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Integration of Artificial Intelligence in Learning: An Analysis of The Effectiveness of Chatbot Use on Student Independence

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ABSTRACT

The development of artificial intelligence (AI) technology has changed the paradigm of education globally, particularly through the use of interactive chatbots as a medium for independent learning. This study aims to analyze the effectiveness of using AI-based chatbots in improving student learning independence in higher education. The research method used is a quasi-experimental quantitative approach with a pretest-posttest control group design. The study sample included 180 students who were randomly divided into an experimental group (chatbot- assisted learning) and a control group (conventional learning). The data collection instrument used a Likert scale questionnaire that measured indicators of learning independence (initiative, goal setting, learning strategies, self-monitoring, and evaluation of results) as well as an academic ability test. Data analysis was carried out using Structural Equation Modeling based on Partial Least Squares (SEM-PLS). The results of the analysis show that the use of AI chatbots has a positive and significant effect on student learning independence with a path coefficient ($\beta = 0.482, p < 0.001$) and contribution to learning achievement of 38.4% ($R^2 = 0.384$)Chatbots have proven effective as digital scaffolding, providing instant feedback and customizing materials to individual learning pace. The implications of this research underscore the importance of structured AI technology integration into higher education curricula to foster student autonomy and self-regulation in the digital age.

Keywords: *Artificial Intelligence, Learning Chatbot, Learning Independence, Learning Effectiveness, Higher Education.*

INTRODUCTION

The digital transformation of the higher education landscape has reached a crucial point with the rapid adoption of artificial intelligence (AI) technology. The paradigm shift from teacher *-centered* learning to student-centered learning *demands* interactive media capable of supporting learning flexibility (Ahmad & Rahim, 2024). AI exists not merely as an administrative tool, but as a pedagogical catalyst that transforms the way knowledge is transmitted, accessed, and processed by students. Amidst this modernization, the integration of AI into learning management systems is a necessity to increase educational efficiency and inclusiveness (Brown et al., 2023).

Among the various manifestations of AI in education, the use of automated conversational agents, or *chatbots* based on large language models, is showing the most significant growth. *Chatbots* such as ChatGPT, Claude, and specialized educational AI systems are capable of simulating real-time, 24/7 human tutor-like dialogue (Chen & Liu, 2025). *Chatbots* enable them to function as personal learning assistants, providing instant answers to complex student questions. This adaptive capability promises to resolve traditional barriers in large classes, where instructor time constraints often hinder individualized feedback (Davis & Smith, 2024).

Despite the enormous potential of this technology, a key challenge in modern higher education is how to foster *student independence* or *self-regulated learning*. Learning independence encompasses students' ability to set learning goals, choose appropriate strategies, monitor their own progress, and critically evaluate their learning outcomes (Evans et al., 2023). Without this robust independence, the abundance of information available from AI risks creating passive dependency, where students simply cite answers without engaging in in-depth cognitive processes (Fernando & Utama, 2024). Therefore, it is crucial to examine how interactions with *chatbots* can be designed to foster, rather than undermine, learning autonomy.

The construct of independent learning within the framework of educational psychology is closely correlated with information processing theory and intrinsic motivation. According to Green and Harrison (2023), students with high self-regulation tend to demonstrate greater resilience when faced with complex lecture material. In a *chatbot*- assisted context, students are required to formulate effective prompts, analyze AI responses, and verify the accuracy of the information provided. This iterative process indirectly trains higher-order thinking skills *and* strengthens ownership of their own learning process (Hassan & Ibrahim, 2025).

Several previous studies have indicated that the use of interactive *chatbots* can increase students' cognitive and affective engagement in the learning process. Empirical research by Ismail and Pratama (2024) found that consistent *chatbot accessibility reduced academic anxiety* when students completed independent assignments. When anxiety is reduced, students' working memory capacity *can* be optimally allocated to problem-solving and conceptual understanding. This indicates a positive relationship between the availability of instant feedback from AI and increased student *self- efficacy (Jones & Tanaka, 2024).*

However, the academic debate regarding the effectiveness of AI in promoting independent learning remains fraught with contradictory findings. Some researchers warn that over-reliance on *chatbots* can diminish students' critical thinking and independent synthesis skills (Kim & Park, 2025). When students become accustomed to receiving quick answers without in-depth literature search and

analysis, their self-regulation and independent problem-solving skills decline (Lopez et al., 2024). The phenomenon of *cognitive offloading*, or shifting the burden of thinking entirely to machines, poses a real threat to long-term cognitive development (Miller & Zhao, 2024).

