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**A Correlation Study of Automated  
Writing Evaluation System  
(Grammarly) and Chinese EFL  
Learners' Writing Self-Efficacy in  
Their Self-Regulated Learning**



**Abstract:** - The rapid advancement of AI-assisted automated writing evaluation (AWE) systems has brought significant changes to English education, particularly in English-as-a-foreign-language (EFL) learners' self-regulated learning (SRL). This transformation is partly attributed to the potential of AWE to enhance learners' writing self-efficacy and subsequently improve their writing performance. However, the impact of AWE on Chinese university students' writing self-efficacy in English SRL remains unclear. Therefore, this study aims to investigate: (1) the current application features of the AWE system Grammarly among Chinese university students, (2) the correlation between the frequency of Grammarly usage and their writing self-efficacy, (3) the relationship between the purpose of Grammarly usage and writing self-efficacy, and (4) the correlation between the function choice of Grammarly and writing self-efficacy. A total of 336 valid questionnaires were collected from Chinese university students, and quantitative data analysis was conducted using SPSS 25.0 and AMOS 24.0 software. Results indicate that most participants are familiar with and satisfied with Grammarly, primarily using it to correct grammar and improve writing accuracy. Moreover, application fluency is positively correlated with writing self-efficacy, and the chosen functions of Grammarly yield different correlations. These findings not only provide insights for educators to effectively integrate English AWE systems into SRL but also offer guidelines for technologists to further develop relevant technology.

**Keywords:** automated writing evaluation; Grammarly; English writing self-efficacy; self-regulated learning; Chinese EFL undergraduate students

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## 1. Introduction

The increasing development of technology in language learning exerted a significant positive impact on English as a Foreign Language (EFL) education (Hung, 2021), in which the automated writing evaluation (AWE) system serves as the representative of the forefront (Liu et al., 2022). As a main area in language assessment, the AWE system is a computer program equipped with relevant technology such as natural language processing that can extract the language-related features of the given text and provide corrective and summative feedback (Barrot, 2023; Escalante et al., 2023; Huawei & Aryadoust, 2023; Hockly, 2019). With the support of big data and technology powered by Artificial Intelligence (AI), AWE systems are capable of generating instant and personalized feedback to learners, which is beneficial to solving the problems of belated and untailed human written evaluation (Saricaoğlu & Bilki, 2021; Zhang & Zou, 2022). Therefore, they are widely acknowledged to become practical tools in self-regulated learning (SRL). Nowadays, lots of AWE systems (e.g. Grammarly, Criterion, Pigai) gained great popularity around the globe, portending the potential of AWE systems in the AI era (Ding & Zou, 2024). These AI-assisted tools are able to score and give feedback on improvement in any genre of the written text, which is applicable in classrooms and SRL scenarios (Li et al., 2015; Ramesh & Sanampudi, 2022).

Previous studies indicated the effective application of the AWE system in EFL education (Huang & Renandya, 2020; Ngo et al., 2022; Nunes et al., 2022). Specifically, researchers investigated the AWE system including its accuracy (Lang et al., 2019; Zhang, 2020), usage (Barrot, 2022), and users' perceptions of it (Li, 2021; Wilson et al., 2024). In the realm of the impact of AWE systems on students, it is found to improve their writing performance (Geng et al., 2024), writing skills (Huynh-Cam et al., 2022), engagement (Zhang & Hyland, 2018), writing accuracy (Wang et al., 2013), etc. However, there is little study investigating the impact of AWE on EFL learners' cognitive processes. Based on the Social Cognitive Theory (Bandura, 2001), self-efficacy has a significant role in learning and behavior change. Notably, Pajares (2003) pointed out that writing self-efficacy is an important predictor of writing performance. All these studies have proven the significance of investigating the application situation of AWE of students and its latent impact on their writing self-efficacy.

Additionally, Chinese college students, as a large population of EFL learners, may not receive adequate guidance from instructors and advisors in recent times, which calls for SRL as a potent method to improve writing (Shen & Bai, 2024). They study in big-size English classrooms with high staff-student ratios and demand for SRL due to the inadequate resources of higher education (Zhang & Hung, 2013).

Hence, this study aims to explore Chinese university students' current application features of the AWE system and the correlation with writing self-efficacy under the SRL context. We adopted Grammarly as the research platform for its universality and high affordance. The findings of the present study can contribute to understanding the underlying relationship between the AWE system and writing self-efficacy and provide implications for instructors to promote it in students' SRL.

## 2. Literature Review

### 2.1 Language assessment and effectiveness of the AWE system

Language assessment is a vital component of language teaching and there are more alternatives for language teachers since different assessment options may have different consequences and washback (Brown & Hudson, 1998). Formative assessment is one of the choices that belong to the language assessment. It is the deep involvement process of students in which they are provided with sharing criteria, effective questioning and feedback, therefore, they can improve themselves in SRL (Black & Wiliam, 2009; Clark, 2012). Considering the

significance of the in-time assessment, previous studies have investigated the impact of formative assessment on students (Andersson & Palm, 2017; Yin et al., 2008), indicating it has correlations with learning motivation and achievement. Although the instant formative assessment is proven to be beneficial to students' overall development, the current educational environment, especially in university, makes it unlikely for teachers to provide instant feedback all the time (Fu et al., 2024). Hence, lots of researchers devoted themselves to seeking technological support to solve the problem. With the advancement of AI and natural language processing technology, using software to conduct language assessments automatically became a reality. Specifically, in writing assessments, automated software has high utility (Calvo & Ellis, 2010; Kellogg et al., 2010).

