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# ChatGPT in higher education: Does acceptance lead to self-directed learning?

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**Abstract**: The rapid development of artificial intelligence (AI) in education has introduced new learning tools, including ChatGPT, a language model that supports interactive academic tasks. However, the effectiveness of such tools in fostering student independence remains under explored. This study investigates whether students' acceptance of ChatGPT contributes to their self-directed learning (SDL) in higher education. The aim of this study is to examine the relationship between students' acceptance of ChatGPT, defined as perceived usefulness and perceived ease of use, and their level of SDL, with frequency of use as a mediating variable. The scope of the study focuses on undergraduate students who have used ChatGPT in academic settings. This research employed a quantitative approach using a survey method. A total of 242 students from various faculties participated in the study. The data were analysed using multiple regression and a Sobel test to assess both direct and indirect effects within the proposed mediation model. The results showed that acceptance of ChatGPT significantly influenced both its usage frequency and students' self-directed learning. Although the direct effect of frequency of use on SDL was not statistically significant, the Sobel test revealed a significant indirect effect, indicating that frequency of use acts as a mediator between acceptance and SDL. In other words, students who perceive ChatGPT as useful and easy to use tend to use it more frequently, and this usage contributes indirectly and significantly to the development of self-directed learning behaviors. These findings suggest that integrating AI tools like ChatGPT into higher education requires not only technical access but also fostering positive perceptions and habits of use to truly enhance students' learning autonomy.
**Keywords**: ChatGPT, technology acceptance, self-directed learning, higher education, artificial intelligence in education

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## Introduction

The integration of artificial intelligence (AI) in higher education has introduced new dynamics into student learning behavior (Achmad & Utami, 2023; Al-Zahrani & Alasmari, 2024; Nguyen, Van Lai, & Nguyen, 2024; Ouyang, Zheng, & Jiao, 2022; Zhou, 2023). Among the many AI tools available, ChatGPT has emerged as one of the most popular platforms (Nehra & Bansode, 2024), widely used by students to support academic tasks such as writing (Imran & Almusharraf, 2023), comprehension, and information retrieval (Huang & Huang, 2024). As a language-based AI system, ChatGPT provides instant and personalized feedback, making it attractive for independent study. However, while access to such tools continues to grow, there is increasing concern regarding how this technology shapes students' learning autonomy. Specifically, does the use of ChatGPT encourage learners to become more self-directed, or does it foster dependency?

In educational research, self-directed learning (SDL) is considered a core competence in 21st-century learning frameworks (Vithayaporn, Yong, & Chai, 2021). SDL refers to a learner's capacity to take initiative in diagnosing learning needs, formulating goals, identifying resources, and evaluating learning outcomes independently (Charokar & Dulloo, 2022; Prastika, Senen, & Cahya, 2023). Prior studies have linked SDL with student motivation (Grande et al., 2022), metacognitive skills (Jin & Ji, 2021), and academic performance (Okwuduba, Nwosu, Okigbo, Samuel, & Achugbu, 2021). However,

the influence of technology—particularly AI—on SDL remains understudied. While digital tools can facilitate access and efficiency, their impact on learner independence is not always linear or positive.

Despite the increasing integration of ChatGPT into students' learning routines, little attention has been given to whether this use enhances or undermines students' ability to manage their own learning processes. Most research to date has focused on how ChatGPT supports task completion rather than on how it affects deeper learning strategies such as self-regulation, goal setting, or reflective thinking. As students become more reliant on automated tools, there is growing concern that frequent use may either empower learners with accessible knowledge or hinder the development of independent academic competencies. This ambiguity presents a critical gap in both pedagogical understanding and policy direction.

One theoretical model that helps to understand technology use behavior is the Technology Acceptance Model (TAM), which posits that perceived usefulness and perceived ease of use determine an individual's willingness to adopt a technology (Ibrahim & Shiring, 2022). In this study, these two dimensions are combined into a broader construct referred to as "ChatGPT acceptance." While TAM has been extensively used in educational technology research, its extension into understanding its influence on SDL via usage patterns (e.g., frequency) remains limited.

