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Predicting Metacognitive Engagement in EFL Writing: The Role of Technology Acceptance and Self-regulated Learning

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Abstract: This study aims to provide insight and a deeper understanding of how technology acceptance contributes to the development of metacognitive engagement in EFL students by integrating the self-regulatory learning process. This study employed a correlational survey design. The data were collected using a questionnaire based on the Technology Acceptance Model (TAM) and Self-Regulated Learning (SRL), both of which are previously validated. Data analysis was performed using descriptive statistics and Partial Least Squares-Structural Equation Modeling (PLS-SEM). In this model, metacognitive engagement was represented as a second-order construct comprising the SRL dimensions. Model evaluation included testing the measurement model (construct validity and reliability) and the structural model to examine the influence of perceived usefulness and ease of use on metacognitive engagement in AI-assisted writing. The findings revealed that the proposed structural model demonstrated substantial predictive power, with Perceived Usefulness and Perceived Ease of Use jointly explaining 64.7% of the variance in EFL students' metacognitive engagement in AI-assisted writing ($R^2 = 0.647$). Perceived Usefulness ($\hat{a} = 0.498$, $t = 9.132$, $p < .001$) and Perceived Ease of Use ($\hat{a} = 0.386$, $t = 6.421$, $p < .001$) had significant positive effects on metacognitive engagement. These results confirmed the H1 and H2 hypotheses proposed in this study, indicating that technology acceptance is significantly associated with self-regulated learning processes underlying metacognitive engagement, thereby providing empirical support for H3. The findings demonstrate that technology acceptance significantly enhances metacognitive engagement in AI-assisted EFL writing. This suggests that AI tools play a meaningful role in fostering reflective, self-regulated writing practices among EFL learners.

Keywords: AI-assisted writing, technology acceptance, self-regulated learning, metacognitive engagement, PLS-SEM.

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INTRODUCTION

Over the past decade, English learners have had access to numerous AI tools to support them in English writing. The emergence of these tools significantly accelerates the learning process by providing direct feedback on writing (Teng, 2025; Yao & Liu, 2025). Many EFL learners use AI because they value the technology based on its advantages, ease, and practicality (Yao & Liu, 2025). Once they have shaped this belief, that AI tools are helpful and not complicated, using the AI technology becomes a natural and integrated part of their learning process (Mouloudj et al., 2025). The paradigm shift in AI usage, from general to more education-oriented purposes, makes it important to understand how EFL learners, as active users, respond to it. Several studies have pointed out the positive impacts of AI on learning outcomes, particularly in enhancing the writing quality and effective engagement of the students in the learning process (e.g., Fauzi et al., 2025; Guo et al., 2022; Marzuki et al.,

2023; Meniado, 2023; Rahmani, 2023; Salam, 2024). This research largely points to similar findings: AI tools are helpful to EFL learners in many ways and from multiple perspectives. On the other hand, research on how AI influences the learners' self-regulated learning (SRL) competence is also developing (e.g., Dahri, Yahaya, Al-rahmi, et al., 2024; Nguyen et al., 2024; Sarý & Han, 2024; Yang-xi et al., 2021).

Nevertheless, although previous studies have highlighted the benefits of using AI in EFL writing, studies that integrate learners' perceptions of AI's usefulness and ease of use with SRL dimensions to explain the formation of metacognitive engagement still face several conceptual and analytical limitations. Studies by Campos (2025) and Teng (2024), for instance, have described learning experiences and general perceptions of AI feedback; however, they have not yet examined how those perceptions influence or relate to self-regulation mechanisms, such as monitoring, evaluation, and strategy use. Then, findings from Dahri et al. (2024), Mazari (2025), and Zhai and Nezakatgoo (2025) have indeed emphasized how AI feedback could help students to review their writing decisions and adjust their strategies. However, these studies have not yet provided a systematic understanding of the cognitive mechanisms that link technology acceptance to the development of metacognitive engagement. Thus, the limitations are not solely related to the scarcity of studies, but rather to the lack of a clear mapping of how perceptions of AI technology interact with the SRL dimension in an integrated manner to shape metacognitive engagement in AI-assisted writing. This gap in analysis is what the researchers of this study aim to bridge.