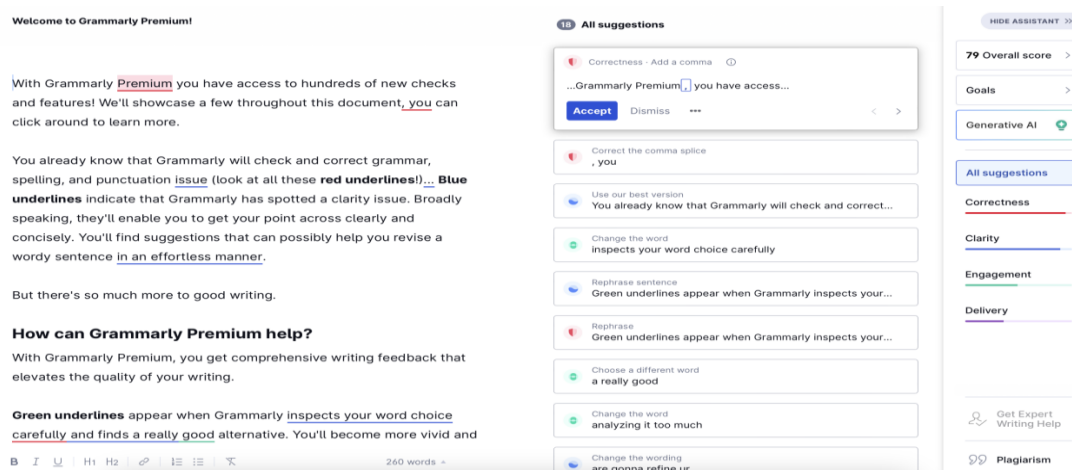
Therefore, in the realm of writing assessment, the AWE system gained great popularity and was applied in multiple scenarios. AWE systems can offer instant and detailed evaluation based on predetermined criteria (Hoang & Kunnan, 2016). Students can receive feedback on their mistakes and correct them before they internalize knowledge, thus enhancing their awareness of mistakes (Zhu et al., 2020). For the problem that teachers are unable to provide customized suggestions, AWE systems are able to solve this by offering automated feedback and scores (Huawei & Aryadoust, 2023).

In addition, some empirical studies indicated the positive influence of the AWE system on students. From the perspective of writing ability, Li (2023) examined the overall effect of the AWE system on learners' writing skills and suggested that the AWE system is more effective than traditional methods. Al-Inbari and Al-Wasy (2023) found the AWE system can positively affect peer and self-editing. Regarding learning psychology, Waer (2023) conducted a comparative study and found that the AWE system helped to reduce students' apprehension and enhance grammatical skills. Overall, existing research indicated that the AWE system is effective for students in improving writing skills and maintaining positive learning status.

## 2.2 Grammarly

Grammarly is a writing assistant that evaluates English texts for errors and plagiarism in the support of AI technology, with over 30 million people and 70,000 teams using it every day to polish articles (Grammarly, 2024). To date, it has gained popularity as a widely used AWE tool owing to its free accessibility, compatibility across multiple platforms, high accuracy and efficiency (Ebadi et al., 2022). With various subscription plans ranging from free, and premium to business, users may use different functions as they like.

Fig.1 is the interface of Grammarly. Grammarly employs a color-coded highlighting system to detect errors. Red lines denote spelling and grammatical mistakes, namely Correctness. Green lines denote vocabulary improvement suggestions, namely Engagement. Blue and purple lines signal Clarity and Delivery accordingly in the premium version, helping adjust the tones and formality level of the given text (Grammarly, 2024). The overall score means the integral performance of writing in this document.



**Figure 1. The Interface of Grammarly**

Consistent research highlighted the positive outcomes associated with utilizing Grammarly as the AWE tool (Ding & Zou, 2024). It is underscored that Grammarly can enhance students' confidence in grammar usage (Cavaleri & Dianati, 2016), overall writing quality (Gain et al., 2019), and academic integrity (Dong & Shi, 2021). Specifically, Sanosi (2022) compared the writing scores of Grammarly users for 14 weeks, suggesting that students who received feedback from Grammarly exhibited a significant improvement in written accuracy. Yousof (2022) utilized a model of attitudes to examine students' perceptions of Grammarly in writing classrooms and revealed a generally positive attitude in all facets. O'Neill and Russell (2019) pointed out that Australian students are highly satisfied with the Grammarly evaluation compared with traditional feedback from academic advisors.

Though numerous benefits are addressed, there are some shortcomings of Grammarly documented in some research. Notably, since Grammarly helps to provide improvement suggestions, studies found that it occasionally misses common mistakes (Sahu et al., 2020). Also, it is found that micro mistakes, such as spelling and grammar, in the writing text are more likely to be detected, compared with macro mistakes such as sentence structure and idea development, etc. (Ghufron & Rosyida, 2018).

Previous studies mainly investigated the impact of Grammarly on writing skills. However, what is absent from the research is the correlation between cognitive effect and Grammarly usage in EFL education. Therefore, in the current study, we intend to examine the correlation of writing self-efficacy with Grammarly, aiming to propose a systematic model of the latent mode that can be helpful to educators in AWE-assisted teaching and student SRL.