The concept of technology acceptance plays a foundational role in determining how users adopt and integrate digital tools into their daily routines (Ma et al., 2025). Rooted in the Technology Acceptance Model (TAM), acceptance is shaped by two core perceptions: perceived usefulness, or the extent to which individuals believe the technology enhances their task performance, and perceived ease of use, or the degree to which the technology is considered free of effort. In higher education, students who perceive ChatGPT as useful and easy to use are more likely to develop a favourable attitude and intention toward its use (Alshammari & Babu, 2025). Therefore, in this study, technology acceptance is operationalized as a single construct combining these two perceptions to represent students' overall appraisal of ChatGPT in learning. Acceptance, however, does not operate in isolation—it influences and is reflected in actual user behaviour, particularly in how frequently a technology is used. In this model, frequency of ChatGPT usage is positioned as a behavioral manifestation of acceptance. The more a student accepts ChatGPT as a helpful and accessible tool, the more likely they are to use it consistently. Prior studies on TAM support this logic by showing that behavioral intention (acceptance) is a strong predictor of actual system use. Thus, frequency of use is conceptualized as a mediating variable, linking students' internal perceptions with external academic outcomes.

The outcome of interest in this study is self-directed learning (SDL), which reflects a learner's ability to take control of their own learning processes. SDL is characterised by self-initiative, goal-setting, and independent problem-solving—all of which are crucial for academic success in flexible, technology-rich environments. The central hypothesis of this study is that students who accept and frequently use ChatGPT will exhibit higher levels of SDL, not because the tool directly promotes independence, but because frequent engagement with it may stimulate deeper inquiry, broaden access to resources, and foster reflective learning habits. Thus, the interplay between acceptance, usage frequency, and SDL provides a meaningful framework for examining the role of AI tools in shaping autonomous learning behavior.

Several previous studies have explored the educational implications of AI tools such as ChatGPT in various domains, particularly in writing assistance, language learning, and information seeking. For instance, Kasneci et al. (2023) reported that ChatGPT can enhance students' productivity and cognitive support during task completion, while a study by Hadi, Mohamad, Johar, & Kadir (2024) found that English as a Second Language (ESL) students perceived it as both useful and easy to use in academic writing. Similarly, Tran and Nguyen (2024) demonstrated ChatGPT's positive impact on English language learning, showing improvements in grammar, vocabulary, and engagement. Research has also highlighted ChatGPT's usefulness in information seeking: Xu et al. (2023) compared ChatGPT with traditional search engines and found that users rated ChatGPT higher on perceived usefulness and satisfaction, particularly for generating ideas and summarizing content. Likewise, Chan and Hu (2023) reported that undergraduates view generative AI tools as highly beneficial for personalized support and brainstorming.

While these studies affirm students' positive attitudes and initial performance gains with ChatGPT—key components of the Technology Acceptance Model (TAM)—most have focused primarily on task-level outcomes. For example, analyses by Susnjak and McIntosh (2024) and Dwivedi

et al. (2021) emphasized ChatGPT's role in improving assignment efficiency and answer quality. However, this body of work has yet to fully address whether frequent or routine use of ChatGPT leads to deeper learning changes, specifically in self-directed learning (SDL). This gap is significant because behavioural intentions and task efficiency do not necessarily translate into the development of autonomous learning skills — such as goal-setting, self-monitoring, and reflective practice — that define SDL.

Despite the growing body of literature on AI in education, very few studies have examined whether the acceptance of ChatGPT leads to deeper forms of learning behavior. Most research has not considered the mechanisms by which acceptance translates into learning outcomes, nor whether the frequency of use acts as a mediating pathway in this relationship. Furthermore, the impact of ChatGPT on students' capacity for self-regulation, independent learning, and reflective engagement remains underexplored. This presents a significant research gap, especially in higher education, where learner autonomy is essential. Therefore, this study seeks to fill that gap by proposing and testing a mediation model linking ChatGPT acceptance to self-directed learning through usage frequency, offering a more comprehensive understanding of how AI shapes not only academic efficiency but also learner independence.

This study aims to investigate the relationship between students' acceptance of ChatGPT and their self-directed learning (SDL) in higher education. Specifically, it examines whether the frequency of ChatGPT usage mediates the effect of acceptance on SDL. By integrating constructs from the Technology Acceptance Model (TAM) with behavioral and cognitive learning outcomes, this study seeks to provide empirical evidence on how students' perceptions and patterns of AI usage contribute to autonomous learning. The findings are expected to inform both educators and policymakers on the pedagogical value of AI tools and how to foster meaningful, independent engagement with technology in academic settings.