Specifically, the gaps the researchers aim to fill are not due to a scarcity of similar studies but rather to the lack of clear modeling of the relationships among technology acceptance, self-regulation, and metacognitive engagement in EFL AI-assisted writing. In fact, in foreign language learning, metacognitive engagement plays a significant role because it allows learners to monitor their study process, evaluate results, and consciously adjust their approaches (Elsa et al., 2025; Vaughan, 2022; Zimmerman & Moylan, 2009). Research (e.g., Feng, 2023; Mouloudj et al., 2025; Mun, 2024) indicates that individuals who engage in metacognitive involvement tend to be more reflective, independent, and consistent in applying effective learning strategies, resulting in better academic achievements and grades (Mouloudj et al., 2025).

In simple terms, metacognition refers to an individual's ability to be aware of and control their own thinking process. It includes selecting learning strategies and indicates whether the steps contribute to their learning development (Brenner, 2022; Chen & Gong, 2025; Vaughan, 2022; Zimmerman & Moylan, 2009). For EFL learners, this cognition is crucial because it enables them to identify which parts of their writing require revision or improvement (Elsa et al., 2025; Feng, 2023). Metacognition also helps EFL learners reflect on their writing weaknesses and adjust their approach to overcome or minimize them (Mazari, 2025). Moreover, it also helps learners determine effective and efficient ways to accomplish their writing (C. Wang et al., 2024). Metacognitive engagement is conceptualized as an emergent outcome of learners' metacognitive regulation processes rather than a standalone latent construct. Therefore, it is inferred through the combined effects of planning, monitoring, strategy use, and evaluation. AI tools, especially generative models, have significant potential to support the reflective learning process through direct, personalized feedback (Mohammed & Khalid, 2025; C. Wang, 2024; C. Wang et al., 2024). One study reports that AI feedback has helped students review their writing decisions and adjust their learning strategies (Mazari, 2025). Nevertheless, without clear and sufficient self-

regulation, the use of AI can weaken independence in learning (X. Xu et al., 2025).

To bridge this gap, this study integrates the Technology Acceptance Model (Davis, 1989) and Self-Regulated Learning (SRL) (Zimmerman, 2000) into a pathway model, which is tested using a hierarchical latent path analysis with multiple regressions. In this framework, PU and PEOU are treated as independent variables (X), and metacognitive engagement, represented by the loading values of the SRL dimensions (2nd order), is treated as the dependent variable (Y). The pathway model of this study is presented in Figure 1 below.

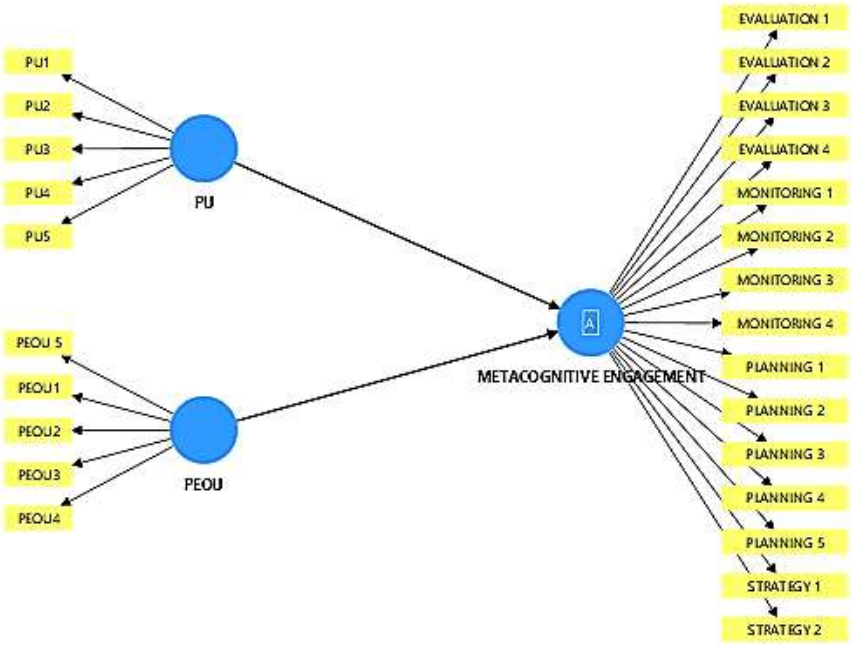

Figure 1. Pathway model of TAM and SRL to predict metacognition engagement in AI-Assisted EFL writing