### 2.3 Self-regulated learning in EFL writing skills

SRL refers to a proactive process in which the learners are motivationally, metacognitively, and behaviorally participating in their learning (Zimmerman, 1989). SRL is deemed an important component for college students to cope with challenges on their own (Duchatelet & Donche, 2019). It is because students are supposed to spare no effort both in and after class to enhance writing skills which are rather difficult. Writing is an output and highly demanding skill for daily and academic communication (Brunstein & Glaser, 2011). It is a fundamental skill for EFL learners to transform knowledge and information (Aidinlou & Far, 2014). Notably, students in the advanced education stage are in more need of developing writing skills for multiple academic tasks (Schillings et al., 2023). In the L2 context, EFL students encounter more obstacles to developing writing skills owing to a lack of logical cognitive processes and linguistic content knowledge (Bai, 2018; Bai & Wang, 2023).

In the realm of writing skills, a large body of studies indicated a positive correlation between SRL and writing performance (Al Asmari, 2013; Bai & Wang, 2021; Teng & Huang, 2019; Teng & Zhang, 2020). Specifically, Sasaki et al. (2018) examined the correlation between self-regulated writing strategies and students' writing enhancement, establishing valid trajectories in L2 writing strategy. Teng and Zhang (2016) reported several detailed SRL strategies including cognitive, metacognitive, and social behavioral strategies have a predictive impact on EFL writing performance.

Freshmen in Chinese universities may not adapt to college learning mode as teachers are more likely to be facilitators and moderators rather than instructors (Shen et al., 2020). As college students may not have sufficient SRL, especially in English writing, more emphasis should be laid on this aspect to ameliorate the situation (Sun & Wang, 2020). Hence, gaps have emerged from the review above regarding what SRL tools or strategies can college EFL learners adopt to enhance their writing skills.

#### 2.4 Writing self-efficacy

Self-efficacy is the individual's self-assessment of the capability to accomplish a task successfully in a specific domain (Bandura, 1989). Previous studies revealed that self-efficacy has a significant impact on the effort and persistence individuals display when engaged in tasks, as well as their demonstrated adaptive responses to challenging situations (Bandura, 1997), which will influence their performance outcomes. In the realm of writing, Pajares and Valiante (2001) defined writing self-efficacy as "students' judgments of their confidence that they possessed the various composition, grammar, usage, and mechanical skills appropriate to their academic level". Various studies indicated that self-efficacy is considered as a prominent predictor of writing behaviors and performance (Camacho et al., 2021; Graham et al., 2017; McCarthy et al., 1985; Shell et al., 1989).

A large body of research was conducted to investigate the relationship of writing self-efficacy with writing proficiency (Wang et al., 2012; Sun & Wang, 2020; Sun et al., 2021; Prat-Sala & Redford, 2012), as well as with the writing achievement (Chen & Zhang, 2019; Teng et al., 2018). Some studies delved into further conceptualizing writing self-efficacy into several components. Bruning et al. (2013) adopted a three-factor approach to deconstructing writing self-efficacy into writing ideation, writing convention, and writing self-regulation. Tang and Xu (2011) proposed writing self-efficacy constitutes two components namely writing skills efficacy and writing task efficacy.

Many instruments were developed in this procedure to measure writing self-efficacy. For writing self-efficacy in the L1 context, Shell et al. (1989) developed the Self-efficacy Scale in Writing early in the study. Pajares and Johnson (1996) and Pajares and Valiante (1997) later developed the writing skills self-efficacy scale. Bruning et al. (2013) developed the Self-Efficacy for Writing Scale (SEWS) tailored for middle school students. In the field of L2 writing self-efficacy, Mills et al. (2006) developed a writing self-efficacy scale to measure learners' beliefs and confidence. Teng et al. (2018) offered a multidimensional conceptualization of writing self-efficacy. Chen et al. (2019) validated a two-factor scale to investigate EFL writers' self-efficacy beliefs about text. Tang and Xu (2011) constructed a writing self-efficacy scale targeted for Chinese university students and Li (2014) better improved it into the EFL Writing Self-efficacy Scale (WSES).

#### 2.5 Research questions

To sum up, previous studies show the positive impact of the AWE system on EFL students' writing (Geng et al., 2024; Huynh-Cam et al., 2022), illustrating the numerous advantages in the EFL education field. Although several studies revealed the applications of the AWE system and its impact on learners' emotions in the L2 learning process, few studies explore the correlation between the AWE system application with writing self-

efficacy. It remains unclear what is the impact of multiple usage frequency and function choice on writing self-efficacy. As such, this study seeks to answer the following research questions:

- RQ1: What are Chinese university students' current application features of the AWE system (Grammarly)?  
 RQ2: What is the correlation of the Grammarly application frequency with their writing self-efficacy in SRL?  
 RQ3: What is the correlation of their purpose with their writing self-efficacy in SRL?  
 RQ4: What is the correlation of their function choice with their writing self-efficacy in SRL?

### 3. Method

#### 3.1 Participants

In the present study, convenience sampling was employed and a total of 360 college students sampled from four Chinese universities in Zhejiang Province, the eastern part of China, were recruited to fulfill the questionnaire altogether from January to March 2024. The participants should be college students and have experience using Grammarly in their study.