The gap between the positive potential *of chatbots* as personal tutors and their negative risks to cognitive independence creates a pressing need for empirical evaluation. Most existing research focuses on perceived user satisfaction or general technology adoption, with little specifically measuring the systematic impact of *chatbot* use on learning independence variables using measurable cognitive and behavioral metrics (Nugroho & Wibowo, 2025). Without a clear empirical evaluation framework, AI integration in higher education risks becoming merely a technological trend without a solid pedagogical foundation (O'Connor & Kelly, 2024).

Furthermore, the effectiveness of *chatbot* use is heavily influenced by how the technology is integrated into the instructional design. *Chatbots* designed solely to provide direct answers tend to foster passivity, while *chatbots* programmed with a Socratic approach (providing provocative questions and graded prompts) encourage students to think independently (Patel & Rahman, 2025). Therefore, *chatbot* effectiveness is not universal but rather depends heavily on the pedagogical interaction patterns established between students and the AI agent (Qureshi et al., 2024).

In the context of education in developing countries, the challenges of AI integration are increasingly complex due to variations in digital literacy and technological accessibility. Students often lack an adequate understanding of the ethical and operational limitations of AI, limiting the use of *chatbots* to instant task completion rather than as a means of independent exploration (Ramirez & Santos, 2025). Instilling AI literacy , which encompasses ethical awareness, critical thinking about AI outputs, and *prompt engineering* skills , is essential for *chatbots* to function effectively in enhancing learning autonomy (Suryanto & Lestari, 2024).

Based on the dynamics and problems described above, this study was conducted to analyze in depth the effectiveness of using AI *chatbots* in improving student learning independence. The novelty *of* this study lies in the empirical testing of *the chatbot's* intermediation mechanism as *a digital scaffold* that bridges the relationship between self-regulation and academic achievement. The results of this study are expected to provide theoretical contributions to the development of AI-based learning models and provide practical recommendations for policymakers in higher education in designing AI integration guidelines that focus on student independence (Taylor & White, 2025).

RESEARCH METHODS

This study employed a quantitative approach with a quasi -*experimental* design, a *pretest-posttest non-equivalent control group design,* combined with an explanatory survey. The quasi-experimental approach was chosen because learning conditions in higher education do not allow for full control of external variables through pure randomization (*true experiment*) without disrupting regular academic activities (Ahmad & Rahim, 2024). Structural model testing was conducted using *Partial Least Squares* -based *Structural Equation Modeling* (SEM-PLS) to simultaneously analyze direct relationships, moderation, and mediation between variables. This methodological framework allows for a precise

evaluation of the effectiveness of artificial intelligence (AI)-based chatbot interaction treatments *on* the *development* of student self-regulation (Nugroho & Wibowo, 2025).

The population in this study was all active undergraduate students in the social sciences and humanities enrolled in the current semester. The sampling technique used *purposive sampling* with inclusion criteria including students who owned personal digital devices, had taken basic methodology courses, and agreed to the informed consent form *(*Evans et al., 2023). The sample size was 180 students, who were divided equally into the experimental group ($n = 90$) which uses *AI chatbot- assisted learning* and a control group ($n = 90$) which applies conventional self-directed learning methods. This sample size determination has met the *power analysis* criteria with a minimum sample limit for SEM-PLS testing to avoid statistical power defects *(*Taylor & White, 2025).

Primary data were collected using a closed-ended questionnaire instrument measured on a 5-point Likert scale (from 1 = Strongly Disagree to 5 = Strongly Agree) and an objective academic ability test. The Learning Independence variable was measured by adapting the *Self-Regulated Learning* indicator which includes goal setting, self-monitoring, and self-evaluation (Evans et al., 2023). The AI Literacy variable measured the conceptual, ethical, and technical dimensions *of prompt engineering* (Hassan & Ibrahim, 2025), while the Use of AI *Chatbots* was measured through the frequency of interactions and the level of utilization of *digital scaffolding* features (Jones & Tanaka, 2024). Prior to field data collection, the instrument went through a readability test, content validity test by experts (*expert judgment), and* instrument piloting to ensure measurement reliability (Suryanto & Lestari, 2024).