The novelty of this study lies in its conceptual and methodological contribution to formulating a path analysis-based predictive model that explains how learners' perceptions of technology, through perceived usefulness and ease of use, activate the self-regulation process and finally predict metacognitive engagement in AI-assisted writing. Unlike previous studies, this research modeled the relationships among variables in a directed manner to provide a more systematic understanding of the roles of TAM and SRL in shaping learners' metacognitive engagement. Furthermore, based on the conceptual framework above, this study aims to test the relationship between TAM and SRL dimensions and their predictive contribution to the metacognitive engagement of EFL learners in the context of AI-assisted writing. The research question posed is: To what extent do the perceptions of AI usefulness and ease of use, along with self-regulation dimensions, predict EFL learners' metacognitive engagement in AI-assisted writing? From this question, three hypotheses are formulated as follows:

H1: Perceived usefulness of AI-assisted writing tools has a significant positive effect on EFL students' metacognitive engagement in writing

H2: Perceived ease of use of AI-assisted writing tools has a significant positive effect on EFL students metacognitive engagement in writing

H3: Metacognitive engagement in AI-assisted writing is a higher-order construct reflected by planning, monitoring, strategy use, and evaluation

METHOD

Research design

This study employed a cross-sectional quantitative correlational design to examine the relationship between the Technology Acceptance Model (TAM) (Davis, 1989) involving Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), and the four dimensions of Self-Regulated Learning (SRL) (Zimmerman, 2000), and how these aspects predict the EFL learners' metacognitive engagement. This design was chosen because it allows researchers to assess the direction and strength of relationships among variables without requiring experimental manipulation or a specific setting (Cohen et al., 2018; Creswell & Creswell, 2018).

Population and sample

The study's population consisted of undergraduate students majoring in English Education and English Literature from three higher education institutions in Pontianak, West Kalimantan, Indonesia. A total of 365 students participated in the study as the research sample, selected through convenience sampling based on accessibility and voluntary participation. All participants had prior experience using AI platforms to learn English. To provide richer information about the participants, self-reported proficiency levels were collected, revealing that 65% participants perceived their writing proficiency as moderate, followed by good (21%), poor (7%), and excellent (9%). The sample size was deemed adequate according to minimum sample guidelines for multivariate analysis (Comrey & Lee, 1992). Below is the demographic data of the research samples:

Table 1. Demographics of the participants

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	112	30.7
	Female	253	69.3
Age	18–20 years	146	40
	21–23 years	176	48.2
	24 years and above	43	11.8
Program of Study	English Education	212	58.1
	English Literature	153	41.9
Year of Study	First Year	54	14.8
	Second Year	129	35.3
	Third Year	117	32.1
	Fourth Year	65	17.8
AI-Assisted Tool Usage Experience	Rarely	27	7.4
	Occasionally	164	44.9
	Frequently	174	47.7
Writing Proficiency	Excellent	33	9
	Good	77	21
	Moderate	230	63
	Poor	25	7

Research Procedures

The research was conducted through a series of systematic steps. First, the researcher distributed the questionnaire online via a Google Form, provided a research information sheet, and obtained informed consent, explaining that participation was voluntary and anonymous. Second, the preliminary data screening was conducted in IBM SPSS version 26 to ensure data quality. Missing values were assessed using descriptive frequency analysis, and none were found. Outliers were identified using boxplots and z-scores ($|z| > 3.29$), indicating no extreme cases. The researchers did not test data normality, as Partial Least Squares Structural Equation Modeling (PLS-SEM) does not require normally distributed data. Third, the data were analyzed using PLS-SEM with SmartPLS 4 to test the hypothesized relationships among the constructs. PLS-SEM was chosen for its suitability for modeling complex constructs. In this study, metacognitive engagement was conceptualized as a second-order latent construct, represented by the four first-order SRL dimensions.

The PLS-SEM analysis was conducted in two main stages. The first stage involved evaluating the measurement model, including examining indicator loadings, internal consistency reliability (CR), and convergent validity (AVE) to ensure each construct was adequately measured. The researchers also assessed the discriminant validity using the Heterotrait-Monotrait Ratio (HTMT). The second stage focused on evaluating the structural model by analyzing path coefficients, explained variance (R^2), and the statistical significance of the hypothesized relationships using bootstrapping procedures. The results of these analyses are presented in the Results section.