We purposefully controlled their language level, and especially their previous experience with Grammarly to confirm the reliability of the collected data. Table 1 shows the demographic profile of participants. A valid sample of  $N = 336$  students (156 men and 180 women) was obtained after discarding invalid data. Their years of college life range from 1 to 4 ( $M = 2.68$ ,  $SD = 1.13$ ). Since the present research is regarding English writing skills, we collected their level of English proficiency, as expressed by their overall IELTS score. Five levels entitled from 1-5 were set, representing the overall IELTS score of 0-5 (5 included), 5-6 (6 included), 6-7 (7 included), 7-8 (8 included), 8-9 (9 included). It is indicated that the participants had a relatively high English proficiency ( $M = 3.33$ ,  $SD = 0.81$ ). We obtained all the participants' consent before the formal research started.

**Table 1. Demographic profile of the participants**

	Variables	Frequency (n = 336)	Percentage/%
Gender	Male	156	46.4
	Female	180	53.6
Major	Engineering	25	7.4
	Arts	214	63.7
	Science	38	11.3
	Business	24	7.1
	Medicine	22	6.5
	Fine Arts	13	3.9
Grade	Freshman	72	21.4
	Sophomore	71	21.1
	Junior	86	25.6
	Senior	107	31.8
English Proficiency (IELTS Score)	0-5 (5 included)	7	2.1
	5-6 (6 included)	32	9.5
	6-7 (7 included)	159	47.3
	7-8 (8 included)	119	35.4
	8-9 (9 included)	19	5.7

#### 3.2 Data collection

The collection tool is a self-report questionnaire which is deemed appropriate because the information needed involves attitude, affective responses, and participants' own behavior (Jupp, 2006; Spector, 1994). The present study used the writing self-efficacy questionnaire to measure the status quo and the underlying correlation

between writing frequency, using purpose, function selection, and writing self-efficacy. Specifically, the scale consists of three parts with 30 items: basic information (5 items), current application features of Grammarly (8 items), and writing self-efficacy (17 items) (see Appendix 1).

The first part contains five items related to participants' basic information including gender, major, grade and English proficiency. In the second part with eight items, we examine the current application features of Grammarly usage from multiple facets including their basic knowledge, application frequency, experience, purpose, and function choice. This part is based on the information on the website of Grammarly (2024). The final part is developed to examine the participants' writing self-efficacy in self-regulated learning. We adopted the writing self-efficacy scale developed by Tang & Xu (2011) and modified it according to several studies (Li, 2014; Pintrich et al., 1991) to make the scale more suitable for the study. This part constitutes two segments, which divide writing self-efficacy into the writing task self-efficacy (WTSE) scale and the writing skill self-efficacy (WSSE) scale. Consisting of seventeen items, the scale is in the form of a 5-point Likert scale, where 1 indicates "strongly disagree", 2 indicates "disagree", 3 indicates "uncertain", 4 indicates "agree" and 5 indicates "strongly agree".

Before the formal research, a pilot study was conducted with 198 participants to check if the designed questions were semantically acceptable as well as the reliability and validity of the questionnaire. The internal consistencies (Cronbach's alpha) were 0.817 and the KMO coefficients were 0.856, indicating the scale is acceptable in its reliability and validity. Then we again modified it according to the feedback of participants and the rough data analysis. An academic colleague who was not involved in the research was invited as an external auditor to review the questions and provide comments to enhance validity.

After the pilot study, we began our formal research online due to the geographical distance. We collected the data online by using the Wenjuanxing platform, which is a well-developed software for conducting questionnaire research. We informed participants of the purpose and the requirements of the study and obtained their consent. In total, 360 surveys were distributed and collected, of which 336 were effective, indicating an effective response rate of 93.3%.

Based on the formal research, we again checked the reliability and validity of the scale. Apart from the descriptive question in part 1 and part 2, the internal consistencies (Cronbach's alpha) were 0.942 (overall 26 items), 0.876 (purpose, 4 items), 0.854 (function, 5 items), 0.913 (WSSE scale, 7 items), and 0.926 (WTSE scale, 10 items) respectively, which indicated its high internal consistency.

The KMO coefficients were 0.948 (overall 26 items), 0.815 (purpose, 4 items), 0.859 (function, 5 items), 0.932 (WSSW scale, 7 items), and 0.955 (WTSE scale, 10 items) respectively, indicating high validity.

Confirmatory Factor Analysis (CFA) was run to assess the goodness-of-fit of the model. Results showed that the built model fit adequately (CMIN/DF = 1.410 (<2.000), RMSEA = 0.035 (<0.100), IFI = 0.977 (>0.900), CFI = 0.976 (>0.900), GFI = 0.917 (>0.900)) based on the fit indices criteria (Byrne, 2006). The model fit statistics are shown in Table 2 and Fig. 2.