Accordingly, the research seeks to answer the following questions:

1. Does ChatGPT's acceptance significantly influence its use frequency among university students?
2. Does the frequency of ChatGPT usage significantly influence students' self-directed learning?
3. Does ChatGPT acceptance directly influence self-directed learning?
4. Does the frequency of ChatGPT usage mediate the relationship between ChatGPT acceptance and self-directed learning?

This research contributes to the existing body of knowledge in several ways. Theoretically, it extends the Technology Acceptance Model (TAM) by linking technological perceptions directly to pedagogical outcomes like self-directed learning, offering a more nuanced understanding of AI's role in student development. Methodologically, it employs a mediation analysis to clarify the mechanism through which perceptions translate into actual learning behaviors. From a practical perspective, the study provides a foundation for higher education institutions to design AI integration strategies that do not merely focus on technical access, but rather on fostering student autonomy and lifelong learning habits in an increasingly automated academic landscape.

## Methods

This study employed a quantitative, cross-sectional correlational research design to examine the relationships among ChatGPT acceptance, frequency of ChatGPT usage, and self-directed learning (SDL) among undergraduate students. Given the non-experimental nature of the study, the analysis focused on identifying associative and mediational relationships rather than establishing causal effects. This study was conducted among undergraduate students enrolled at Universitas ST in Indonesia. The participants were selected through purposive sampling, focusing on students who had previously used ChatGPT for academic purposes. A total of 242 students voluntarily participated in the study. Data collection was conducted through an online survey distributed via Google Forms. Prior to participation, respondents were informed of the study's objectives and provided consent.

The instrument utilised in this study comprised three sections: (1) ChatGPT acceptance, (2) frequency of ChatGPT usage, and (3) self-directed learning (SDL). The ChatGPT acceptance variable was derived from the Technology Acceptance Model (TAM), combining perceived usefulness and perceived ease of use into a unified construct. Each item was adapted to reflect students' perceptions of

ChatGPT as an educational tool. The frequency of ChatGPT use was measured via self-report, with participants asked how often they used the programme for academic tasks. The SDL was measured using an adapted version of the scale originally proposed by Knowles (1975), which evaluates learners' ability to take initiative, set learning goals, monitor progress, and evaluate outcomes. A number of items were revised in order to reflect contemporary learning contexts and the integration of digital tools.

The questionnaire consisted of 38 items measuring three main constructs: ChatGPT acceptance, frequency of ChatGPT usage, and self-directed learning. Prior to hypothesis testing, a reliability analysis was conducted to assess the instrument's internal consistency. The results indicated excellent reliability, with a Cronbach's alpha coefficient of 0.953 across all 38 items, exceeding the recommended threshold of 0.70. This finding suggests that the instrument demonstrates high internal consistency and is suitable for further statistical analysis.

The collected data were analysed using IBM SPSS. The use of descriptive statistics was instrumental in summarising participant characteristics and the central tendencies of each variable. A series of linear regression analyses was conducted to examine the direct relationships between ChatGPT acceptance, usage frequency, and self-directed learning. Furthermore, the Sobel test was employed to evaluate the significance of the indirect effect of ChatGPT acceptance on self-directed learning via frequency of use, to test for mediation. Throughout the analysis, a significance level of $p < 0.05$ was applied (Sobel, 1982).

The present study was subject to several limitations. As a cross-sectional survey relying on self-reported data, responses may be subject to recall biases or inaccuracies. The use of purposive sampling within a single institution also limits the generalisability of findings to broader student populations. Furthermore, the frequency of ChatGPT use was measured based on students' perception rather than objective usage logs, which may not precisely capture behavioural patterns. Nevertheless, the present study constitutes a significant preliminary step in understanding the mechanisms by which acceptance of AI may influence autonomous learning behaviours in higher education contexts.

## Results and Discussion

### Results

The demographic profile of respondents in this study is presented in Table 1. It consisted of 242 university students, with a majority being female (78.5%) and male participants accounting for 21.5%.