Research Instruments

The data were collected using a questionnaire comprising 25 items that assessed aspects of TAM (Davis, 1989) and SRL (Zimmerman, 2000). The TAM questionnaire consisted of two constructs: Perceived Usefulness (PU), comprising 5 items (e.g., "Using AI tools improves the quality of my independent English learning" and "Using AI tools helps me learn English more quickly"), and Perceived Ease of Use (PEOU), comprising 5 items (e.g., "Learning to operate AI tools for English study is easy for me" and "I find AI tools easy to use for my English learning tasks"). Meanwhile, the SRL questionnaire consisted of four subscales: the Planning dimension (5 items, e.g., "I plan which specific AI tools or features I will use to achieve my learning goal" and "I schedule specific times to use AI tools for my English study"), the Monitoring dimension (4 items, e.g., "While using an I tool, I try to stay focused on the learning task" and "I monitor my understanding of the feedback or information provided by the AI tool"), the Strategy dimension (2 items, e.g., "I try to apply strategies suggested by the AI tool (if any) to improve my skills"), and the Reflection dimension (4 items, e.g., "I evaluate the quality of my work or learning outcome after using an AI tool" and "I reflect on whether the AI tool I used was effective for my specific learning needs"). All items were rated on a five-point Likert Scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Higher scores indicate greater perceived usefulness, ease of use, and stronger self-regulated learning behaviors.

Specifically, the strategy subscale, consisting of only two items, refers to the adaptation of regulatory strategy indicators commonly used in writing-based SRL research, particularly in the context of revision and decision-making (He & Chen, 2011; Teng, 2025). However, this limited number of items is recognized as a limitation of the instrument, as it may narrow the scope of the strategy construct's representation. This limitation is taken into account in the interpretation of results and is

recommended for future research. The four SRL dimensions were not analyzed as independent predictors of metacognitive engagement. However, they are specified as the first-order components forming a higher-order construct of metacognitive engagement in the PLS-SEM model.

Data Analysis Techniques

The data analysis was done through three main stages. First, descriptive statistics (mean, standard deviation, minimum, and maximum values) were calculated using IBM SPSS version 26 to provide an overview of respondents' perceptions of AI usefulness, ease of use, and self-regulated learning behaviors. Second, the measurement model was evaluated using PLS-SEM in SmartPLS, which included Composite Reliability (CR) and Average Variance Extracted (AVE) for convergent validity, and the HTMT criterion to test discriminant validity. Third, the structural model was evaluated using SmartPLS to test the hypothesized relationships. Here, the path coefficients were examined to assess the predictive effects of PU and PEOU on metacognitive engagement; the coefficient of determination (R^2) was used to assess the model's explanatory power; and statistical significance was assessed via bootstrapping with 5,000 subsamples.

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Ethical Considerations and AI Declaration

The researchers obtained informed consent via the questionnaire and ensured that participants' data and responses remained confidential. During the research, the researchers used ChatGPT (GPT-5 by OpenAI) to enhance language clarity, ensure structural consistency, and refine their writing. ChatGPT was not used to examine, understand, or generate new ideas for the data. The researchers wrote the whole paper, including the statistical analysis and interpretation. The researchers carefully examined and revised ChatGPT's suggestions to ensure they were accurate, legitimate, and academically honest.

■ RESULT AND DISCUSSION

Students' Perceptions of TAM and SRL Constructs

The results of the descriptive analysis show that the EFL learners, participants in this study, have strong and positive perceptions of technology acceptance. The perceived ease of use mean score ranges from 3.69 to 3.90, with the highest mean reaching 3.80 and a standard deviation of 0.87. This analysis suggests that most learners perceive AI as beneficial and easy to use for writing assignments. Previous research also shares a similar pattern that learners view AI, such as chatbots or automatic writing tools, as a support to revise, as well as enhance the quality of their writing (García et al., 2025; Jin, Yang, Martínez Maldonado, et al., 2025; Johnston et al., 2024). Learners are still quite likely to utilize AI in their writing because they found it easy to use and useful (Rahmayanti et al., 2025; Salam, 2024; Tossell et al., 2024; Wei et al., 2023). The low variation score (skewness and kurtosis values = ±1) indicates that this positive perception is relatively evenly distributed among the participants. The responses indicate that utility and ease of use function as motivating factors that sustain their confidence and engagement in using AI to support their writing progress and performance (Kanont et al., 2024; Ni & Cheung, 2022; Y. Wang & Chuang, 2023; T. Xu & Jumaat, 2025; Z. Xu, 2025; Zheng et al., 2024).