**Table 2. Fit indices for the model of CFA**

	CMIN/DF	RMSEA	IFI	CFI	PCFI	GFI
The present model	1.410	0.035	0.977	0.976	0.880	0.917
Standard fit	<2.000	<0.100	>0.900	>0.900	>0.900	>0.900

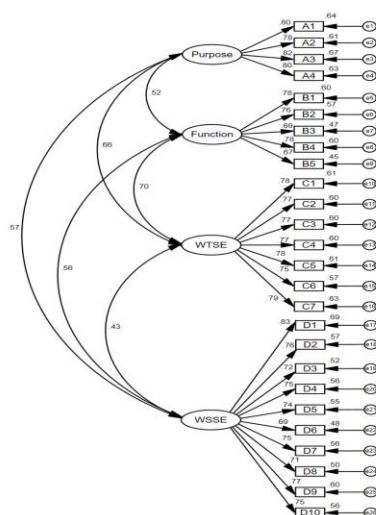


Figure 2. CFA structure of the scale

### 3.3 Data analysis

To reveal the correlation between writing self-efficacy and the application of Grammarly, the collected data was imported to SPSS 26.0 for quantitative analyses. Based on the hypothesis we came up with before the research, AMOS 24.0 was utilized to analyze the underlying relation. Descriptive statistics such as the basic information of participants, and the application features of Grammarly were reported and interpreted. A CFA was performed to examine the validity of the built scale. Pearson correlation coefficients were used to represent the relationships between Grammarly application frequency with their writing self-efficacy. SEM was run to form the model.

## 4. Findings

### 4.1 The current application features of the AWE system

Five aspects of application features are examined, including familiarity, frequency, satisfaction of the experience, satisfaction of the accuracy and satisfaction of the effectiveness. The minimum, maximum, means, and standard deviations of college students' current application features of the AWE system are shown in Table 3.

**Table 3. Descriptive statistics of current application features of the AWE system**

Features	Min	Max	Mean	SD
The familiarity of the AWE system	2.00	5.00	3.88	0.80
The frequency of using AWE system	1.00	4.00	2.91	1.03
The satisfaction of the experience with the AWE system	1.00	5.00	3.79	1.11
The satisfaction of the accuracy of the AWE system's writing advice	1.00	5.00	3.91	1.09
The effectiveness of the AWE system in improving English learning	1.00	5.00	3.89	1.02

Table 3 suggests that college students' familiarity with the AWE system is at a medium level ( $M = 3.88$ ,  $SD = 0.80$ ) between 3 (I basically know it) and 4 (I know it), indicating that college students' understanding of the AWE system is basically at a relatively good level. Students use the AWE system frequently ( $M = 2.91$ ,  $SD = 1.03$ ), which is 3 to 5 times per week on average. For the satisfaction of the AWE system, students reported that they are relatively satisfied with the AWE system ( $M = 3.97$ ,  $SD = 1.11$ ) as well as the accuracy of the provided writing advice ( $M = 3.91$ ,  $SD = 1.09$ ). Notably, the standard deviation of the satisfaction of the experience with



the AWE system is relatively higher than the rest, showing the experience brought by the AWE system has great volatility. The AWE system is relatively effective in improving students' English proficiency ( $M = 3.89$ ,  $SD = 1.02$ ).

4.2 The correlation of Grammarly application frequency with their writing self-efficacy

Pearson correlation coefficients are shown in Table 4. It is indicated that Grammarly application frequency is positively correlated with writing self-efficacy. Among the 336 participants, 125 reported they used the AWE system six to eight times per week, and 115 reported used over nine times per week, revealing the high utility of the AWE systems in college students' daily study. Notably, the subcategories of writing self-efficacy including WTSE,  $r = 0.45$ ,  $p < .01$ , and WSSE,  $r = 0.32$ ,  $p < .01$ , have a positive relationship with frequency, indicating that when the frequency of using the AWE system is increased, the WTSE and WSSE will be significantly improved accordingly, so as the overall writing self-efficacy.

Table 4. Pearson correlation coefficients of Grammarly application frequency with writing self-efficacy

	Frequency	WTSE	WSSE
Frequency	1.000	0.454**	0.317**
WTSE	0.454**	1.000	0.405**
WSSE	0.317**	0.405**	1.000

Note. (a) \*\* $p < 0.01$ , two-tailed; (b) WTSE = writing task self-efficacy; WSSE = writing skills self-efficacy.

4.3 The correlation of purpose and function choice with writing self-efficacy

4.3.1 Analysis of the correlation between purpose and writing self-efficacy

To analyze the impact of the main purpose of using Grammarly on writing self-efficacy, this paper divided the purpose into four dimensions, which are correcting grammar mistakes (CGM), improving language accuracy (ILA), changing the writing style and tone (CST), and enhancing linguistic fluency (ELF). In addition, writing self-efficacy was divided into two variables, which are WTSE and WSSE. The structural equation model (SEM), as shown in Figure 3, reveals the results of the path analysis presented in Table 5.