**Table 1.** Respondent Demographic

| Gender | Frequency | Percent |
|---|---|---|
| Female | 190 | 78.5 |
| Male | 52 | 21.5 |
| Total | 242 | 100.0 |

In terms of age distribution, as presented in Table 2, most respondents were in the 18–20 age range, with the largest proportion aged 19 (40.9%), followed by 20 (26.4%) and 18 (17.4%). A smaller number of respondents were between 21 and 26 years old, and a few were outside the typical undergraduate age range, including one respondent aged 31 (0.4%). This indicates that the sample primarily consists of young adults in the early stages of their higher education.

**Table 2.** Distribution of Respondents by Age

| Age Range (Years) | Frequency | Percentage (%) |
|---|---|---|
| 17 | 1 | 0.4 |
| 18 | 42 | 17.4 |
| 19 | 99 | 40.9 |
| 20 | 64 | 26.4 |
| 21–26 | 35 | 14.5 |
| ≥ 27 | 1 | 0.4 |
| Total | 242 | 100.0 |

Table 3 presents the descriptive statistics of the four main variables measured in this study. The ChatGPT usage frequency variable has a mean of 9.83 and a standard deviation of 1.524, within a possible range of 5 to 15. This indicates that, on average, students reported a moderately high level of ChatGPT use for academic purposes, with relatively low variability among respondents.

**Table 3.** Descriptive Statistics

| Variable | N | Range | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| ChatGPT Usage Frequency | 242 | 10 | 5 | 15 | 9.83 | 1.524 |
| Perceived Usefulness | 242 | 24 | 16 | 40 | 27.42 | 4.157 |
| Perceived Ease of Use | 242 | 19 | 11 | 30 | 21.28 | 3.188 |
| Self-Directed Learning (SDL) | 242 | 72 | 48 | 120 | 85.00 | 11.296 |

The Perceived Usefulness of ChatGPT had a mean score of 27.42 (on a scale from 16 to 40) and a standard deviation of 4.157, suggesting that students generally perceived ChatGPT as a useful tool in supporting their learning activities. Similarly, Perceived Ease of Use had a mean of 21.28 (range: 11–30) with a standard deviation of 3.188, indicating a favourable but slightly more varied perception of ChatGPT's ease of use.

The Self-Directed Learning (SDL) variable recorded a mean score of 85.00 out of a possible 120, with a relatively high standard deviation of 11.296, reflecting substantial variation in SDL levels across participants. This suggests that while most students demonstrated a fairly high degree of learning autonomy, there were meaningful differences in how independently they manage their learning processes.

**Research Question 1: Does ChatGPT acceptance significantly influence the frequency of its use among university students?**

A simple linear regression analysis was conducted to examine the effect of students' acceptance of ChatGPT on the frequency of ChatGPT usage in academic activities. The results of the analysis are presented in Table 4.

**Table 4.** Summary of Regression Analysis – ChatGPT Acceptance on Usage Frequency

| Description | Value |
|---|---|
| Regression Coefficient (B) | 0.051 |
| t-value | 3.584 |
| Sig. (p-value) | 0.000 |
| Coefficient of Determination ($R^2$) | 0.051 |
| F-value (Simultaneous Test) | 12.846 |
| Sig. F | 0.000 |

Table 4 shows that the analysis yielded an R-squared value of 0.051, indicating that students' acceptance of ChatGPT explain 5.1% of the variance in ChatGPT usage frequency. The remaining 94.9% of the variance is attributable to variables not included in the model. The F-test yielded an F value of 12.846 with $p = 0.000$, indicating that the regression model is statistically significant overall. This finding suggests that the increased utilisation of ChatGPT is predominantly driven by its growing acceptance among users.

The findings of this study indicate that the regression coefficient ($B = 0.051$), when considered in conjunction with a t-value of 3.584 and a significance level of $p = 0.000$, supports the positive, statistically significant impact of ChatGPT acceptance on usage frequency. It can thus be concluded that a direct correlation exists between the extent to which students accept ChatGPT and the frequency with which they utilise it in their learning activities. Based on the findings, Hypothesis 1 (H1) is substantiated, indicating that ChatGPT acceptance has a favourable and substantial impact on its utilisation frequency among university students.

**Research Question 2: Does the frequency of ChatGPT usage significantly influence students' self-directed learning?**

A simple linear regression analysis was conducted to examine the effect of ChatGPT usage frequency on students' self-directed learning (SDL). Table 5 below provides a synopsis of the findings derived from the analysis.