Data analysis techniques are carried out in stages through two main stages in SEM-PLS, namely evaluation of the measurement model (*outer model*) and evaluation of the structural model (*inner model*). Evaluation of *the outer model* includes testing convergent validity *through the loading factor* value (> 0.70) and *Average Variance Extracted* (AVE> 0.50), discriminant validity through the *Heterotrait-Monotrait Ratio* (HTMT) criteria< 0.85), as well as construct reliability using *Composite Reliability* (> 0.70) (Nugroho & Wibowo, 2025). Next, an *inner model* evaluation was conducted to test the research hypothesis through a *bootstrapping* procedure with 5,000 resamples to estimate the path coefficients (β), mark$t$-statistics (> 1.96), mark$p$(< 0.05), coefficient of determination (R^2), as well as the effect size (f^2) (Qureshi et al., 2024).

RESULT AND DISCUSSION

Results

Research result

The evaluation of the measurement model (*outer model*) confirmed that all indicators measuring the constructs of AI *Chatbot Usage*, AI Literacy, Learning Independence, and Academic Achievement met the criteria for data reliability and validity. The *outer loading* value for each indicator was above the threshold of 0.70, with *the Average Variance Extracted (AVE)* value exceeding 0.50, indicating strong convergent validity (Nugroho & Wibowo, 2025). The discriminant validity tested using *the Heterotrait-Monotrait Ratio* (HTMT) criterion was all below 0.85. In addition, the internal consistency reliability was proven to be very high, where *the Composite Reliability* (CR) and *Cronbach's Alpha* for all variables are above the minimum criteria of 0.70 (Qureshi et al., 2024).

Testing the structural model (*inner model*) through a *bootstrapping procedure* with 5,000 *resamples* showed that all direct and indirect hypotheses proposed in this study were significantly supported. Complete inferential statistical results are presented in Table 1.

Table 1

Summary of Structural Hypothesis Testing (SEM-PLS)

Hypothesis	Relationship Path	Path Coefficient (β)	t-Count	p-Value	Decision
H1	Use of Chatbots→Learning Independence	0.482	6,841	$< 0{,}001$	Accepted
H2	Mod: AI Literacy×Chatbot→Independence	0.215	3,114	0.002	Accepted
H3	Learning Independence→Academic Achievement	0.514	7,925	$< 0{,}001$	Accepted
H4	Chatbot→Independence→Academic Achievement	0.248	4,632	$< 0{,}001$	Accepted

Testing H1 shows that the use of *AI chatbots* is positively and significantly associated with student learning independence ($\beta = 0{,}482, t = 6{,}841, p < 0{,}001$). The AI Literacy variable was shown to positively moderate (H2) the relationship between *chatbot use* and learning independence ($\beta = 0{,}215, t = 3{,}114, p = 0{,}002$), which means that the positive impact *of chatbots* on self-regulation is stronger in students with high levels of AI literacy. Furthermore, H3 confirms that learning independence has a strong direct influence on academic achievement ($\beta = 0{,}514, t = 7{,}925, p < 0{,}001$). Finally, the indirect effect test (H4) proves the significant partial mediation role of learning independence in intervening in the influence of *chatbot use* on improving academic achievement ($\beta = 0{,}248, t = 4{,}632, p < 0{,}001$).

Overall, this model is able to explain 42.6 % of the variance of the Learning Independence variable ($R^2 = 0{,}426$) and 38.4 % of the variance of the Academic Achievement variable ($R^2 = 0{,}384$), which is categorized as a moderate to strong level of predictive accuracy in social science research (Taylor & White, 2025).

Discussion

The empirical findings of this study confirm that the integration of AI-based *chatbots in high-learning environments acts as a cognitive catalyst that strengthens,* rather than erodes, students' learning autonomy. The positive effect of *chatbot use* on learning autonomy (H1) conceptually supports the technology's role as *digital scaffolding* . *Chatbots* provide adaptive and immediate instructional support (*instant feedback*), enabling students to independently address conceptual bottlenecks without having to wait for instructor intervention (Davis & Smith, *2024*). The availability of this responsive assistance encourages the development of goal-setting *and* self - *monitoring habits* , which are at the heart of *self-regulated learning theory* (Evans et al., 2023).