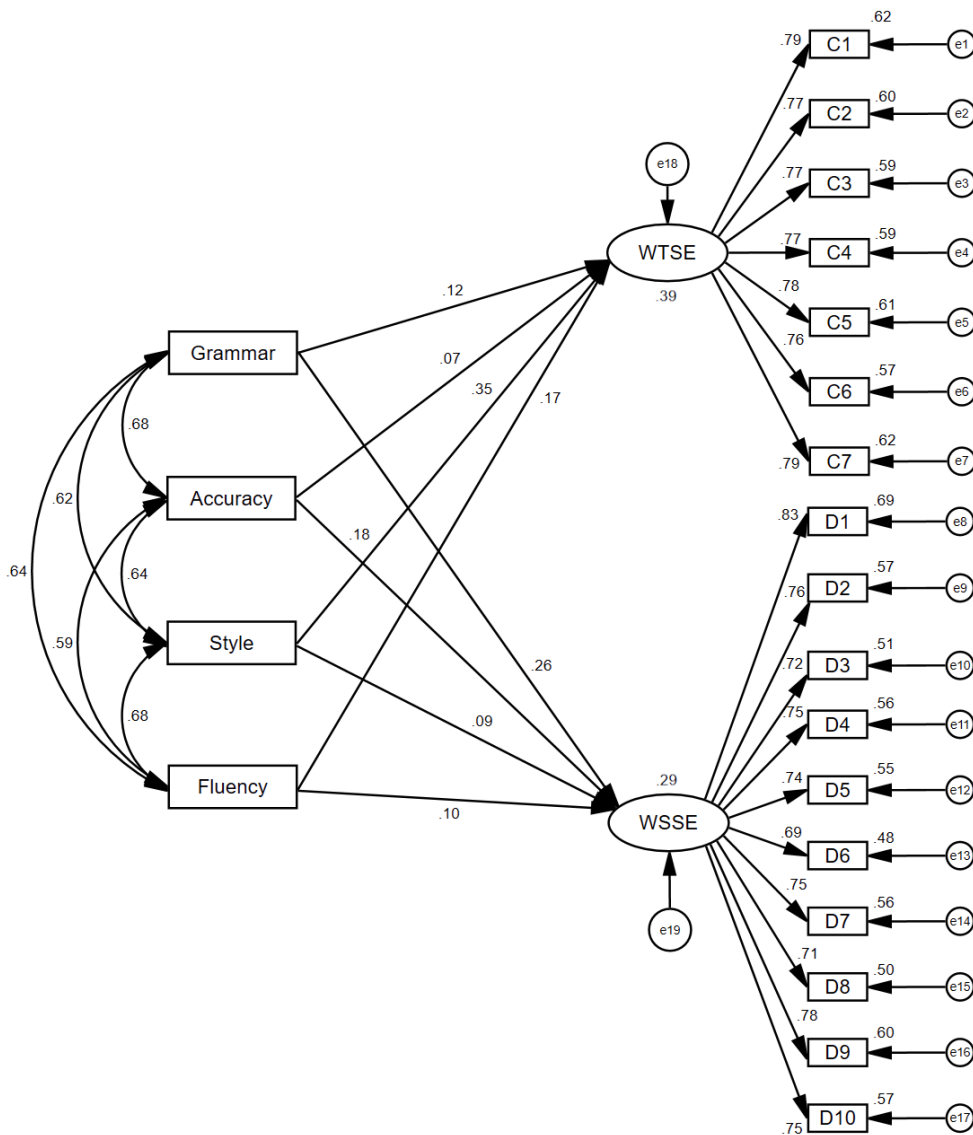


Figure 3. The SEM model of the relationship between purpose and writing self-efficacy

Table 5. The path analysis on the correlation between purpose and writing self-efficacy

			Estimate	S.E.	C.R.	P Label
WTSE	<---	CGM	0.093	0.118	1.715	0.086
WTSE	<---	ILA	0.053	0.070	1.028	0.304
WTSE	<---	CST	0.272	0.354	5.004	***
WTSE	<---	ELF	0.130	0.174	2.549	0.011
WSSE	<---	CGM	0.171	0.257	3.486	***
WSSE	<---	ILA	0.116	0.178	2.473	0.013
WSSE	<---	CST	0.060	0.093	1.274	0.203
WSSE	<---	ELF	0.062	0.099	1.374	0.169

Note. CGM = correcting grammar mistakes; ILA = improving language accuracy; CST = changing the writing style and tone; ELF = enhancing linguistic fluency; WTSE = writing task self-efficacy; WSSE = writing skills self-efficacy.

Table 5 For WTSE, it is reported that there is a significant relationship between changing the writing style and tone ( $p = 0.000 < 0.05$ ), enhancing linguistic fluency ( $p = 0.011 < 0.05$ ) and writing self-efficacy. The path coefficients of changing the writing style and tone and enhancing the fluency of language in articles are 0.272 and 0.130 respectively, which are positive, indicating that college students' WTSE will significantly increase when using Grammarly for writing style and tone and enhancing linguistic fluency. The rest two variables, which are correcting grammar mistakes ( $p = 0.086 > 0.05$ ) and improving language accuracy ( $p = 0.304 > 0.05$ ), reported no significant relationship in enhancing WTSE. As for WSSE, the results reported are opposite to the aforementioned. Correcting grammar mistakes ( $p = 0.000 < 0.05$ ) and improving language accuracy ( $p = 0.013 < 0.05$ ) have a significant impact on WSSE, with the path coefficients being 0.171 and 0.116 respectively. The other two variables, changing the writing style and tone, and enhancing linguistic fluency, are not statistically significant with p-values = 0.203 ( $> 0.05$ ) and = 0.169 ( $> 0.05$ ) respectively.

The fitness of the SEM model was examined and shown in Table 6. CMIN/DF = 1.206 ( $< 2.000$ ), RMSEA = 0.025 ( $< 0.100$ ), IFI = 0.991 ( $> 0.900$ ), CFI = 0.991 ( $> 0.900$ ), GFI = 0.943 ( $> 0.900$ ), reporting a good fit of the model.