**Table 5.** Summary of Regression Analysis – Frequency of ChatGPT Use on Self-Directed Learning

| Description | Value |
|---|---|
| Regression Coefficient (B) | –0.622 |
| t-value | –1.304 |
| Sig. (p-value) | 0.194 |
| Coefficient of Determination ($R^2$) | 0.007 |
| F-value (Simultaneous Test) | 1.700 |
| Sig. F | 0.194 |

The findings in Table 5 suggest that the R-square value is 0.007, indicating that only 0.7% of the variance in students' self-directed learning can be attributed to the frequency of ChatGPT use. This finding indicates that the impact of usage frequency on SDL is negligible. The F-test yielded a value of 1.700, with a p-value of 0.194, which is above the standard threshold of 0.05. This finding indicates that the regression model is not statistically significant.

In a similar vein, the regression coefficient (B = –0.622) was not statistically significant (p = 0.194), indicating that ChatGPT usage frequency does not have a substantial effect on students' self-directed learning. Furthermore, the negative sign of the regression coefficient indicates an inverse relationship between usage frequency and SDL. While this relationship does not attain statistical significance, it suggests a potential association between higher usage frequency and marginally lower SDL scores. However, it is important to note that this trend cannot be statistically generalised. In consideration of the findings, it can be concluded that Hypothesis 2 (H2) is to be rejected. This indicates that the frequency of ChatGPT usage does not exert a significant effect on self-directed learning among the university student population examined in this study.

**Research Question 3: Does ChatGPT acceptance directly influence self-directed learning?**

In order to examine the extent to which students' acceptance of ChatGPT influences their self-directed learning (SDL), a simple linear regression analysis was conducted. The results of the study are summarised in Table 6.

**Table 6.** Summary of Regression Analysis – ChatGPT Acceptance on Self-Directed Learning

| Description | Value |
|---|---|
| Regression Coefficient (B) | 0.718 |
| t-value | 7.365 |
| Sig. (p-value) | 0.000 |
| Coefficient of Determination ($R^2$) | 0.184 |
| F-value (Simultaneous Test) | 54.249 |
| Sig. F | 0.000 |

The analysis yielded an R-square of 0.184, indicating that their level of acceptance of ChatGPT explains 18.4% of the variation in students' self-directed learning. This finding suggests that students' perception of ChatGPT as both useful and easy to use contributes substantially to the promotion of independent learning behaviours.

The F-test yielded an F value of 54.249 with a p-value of 0.000 (< 0.05), indicating that the regression model is statistically significant in its entirety. The regression coefficient B was 0.718, with a t-value of 7.365 and a p-value of 0.000, indicating a positive, statistically significant relationship between ChatGPT acceptance and self-directed learning. It may be posited that an increase in the number of students who accept ChatGPT as a valuable, user-friendly tool is indicative of greater engagement in self-directed learning. In light of the findings, it can be concluded that Hypothesis 3 ($H_3$) is accepted,

indicating that ChatGPT acceptance has a positive and significant effect on students' self-directed learning.

**Research Question 4: Does the frequency of ChatGPT usage mediate the relationship between ChatGPT acceptance and self-directed learning?**

To examine whether ChatGPT usage frequency mediates the relationship between ChatGPT acceptance and students' self-directed learning, a mediation analysis was conducted using the Sobel test approach. This test evaluates the significance of the indirect effect of the independent variable (ChatGPT acceptance) on the dependent variable (self-directed learning) via the mediator (usage frequency). The coefficients and standard errors from the two regression paths are summarized in Table 7 as follows.

**Table 7.** Summary of Coefficients for Sobel Test

| Regression Path | Coefficient (B) | Std. Error (SE) |
|---|---|---|
| ChatGPT Acceptance → Usage Frequency | 0.051 | 0.014 |
| Usage Frequency → Self-Directed Learning (SDL) | –1.411 | 0.435 |
| Z Sobel | –2.423 | – |
| Sig. (two-tailed) | 0.015 | – |