Across the SRL dimensions, the results vary but remain positive. In the Planning aspect, for instance, learners responded positively to planning their writing, even though the learning goals had not been determined or set consistently, as previous research has discussed (Chung et al., 2021; He et al., 2011; Philippakos, 2020). EFL learners often begin tasks without detailed preparation, relying more on real-time

adjustments than on structured goal-setting (Tabari, 2021; Yang et al., 2025). On the contrary, the Monitoring dimension has a high response (m = 3.77, SD = 0.88). This result indicates that participants used AI feedback to track the development of their writing and made adjustments as needed (Aladini et al., 2024; Teng, 2025; X. Xu et al., 2025).

Next, the strategy dimension receives a moderate-level response with a high mean score of 3.47 and a standard deviation of 0.90. This result suggests that the participants did not consistently employ the strategy. Previous research (Aladini et al., 2024; Teng, 2025; X. Xu et al., 2025; Yan & Zhang, 2024) noted a similar challenge that although the students used various strategies in revising their writing, the implementation of those strategies was still inconsistent, and tended to be reactive, with a stronger focus on surface improvement than on in-depth writing strategies. However, in terms of the Reflection aspect, the participants showed high engagement. The highest mean score reaches 3.68 with a standard deviation of 0.88 (m = 3.68, SD = 0.88). This result indicates that the participants accepted the AI feedback with a strong intention to understand how the tools' feedback influenced their writing. This ability indicates that participants are beginning to recognize patterns in their writing and understand areas for improvement (M. Campos, 2025; Dahri, Yahaya, Al-rahmi, et al., 2024; Feng, 2023; Sarý & Han, 2024). Reaching this level of engagement indicates that students are improving at self-evaluation, a crucial aspect of metacognitive growth in academic writing.

Finally, based on the metacognitive engagement index interpretation, the researchers found that the students have a high level of awareness in managing their learning process, with a score of 3.64. Their responses on the TAM and SRL constructs suggest active interactions with AI tools they used for writing, which were beyond mechanical use of tools, but involved consideration, evaluation, and adjustment, which are the indicators of a metacognition state (Alangari, 2025; Lai, 2025; Mohammed & Khalid, 2025). They were consciously managing their thinking, considering when and why to use feedback, evaluating the quality of their revisions, and adapting their writing processes accordingly (Dwivedi et al., 2023; Nhan et al., 2025; Rofikah et al., 2025; Teng, 2025; T. Xu & Jumaat, 2025; Yin & Dou, 2025). This balance between knowledge of cognition and knowledge of regulation illustrates a deeper engagement with learning, much like what Fan et al. (2024) described as "reflective literacy," where learners not only produce text but also consciously refine how they learn to write (Jin et al., 2025; C. Wang et al., 2024; K. Yang et al., 2025).

The overall findings on the TAM and SRL constructs show that the participants in this study not only accept technology positively but also integrate it into their self-regulation process. The consistent response pattern in monitoring and reflection indicates that AI feedback has served as a trigger for EFL learners to review their thinking processes and adjust their writing strategies more consciously. Meanwhile, the tendency to rely on unstable strategies remains transitional in the use of AI as a regulatory tool, rather than merely a corrective one. The combination of strong technology acceptance and sufficiently mature SRL engagement indicates that students have a cognitive foundation that supports the development of metacognitive engagement, especially when technology is integrated into reflection and decision-making. The emerging pattern shows that AI not only facilitates writing tasks but also shapes a more autonomous, reflective, and self-development-oriented learning culture, in line with previous findings regarding the role of technology in strengthening reflective literacy practices in the EFL environment. Table 2 below presents the descriptive statistics for the TAM and SRL constructs.

