges through active interpretation and evaluative engagement with information rather than passive absorption. Comparable positive associations between AI utilization, digital literacy, and critical thinking have been identified in recent empirical work (Andani & Friyatmi, 2025; Fadholi, 2025; Oktafiani & Setiaji, 2025). Additionally, digital literacy equips students to appraise the credibility of sources and exercise well-reasoned academic judgment, thereby reinforcing critical thinking processes (Chen, 2025). These findings collectively reframe digital literacy not simply as a technological skill, but as an essential cognitive prerequisite for meaningful engagement in AI-enhanced learning environments.

The most theoretically significant contribution of this study lies in demonstrating Critical Thinking's full mediating role. The data confirm that Critical Thinking completely mediates the associations between Perceived Usefulness and Academic Achievement, and between Digital Literacy and Academic Achievement, while no mediation is observed for Perceived Ease of Use. This result reinforces and extends Liu et al (2025), who proposed that

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critical thinking serves as the operative cognitive link between AI use and academic performance, by providing evidence of full mediation within the Indonesian higher education context. These findings imply that AI tools do not inherently improve academic outcomes through mere technological exposure; rather, their educational benefits materialize only when students bring critical interpretive and evaluative capacities to bear on AI-generated content. This study therefore answers all four research questions by demonstrating that the pathway from technology acceptance and digital competence to academic achievement is mediated primarily through Critical Thinking—establishing cognitive engagement as the central mechanism through which ChatGPT supports meaningful learning outcomes and extending the Technology Acceptance Model by identifying critical thinking as the missing cognitive link between AI adoption and academic performance.

E. Implication

Theoretically, this study extends the Technology Acceptance Model (TAM) by establishing that the educational value of generative AI is realized primarily through Critical Thinking, rather than through perceived usefulness or perceived ease of use in isolation. Practically, the findings underscore the importance of AI integration strategies that deliberately foster critical thinking, including source verification, argument evaluation, and reflective inquiry. Higher education institutions and policymakers should further develop comprehensive AI literacy frameworks that integrate digital and critical literacy to promote responsible AI engagement, reduce passive dependence on generative AI tools, and maximize meaningful academic achievement in an era of rapidly expanding AI adoption.

F. Limitation and Suggestion for Further Research

This study is constrained by its focus on students from a single academic program at Universitas Negeri Semarang, which limits the generalizability of the findings to other institutional and disciplinary contexts. The cross-sectional design and reliance on self-reported questionnaire data additionally introduce the risk of common-method bias and restrict the extent to which definitive causal inferences can be established. Individual variation in the frequency, purpose, and depth of ChatGPT use also remained unmeasured, potentially confounding observed relationships among the study variables.

Future research would benefit from employing longitudinal or mixed-methods designs spanning a broader range of institutions and academic disciplines to strengthen external validity. Integrating objective behavioral measures of AI engagement alongside variables such as academic motivation, self-regulated learning strategies, and metacognitive awareness would further enrich understanding of how AI-supported learning environments contribute to student academic achievement.

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G. Conclusion

This study establishes that Critical Thinking constitutes the primary cognitive mechanism mediating the relationships between Perceived Usefulness and Digital Literacy on the one hand and Academic Achievement on the other, while Perceived Ease of Use demonstrates no significant direct or indirect effects on either outcome. These results underscore that the educational benefits of ChatGPT are not determined by technology acceptance alone, but are contingent on students' capacity for critical evaluation and meaningful integration of AI-generated content into learning processes. By extending the Technology Acceptance Model with Critical Thinking as a full mediating construct, this study provides both theoretical and practical evidence that effective AI integration in higher education must prioritize the development of cognitive engagement alongside digital literacy competencies.

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