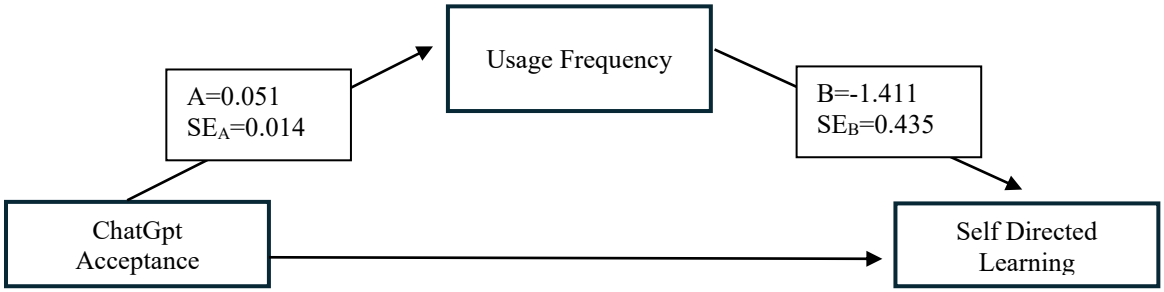


**Figure 1.** Mediation Model of ChatGPT Acceptance, Usage Frequency, and Self-Directed Learning

The research findings demonstrated that the development of multimedia-based E-Folklore media was an effective effort to improve reading comprehension. The study utilized the ADDIE instructional design model for Research and Development (R&D) and was tested on fourth-grade students. The final product was a multimedia E-Folklore platform developed to meet high-quality standards. This quality was validated through assessment results from both media and material experts. Consequently, the results indicated that this E-Folklore media was feasible and ready for use by students in educational settings. The Sobel test (Sobel, 1982) formula used is as follows.

$$z = \frac{ab}{\sqrt{(b^2\mathrm{SE}_a^2) + (a^2\mathrm{SE}_b^2)}}$$

Where:

1. a is the regression coefficient from ChatGPT Acceptance to Usage Frequency (0.051)
2. SEa is the standard error of a (0.014)
3. b is the regression coefficient from Usage Frequency to SDL (–1.411)
4. SEb is the standard error of b (0.435)

$$Z = \frac{(0.051 \times -1.411)}{\sqrt{(-1.411)^2 \times (0.014)^2 + (0.051)^2 \times (0.435)^2}}$$

$$Z = \frac{-0.071961}{\sqrt{(1.991)^2 \times 0.000196 + 0.002601 \times 0.189225}}$$

$$Z = \frac{-0.071961}{\sqrt{0.000393 + 0.000492}} = \frac{-0.071961}{\sqrt{0.000885}}$$

$$Z = \frac{-0.071961}{0.02974} = -2.423$$

The calculation yielded a Z value of –2.423, with a two-tailed significance of 0.015, which is less than 0.05. This indicates that the indirect effect is statistically significant. The findings indicate that usage frequency plays a significant mediating role in the relationship between ChatGPT acceptance and students' self-directed learning. It was demonstrated that students who perceive ChatGPT as beneficial and straightforward to use are more likely to use it more regularly. This frequent use serves as a significant catalyst in enhancing their autonomous learning behaviours. Consequently, Hypothesis 4 (H4) was substantiated, thereby validating the substantial mediating role of usage frequency in the association between ChatGPT acceptance and self-directed learning.

**Discussion**

The objective of the present study was to examine the correlation between ChatGPT acceptance among university students and their self-directed learning (SDL), whilst also investigating whether the frequency of ChatGPT use influences this association. The findings provide several significant insights into the manner in which emerging AI tools may influence students' autonomy in learning environments.

Firstly, the results confirmed that ChatGPT acceptance significantly influences its usage frequency, a finding firmly rooted in the theoretical assumptions of the Technology Acceptance Model (TAM) proposed by Davis. According to TAM, perceived usefulness and perceived ease of use are the two principal factors that determine users' behavioral intention to use a technology. In this study, students who believed that ChatGPT could improve their academic performance (usefulness) and was accessible with minimal effort (ease of use) were more likely to engage with it more frequently in learning activities. This behaviour reflects a typical TAM pathway in which cognitive appraisals of a technology translate into actual behavioural engagement. This relationship aligns with findings from prior studies in educational technology contexts. For instance, Kasneci et al. (2023) showed that students who found AI-based tools like ChatGPT helpful and intuitive were more inclined to adopt them regularly in their study routines. Similarly, Susnjak and McIntosh (2024) emphasised that students' trust in generative AI's ability to streamline tasks influenced their willingness to integrate it into academic workflows. Extending this pattern, Dwivedi et al. (2021) highlighted that across educational sectors, AI adoption is positively influenced by students' perceived value and usability of the tools, especially when these tools offer personalised, context-aware feedback.