Table 2. Descriptive statistics of TAM and SRL constructs

Construct / Dimension	Item Range	Mean	SD	Skewness	Interpretation
Perceived Usefulness (PU)	PU1–PU5	3.83	0.87	−0.24	High
Perceived Ease of Use (PEOU)	PEOU1–PEOU5	3.80	0.84	−0.15	High
Planning	PL1–PL5	3.32	0.94	−0.29	Moderate
Monitoring	MON1–MON4	3.77	0.88	−0.48	High
Strategy Use	STRG1–STRG2	3.47	0.90	−0.15	Moderate
Evaluation / Reflection	EVA1–EVA4	3.68	0.88	−0.28	High

Measurement Model Evaluation

Four measurement models are used to assess the construct's reliability and validity, as indicated by outer loadings from PLS algorithms. The first model is indicator reliability, presented by Cronbach's Alpha. Most indicators demonstrated loadings above 0.70. Several items exhibited loadings between 0.40 and 0.69; however, given the complexity of the metacognitive engagement construct and its representation through multiple SRL indicators, these values were considered acceptable for exploratory and predictive research. Therefore, no indicators were removed at this stage to preserve the constructs' theoretical coverage. The second model is internal consistency reliability, examined using Composite Reliability (CR). The CR valus of PU, PEOU, Monitoring, Evaluation, and Strategy constructs exceeded the threshold of 0.70 (CR > 0.70). This result indicates that the items are satisfactorily reliable. Meanwhile, the Planning construct has a CR of 0.649, slightly lower than 0.70. However, this value remained within the acceptable range for heterogeneous indicator constructs, so the items were maintained.

The third model is the convergent validity, as measured by Average Variance Extracted (AVE). The results show that most constructs achieved AVE values close to or exceeding 0.50 (the recommended criterion), ranging from 0.378 for metacognitive engagement to 0.706 for the Strategy dimension. However, particularly for metacognitive engagement, this value is expected, given its conceptualization as a higher-order construct integrating multiple dimensions of SRL. This result, furthermore, suggests that metacognitive engagement captures a broad regulatory process rather than a narrow trait. The fourth model was evaluated for discriminant validity using the Heterotrait-Monotrait ratio (HTMT). The majority of HTMT values were below the recommended threshold of 0.90, ranging from 0.638 to 1.118. Higher HTMT values, which involve metacognitive engagement, reflect its conceptual proximity to the SRL dimensions used as indicators. They also theoretically justified it in a higher-order measurement model. The results of the measurement model evaluation are presented in Tables 3 and 4 below.

Table 3. CR and AVE analysis result

Construct / Dimension	Cronbach's Alpha	CR (rho_a)	CR (rho_c)	AVE
Evaluation	0.711	0.733	0.821	0.537
Metacognitive engagement	0.875	0.893	0.897	0.378
Monitoring	0.771	0.783	0.856	0.600
PEOU	0.839	0.843	0.885	0.608
Planning	0.649	0.659	0.780	0.420
PU	0.856	0.863	0.896	0.634
Strategy	0.584	0.584	0.828	0.706

Table 4. HTMT analysis result

	Evaluation	ME	Monitoring	PEOU	Planning	PU	Strategy
Evaluation							
ME	1.065						
Monitoring	0.997	1118					
Peou	0.667	0.758	0.797				
Planning	0.669	1.029	0.823	0.638			
Pu	0.678	0.789	0.828	0.707	0.640		
Strategy	0.867	1.051	1.062	0.750	0.650	0.858	

Structural Model Evaluation

After confirming the adequacy of the measurement model, the structural model was tested to validate the hypothesized relationship between the technology acceptance variables and metacognitive engagement. The model's predictive power (R2) for metacognitive engagement was 0.647. It reveals that PU and PEOU jointly accounted for about 64.7% of the variance in the learner's metacognitive engagement in AI-assisted writing. The magnitude of this value indicates a high degree of predictive accuracy, demonstrating the model's strong explanatory power.