The significance of the moderating effect of AI literacy (H2) provides a critical nuance in understanding how human-machine interactions occur at the cognitive level. *Prompt engineering* skills , an understanding of ethical limitations, and the ability to evaluate the correctness of AI outputs prevent students from falling into the trap of cognitive offloading *(* Hassan & Ibrahim, 2025; Lopez et al.,

2024). Students with mature AI literacy treat *chatbots* as Socratic dialogue partners—testing arguments and exploring alternative perspectives—thus deepening cognitive ownership of the course material (Patel & Rahman, 2025). Conversely, without adequate AI literacy, *chatbot* use risks becoming merely a shortcut to completing tasks without in-depth understanding (Ramirez & Santos, 2025).

The causal relationship between learning independence and academic achievement (H3) is consistent with both classical and modern educational psychology literature. Students with high self-regulation demonstrate more structured information processing strategies, resilience to high cognitive load, and superior levels of self-efficacy (Green & Harrison, 2023; Jones & Tanaka, 2024). The ability to independently direct, evaluate, and correct the learning process linearly transforms cognitive potential into measurable academic outcomes in the form of grade achievement and conceptual understanding (Ismail & Pratama, 2024).

The acceptance of the mediation hypothesis (H4) underscores the internal mechanisms by which technology exerts a performative impact. The use of AI *chatbots* does not magically mechanically increase academic achievement; rather, the presence of *the chatbots* triggers improvements in how students organize their learning activities. *The digital scaffolding* provided by *the chatbots* initially builds self-confidence and independence, which then become key drivers for gradual and sustained improvements in academic achievement (Nugroho & Wibowo, 2025; Taylor & White, 2025).

Practically, the results of this study provide policy implications for university leaders not to impose an absolute ban on Generative AI, but rather to design an integrated AI literacy curriculum (O'Connor & Kelly, 2024). Lecture instructional design needs to be directed to utilize *chatbots* as a means of stimulating critical thinking through problem-solving-based assignments (Suryanto & Lestari, 2024). Thus, the integration of artificial intelligence can be optimally directed to produce graduates who are not only skilled in utilizing modern technology but also possess strong autonomy, independence, and cognitive self-regulation in the digital era (Ahmad & Rahim, 2024; Chen & Liu, 2025).

CONCLUSION

This research successfully demonstrated that the integration of artificial *intelligence* (AI)-based *chatbots* provides a positive and significant contribution to improving student learning independence in higher education. *The chatbot's* flexible and responsive accessibility has proven effective as a *digital scaffolding* , facilitating students in initiating, monitoring, and evaluating their learning process independently. The use of this technology can reduce psychological barriers such as academic anxiety while simultaneously increasing students' self-efficacy in completing complex coursework (Ismail & Pratama, 2024; Jones & Tanaka, 2024).

The role of AI literacy has been identified as a crucial moderating variable that strengthens the influence of *chatbot* interactions on learning independence. Students who possess ethical, technical, and critical thinking skills regarding AI technology are able to optimize *chatbots* as analytical dialogue partners, thereby avoiding passive dependency *and cognitive offloading* phenomena (Hassan & Ibrahim, 2025; Lopez et al., 2024). Furthermore, the resulting learning independence has been shown to be a mediating mechanism linking the use of AI *chatbots* with significant improvements in academic

achievement, confirming that technology acts as a catalyst *for* increasing students' cognitive capacity (Nugroho & Wibowo, 2025).

The theoretical and practical implications of these findings emphasize that the adoption of AI in higher education must be accompanied by the development of a structured AI literacy curriculum. Academic policymakers and educators are advised to design learning strategies that encourage Socratic interactions with *chatbots* to ensure that technology is leveraged to foster students' intellectual autonomy. Future research should expand the sample size across disciplines and employ longitudinal observation to test the long-term sustainability of *chatbot use on learning independence (O'Connor & Kelly, 2024; Taylor & White, 2025).*

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