Moreover, this study reinforces emerging research suggesting that acceptance is not merely a static perception but a gateway to technology-enabled learning behaviours. Börekci and Çelik (2024) argue that in AI-assisted environments, user acceptance serves as a psychological threshold that activates deeper learning engagement. The more students accept the tool, the more it becomes embedded in their academic behavior. In that sense, ChatGPT is not simply used because it exists, but because its perceived cognitive value compels students to integrate it into their personal learning strategies. Interestingly, the current finding also suggests that acceptance may carry even greater weight in self-regulated learning contexts, where students autonomously choose and orchestrate the tools they use. As shown by Tao (2011) and, more recently, by Wang et al. (2021), acceptance is particularly critical in educational settings where learners have discretion over tool selection—such as optional AI platforms outside formal learning management systems. Therefore, this study adds nuance to TAM by illustrating how behavioural intention translates into behavioural frequency, particularly in technology-rich learning environments that promote autonomy.

In the context of AI in education, this result contributes to a broader understanding of how intelligent tools are becoming co-agents in learners' cognitive processes, contingent on initial acceptance. As noted by Holstein et al. (2019), AI tools must be perceived not only as efficient but also as pedagogically trustworthy to be adopted meaningfully. ChatGPT, with its capacity for natural language interaction and responsiveness, meets this criterion—but only when students recognize its affordances and limitations. Hence, acceptance becomes a filtering mechanism: students who accept ChatGPT tend to incorporate it into their academic practice, while those who don't may underutilise it despite its capabilities.

Secondly, the study found that students' acceptance of ChatGPT significantly and directly influenced their self-directed learning (SDL). This result suggests that acceptance of AI tools is not

merely a precursor to usage behavior but may also activate deeper cognitive and motivational processes related to autonomy in learning. In other words, students who view ChatGPT as both useful and easy to use appear more likely to engage in proactive, self-managed learning behaviors such as planning, goal-setting, and resource-seeking. This reinforces the notion that acceptance functions as a motivational amplifier, aligning learners' perception of tool value with their willingness to take ownership of their learning.

This finding meaningfully extends the Technology Acceptance Model (TAM) into what may be called the cognitive-behavioural domain of education. While TAM was originally designed to explain technology usage behavior, recent scholarship has explored how acceptance can lead to broader learning outcomes beyond system interaction. For instance, Ifenthaler & Yau (2020) argue that learners who value digital tools are more likely to adopt metacognitive learning strategies, including self-monitoring and reflection. Similarly, Wang et al. (2024) demonstrate that technology acceptance is positively associated with academic self-efficacy, which, in turn, fosters autonomous learning. The direct link found in this study between ChatGPT acceptance and SDL supports this theoretical evolution of TAM—from a tool-use model to a learning-behavior model.

Importantly, this result also highlights the potential of AI-powered tools to enable learner autonomy, provided they are accepted not just functionally but also pedagogically. When students believe that ChatGPT enhances understanding, provides reliable guidance, and aligns with their learning preferences, they are more likely to integrate it into self-directed learning routines. This aligns with findings from Wang et al. (2021), who found that student trust and the perceived alignment of AI tools with personal learning goals are critical drivers of independent learning behaviour. Therefore, the significance of ChatGPT's acceptance in predicting SDL not only validates AI's role in enhancing educational engagement but also calls for intentional integration strategies that foster both trust and skill in AI-supported learning environments.