Figure 2 in this section illustrates the structural model linking PU and PEOU to Metacognitive Engagement in AI-assisted writing. Both PU and PEOU are represented as latent constructs measured by multiple observed indicators, with factor loadings ranging from 0.73 to 0.85, indicating strong indicator reliability. The structural path analysis reveals that PU (â = 0.523) and PEOU (â = 0.375) both have positive effects on metacognitive engagement, collectively explaining 64.7% of its variance ($R^2 = 0.647$). Among the three dimensions of metacognitive engagement (Evaluation, Monitoring, and Planning), the factor loadings (0.30–0.79) reflect robust contributions across indicators. This model demonstrates good predictive accuracy and supports the hypothesized positive relationships between technology acceptance and metacognitive engagement.

Furthermore, the significance of the structural paths was tested using bootstrapping with 5.000 resamples. As shown in Table 5,

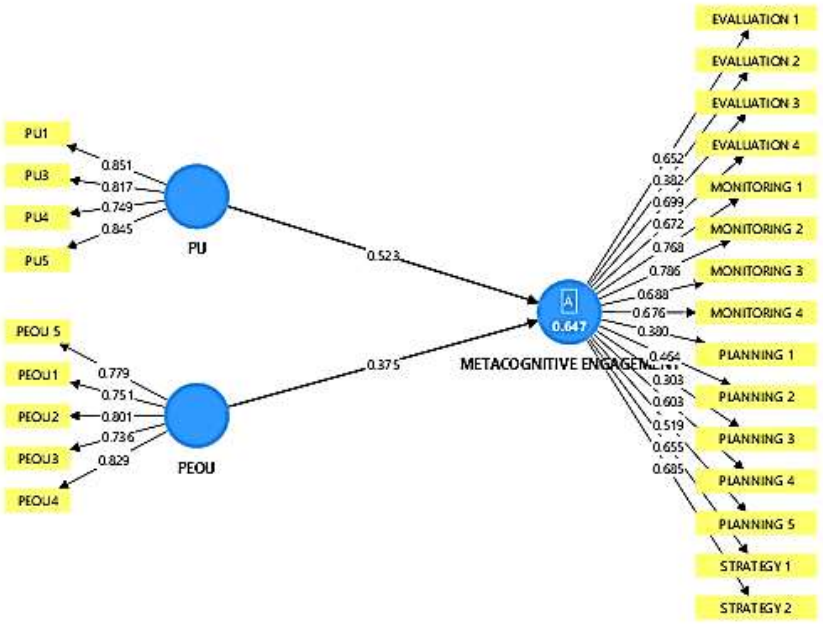

Figure 2. The structural path analysis result

perceived usefulness had a significant positive effect on metacognitive engagement (â = 0.498, t = 9.132, p < .001). This result indicates that learners who perceived AI tools as useful were more likely to engage in metacognitive regulation while writing. Moreover, perceived ease of use had a significant positive effect on metacognitive engagement (â = 0.386, t = 6.421, p < .001). This result indicates that when AI tools are perceived as easy to use, students can devote more cognitive resources to monitoring, evaluating, and regulating their writing processes rather than to managing technical difficulties. While the significance of the structural path for perceived usefulness supports H1, the analysis of the perceived ease of usestructural path supports H2.

Table 5. Bootstrapping analysis result

	Original sample (β)	Sample mean (M)	Standard deviation	T statistics (|O/STDEV|)	P values
PEOU -> ME	0.386	0.388	0.060	6.421	0.000
PU -> ME	0.498	0.501	0.055	9.132	0.000

In addition to the explanation, the results of a path coefficient comparison show that perceived usefulness (PU) significantly impacts metacognitive engagement more than perceived ease of use (PEOU). These findings suggest that while both variables positively contribute to the students' engagement in metacognitive processes, the perceived pedagogical value of AI tools plays a more decisive role than their usability (Li-jie et al., 2024; Yao & Liu, 2025; Zhai & Nezakatgoo, 2025). The possible interpretation is that students are more likely to engage in planning, monitoring, and evaluating their writing when they believe that AI tools genuinely enhance the quality and effectiveness of their learning. Although ease of use remains important, its influence is secondary to the belief that the tool is beneficial and meaningful for academic performance (Amani & Bisriyah, 2025; Chen & Gong, 2025; Salam, 2025; Zhao et al., 2025), according to the results.