**Table 6. Fit indices for the model regarding purpose with writing self-efficacy**

	CMIN/DF	RMSEA	IFI	CFI	PCFI	GFI
The present model	1.206	0.025	0.991	0.991	0.845	0.943
Standard fit	$< 2.000$	$< 0.100$	$> 0.900$	$> 0.900$	$> 0.900$	$> 0.900$

#### 4.3.2 Analysis of the correlation between function choice and writing self-efficacy

To analyze the impact of the function choice of using Grammarly on writing self-efficacy, this paper divided the function according to Grammarly into five dimensions, which are correcting grammar and spelling mistakes (Correctness), improving language clarity (Clarity), improving the accuracy of words (Engagement), improving the overall expression (Delivery) and using AI to rewrite (Rewrite). In addition, writing self-efficacy was divided into WTSE and WSSE which are the same as the aforementioned. The structural equation model (SEM), as shown in Figure 4, reveals the results of the path analysis presented in Table 7.

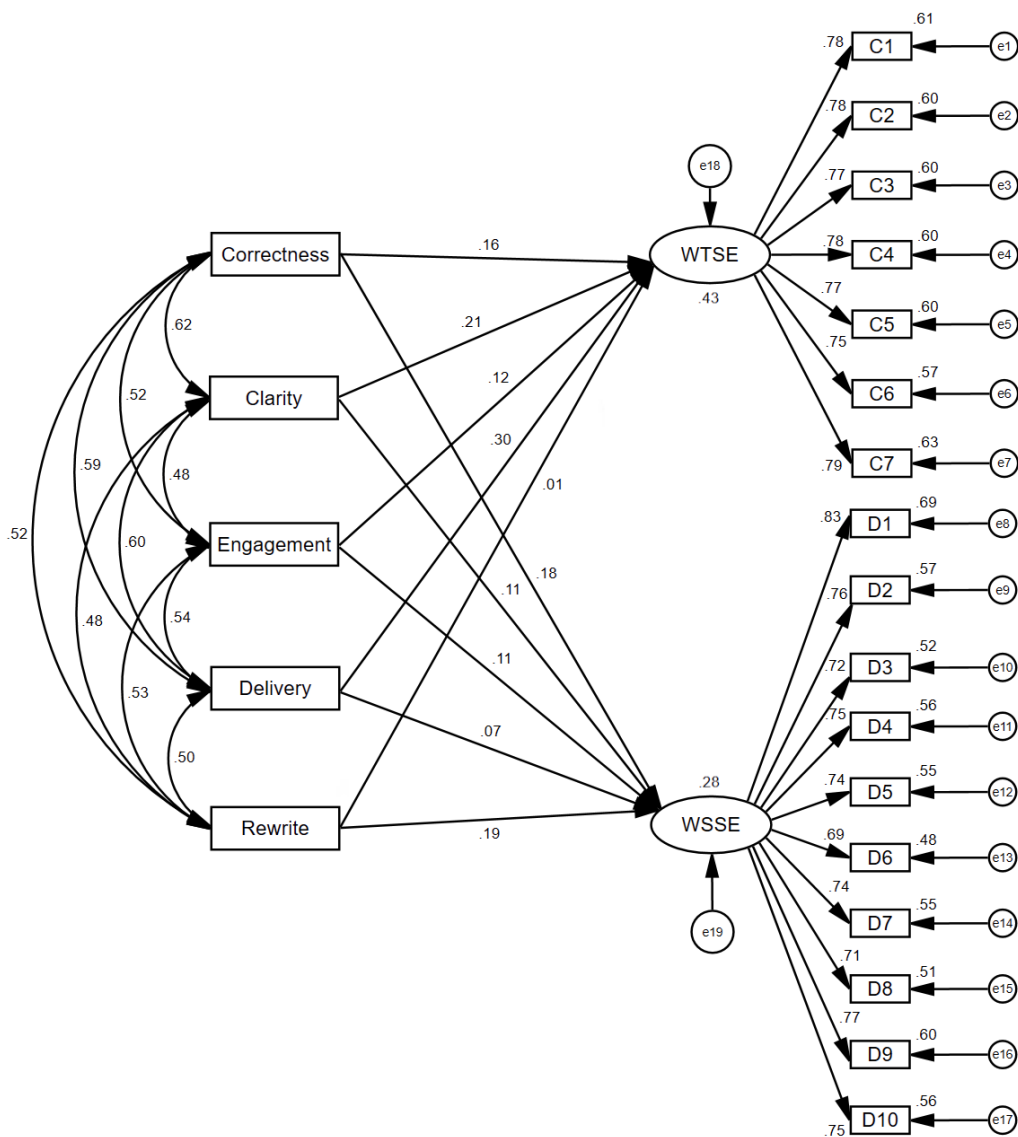


Figure 4. The SEM model of the relationship between function choice and writing self-efficacy

Table 7. The path analysis on the correlation between function choice and writing self-efficacy

			Estimate	S.E.	C.R.	P
WTSE	<---	Correctness	0.132	0.155	2.442	0.015
WTSE	<---	Clarity	0.189	0.208	3.329	***
WTSE	<---	Engagement	0.106	0.116	1.990	0.047
WTSE	<---	Delivery	0.252	0.303	4.749	***
WTSE	<---	Rewrite	0.007	0.007	0.126	0.900
WSSE	<---	Correctness	0.129	0.184	2.632	0.008
WSSE	<---	Clarity	0.079	0.106	1.558	0.119
WSSE	<---	Engagement	0.082	0.110	1.719	0.086
WSSE	<---	Delivery	0.048	0.071	1.036	0.300
WSSE	<---	Rewrite	0.150	0.194	3.071	0.002

Note. WTSE = writing task self-efficacy; WSSE = writing skills self-efficacy.