The analysis revealed that the direct relationship between ChatGPT usage frequency and students' self-directed learning (SDL) was not statistically significant, suggesting that greater ChatGPT use does not automatically lead to greater learner autonomy. Research in broader educational technology supports this finding, indicating that frequency of use alone often fails to predict learning outcomes—quality and depth of engagement matter far more. For instance, Juuti et al. (2022) found that while survey-based studies often show minimal impact of tech frequency on outcomes, the educational value emerges when technology is meaningfully integrated into teaching practices. A large school-based study by Juuti et al. (2022) concluded that quality of integration explains significantly more variance in engagement and digital competencies than frequency of use. The rejection of Hypothesis 2 suggests that the frequency of ChatGPT usage alone is insufficient to significantly relate to students' self-directed learning. This finding aligns with prior research indicating that mere exposure to or frequent use of digital learning technologies does not automatically translate into enhanced learner autonomy (Azevedo & Cromley, 2004; Kirschner & De Bruyckere, 2017). Several studies have emphasised that self-directed learning is shaped more by learners' metacognitive regulation, intentional goal-setting, and reflective practices than by the quantity of technology use itself (Broadbent & Poon, 2015). In the context of AI-supported learning, recent evidence suggests that generative AI tools may primarily serve as supportive resources rather than autonomous learning drivers, meaning that, without deliberate learning strategies, frequent interaction with such tools may not foster independent learning behaviours (Kasneci et al., 2023b). Thus, the present finding reinforces the notion that technology usage frequency must be accompanied by purposeful engagement and self-regulatory processes to meaningfully support self-directed learning in higher education.

Nevertheless, the Sobel test revealed a statistically significant indirect effect, indicating that usage frequency mediates the relationship between ChatGPT acceptance and SDL. This finding underscores a critical insight: while frequency alone may not suffice to improve learner autonomy, it functions as a conduit through which positive perceptions of ChatGPT can be translated into self-directed learning behaviors. Students who accept and trust ChatGPT are more likely to use it frequently, and this repeated exposure may gradually influence their learning habits, especially if scaffolded by guidance or reflective practice. This is consistent with Kharroubi and ElMediouni, (2024) self-regulated learning framework, which emphasizes that behavioral engagement must be supported by metacognitive strategies to foster autonomy. Therefore, the mediation result illustrates that usage frequency plays an enabling—though not standalone—role in the larger process of moving from technological acceptance to independent

learning.

An alternative explanation is that students who are already more self-directed are more likely to perceive ChatGPT as useful, thereby inflating the observed relationship between acceptance and SDL. Furthermore, given that usage frequency was self-reported rather than objectively tracked, it is possible that some students may have over- or under-estimated their actual use, which could influence the strength of the mediation effect.

The implications of this study are twofold, both theoretical and practical. In principle, it extends the application of TAM beyond behavioural intention and actual use, connecting it to cognitive learning outcomes such as SDL. The findings of this study suggest that educational institutions should consider two key actions. Firstly, they should promote access to AI tools. Secondly, they should invest in building student awareness and skill in using them purposefully. The mere provision of ChatGPT is insufficient in itself; rather, cultivating favourable perceptions and facilitating reflective utilisation may prove pivotal in promoting autonomous learning behaviours. Additionally, studies in cybersecurity education using AI tools, such as those by Marquardson (2024), have shown that structured support and student training are essential for AI tools to enhance SDL, reinforcing the idea that frequency matters most when supported by pedagogical guidance.

## Conclusion

The present study provides empirical evidence that students' acceptance of ChatGPT significantly predicts both their usage frequency and self-directed learning in higher education. It was found that, while usage frequency did not directly influence learning autonomy, it did significantly mediate the relationship between acceptance and self-directed learning. The findings suggest that students who perceive ChatGPT as useful and easy to use are more likely to engage with it frequently, and through this engagement, gradually enhance their ability to learn independently. The significance of this study lies in extending the Technology Acceptance Model (TAM) to encompass cognitive learning outcomes, such as self-directed learning, which are becoming increasingly vital in AI-supported learning environments. By empirically establishing a correlation between acceptance, usage behaviour, and learner autonomy, this research contributes to the existing discourse on the role of artificial intelligence in education.

In the context of prior studies, this paper reinforces the view that technology alone does not lead to educational transformation; its impact depends on how it is perceived, adopted, and meaningfully integrated into learning strategies. The findings emphasise the necessity for educators and institutions to facilitate not only access to AI tools, but also student awareness, intentional use, and reflective engagement, if such tools are to genuinely support autonomous learning in the digital age.

Future research is encouraged to employ longitudinal or experimental designs to better capture changes in self-directed learning over time and to clarify the directionality of the relationships observed in this study. In addition, incorporating objective measures of AI usage, such as system log data, could provide a more accurate representation of students' engagement with ChatGPT. Further studies may also explore additional mediating or moderating variables—such as metacognitive skills, digital literacy, or instructional scaffolding—to deepen understanding of how AI acceptance translates into meaningful learning outcomes across diverse higher education contexts.

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