When combined with descriptive results, these structural models provide a much clearer picture of the direction of the relationships among variables in this study. When students encounter AI tools in their writing process, what seems to matter most is not merely how easy these tools are to operate, but how meaningful and beneficial they perceive them to be for their learning experiences. Students who view AI as a valuable partner in refining their thoughts and improving their drafts tend to engage more deeply in reflective self-regulation (Amani & Bisriyah, 2025; Lan & Zhou, 2025; Wu & Chiu, 2025). They do not simply follow what the system suggests; instead, they think critically about their writing decisions, evaluate alternatives, and use AI feedback as a prompt to question and improve their own strategies (Rahayu et al., 2024; Siddiqui, Feliciano, et al., 2025; C. Wang & Searsmith, 2025). This pattern reflects a shift from passive tool usage to active metacognitive engagement.

Within this dynamic, perceptions of usefulness appear to carry a greater psychological weight than perceptions of ease. While a tool's simplicity certainly reduces friction and helps students stay focused, it is the sense of pedagogical value that sparks genuine reflection (Braad et al., 2022; Lee & Ng, 2009; Zhao et al., 2025). When students believe this way, they are more likely to monitor their progress, evaluate their arguments, and plan revisions with purpose. This reinforces the idea that meaningful engagement arises not from effortless experiences, but from purposeful ones, where technology is perceived as a partner in thinking,

not just a shortcut in doing (Godsk & Møller, 2024; Koltovskaia et al., 2024; Siddiqui, Pea, et al., 2025). Most importantly, the pattern of relationships observed in this study supports the third hypothesis (H3), which posits that metacognitive engagement operates as a higher-order construct reflected through planning, monitoring, strategy use, and evaluation. The interconnectedness among these dimensions reveals that students' engagement with AI-assisted writing is not fragmented but systemic. The most possible flows are Planning initiates cognitive control, Monitoring sustains it, Evaluation completes the reflective cycle, and Strategy bridges these phases. These results, therefore, suggest that AI tools do more than support writing mechanics; they scaffold a metacognitive ecosystem where reflection, regulation, and strategy mix into deeper learning (Granström & Oppi, 2025; Jin, Yang, Martínez Maldonado, et al., 2025; Kong et al., 2024; C. Wang & Searsmith, 2025)

This finding resonates with previous studies suggesting that students' positive views of technology are closely tied to their cognitive control and persistence in learning (Kanont et al., 2024; Ni & Cheung, 2022; Y. Wang & Chuang, 2023). Perceptions of technology's usefulness and ease of use, as well as continuous exposure to AI-generated feedback, are also associated with cognitive control and learning persistence, and encourage students to be more open to self-observation and evaluation (Aladini et al., 2024; Teng, 2025). However, this study extends those findings by demonstrating that metacognitive engagement, when supported by AI, is best understood as a multilayered construct that integrates the four dimensions of self-regulated learning. This empirical evidence revealed in this study underscores a critical shift in understanding AI-assisted writing, not merely as a technological enhancement to writing performance. Unlike previous research that has primarily examined technology acceptance from a behavioral or attitudinal perspective, this study bridges the gap between technology adoption and metacognitive theory by empirically validating that students' engagement with AI tools embodies higher-order reflective processes. This conceptual integration represents a novel contribution to the literature.

Despite the significant results, the researchers acknowledge that a limitation of this study lies in the sampling technique. Despite the adequate sample size of 365 participants, the use of convenience sampling is a methodological limitation of this study. The selected sampling technique restricts the researchers' ability to generalize the findings beyond the specific institutions involved in this study. Therefore, the results should be interpreted with caution and understood as reflecting patterns similar to those found in a university setting for an English language education study program, rather than a broader EFL learner population.

■ CONCLUSION

The findings of this study have revealed that the interplay between the constructs of the Technology Acceptance Model (TAM) and Self-Regulated Learning (SRL) offers valuable insights into how students cultivate metacognitive engagement in AI-assisted writing. When students perceive the technology as useful and easy to use, they become more motivated to manage their own learning processes. In this context, AI use goes far beyond a mechanics corrector; yet, it becomes a reflective space that learners can actively examine their thinking, organize their ideas, and refine their writing with greater awareness. From an instructional perspective, the findings support educators' ability to design AI-supported learning experiences that provide personalized feedback and promote continuous self-reflection. Finally, rather than serving solely as a corrective tool, AI can function as a collaborative learning partner to nurture students' growth into more self-regulated, reflective, and confident writers.

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