As shown in Table 7, in the aspect of WTSE, four functions including Correctness ( $p = 0.015 < 0.05$ ), Clarity ( $p = 0.000 < 0.05$ ), Engagement ( $p = 0.047 < 0.05$ ), Delivery ( $p = 0.000 < 0.05$ ) have a significant impact on improving writing self-efficacy, which can be confirmed by the positive result in the path analysis. Therefore, it can be concluded that when college students intend to use Grammarly to accomplish given tasks, the four functions can be helpful in improving their writing self-efficacy. Additionally, Correctness ( $p = 0.008 < 0.05$ ) and Rewrite ( $p = 0.002 < 0.05$ ) and the positive results of the path analysis show a significant impact on students' WSSE, revealing that when college students intend to improve their writing skills, the two functions are essential in enhancing their writing self-efficacy, while the rest three functions are not paid great attention in this aspect.

The fitness of the SEM model was examined and shown in Table 8. CMIN/DF = 1.206 (<2.000), RMSEA = 0.025 (<0.100), IFI = 0.991 (>0.900), CFI = 0.991 (>0.900), GFI = 0.943 (>0.900), reporting a good fit of the model.

**Table 8. Fit indices for the model regarding function choice with writing self-efficacy**

	CMIN/DF	RMSEA	IFI	CFI	PCFI	GFI
The present model	1.345	0.032	0.984	0.984	0.826	0.937
Standard fit	<2.000	<0.100	>0.900	>0.900	>0.900	>0.900

## 5. Discussion

### 5.1 College students' current application features of the AWE systems

As revealed above, most students showed a high level of satisfaction in their experience with the AWE systems. The similar results can be found in Li et al. (2015). Some participants agreed that the AWE systems meet their requirements like assisting them to improve essays and are easy to use. It shows that the AWE systems have a relatively high perceived ease of use, which is in line with the studies conducted by Cheng & Yuen (2018) regarding the technology acceptance model.

However, less than one fourth students are still dissatisfied with the AWE system. The present study lacks an investigation of students' detailed concerns regarding the aspect. The dissatisfied reasons can be complemented by Li et al. (2015) who found occasional system errors lead to dissatisfies and Mohsen & Abdulaziz (2019) who found unfamiliarity to AWE tools cause dissatisfies.

Furthermore, two specific areas of the users' experience with the AWE systems, namely the accuracy of the provided writing advice and the effectiveness of English learning were investigated as well. Specifically, undergraduates noted the AWE systems can provide high-accuracy suggestions regarding essay improvement. The relatively high standard derivation implies the divergence of students' experience, which is aligned with the research conducted by Ranalli et al. (2017). Moreover, students acknowledged the effectiveness of the AWE system in improving English self-regulated learning, indicating the AWE systems have a high perceived usefulness that corroborates the findings in previous studies (Li, 2021; Zhai & Ma, 2022).

### 5.2 Correlation between the Grammarly application frequency and writing self-efficacy

Students' responses showed a high frequency of using the AWE system. Compared with the previous studies assuming the submission frequency is positively related to the derived benefits (Attali, 2004; Li, 2021), the present study further delves into the relationship between using frequency and writing self-efficacy. The Pearson correlation coefficient indicates that using frequency is positively related to writing self-efficacy both on WTSE

and WSSE, which conforms to the results by Chen & Cheng (2008) and Hegelheimer & Lee (2013) regarding writing success. Although the reason of high frequency is not covered in this research, Lachner et al.(2017) and Zhang (2017) have proved that students who use the AWE systems more frequently to receive more experience in modifying writing and improving writing performance.

### 5.3 Correlation between college students' main using purpose and writing self-efficacy

The present study probes into the correlation between main using purpose and writing self-efficacy. We divided the using purpose into four categories, namely CGM, ILA, CST, and ELF as aforementioned. Notably, among all the factors, changing the writing style and tone (CST) and enhancing linguistic fluency (ELF) are the two variables that influence students' WTSE, which indicates when students intend to finish writing tasks, they pay more attention to the overall quality of the essays rather than the specific details of them. This phenomenon is illustrated in previous studies as students paid more attention to the organization-related and genre-related outcomes of the AWE systems (Cotos et al., 2017; Fu et al., 2024). For the CST facet, students laid more emphasis on some genre-related aspects including rhetorical knowledge, formal language features, and causal language features, etc. (Cotos et al., 2017; Saricaoglu, 2019) and Grammarly's function in this area gained their favor. For the ELF facet, coherence and cohesion are considered to improve the essay and students attach great importance to them as well (Lai, 2010; Liu et al., 2016).

As for WSSE, correcting grammar mistakes (CGM) and improving language accuracy (ILA) became the dominant variables. Students' writing self-efficacy is tightly related to modifying the details of the essay, which can be called language-related and content-related outcomes (Fu et al., 2024). Grammatical accuracy and sentence accuracy will dramatically influence their self-improving procedure in AWE-assisted learning (Barrot, 2023; Guo et al., 2021). Hence, when applying the AWE system with such intention, their writing self-efficacy will be influenced even promoted by AWE systems (Wilson & Roscoe, 2020).

### 5.4 Correlation between college students' function choice and writing self-efficacy

In terms of the function choice of Grammarly, we adopted five detailed functions, including Correctness, Clarity, Engagement, Delivery and Rewrite. These five functions followed sections in the official website to cover the utility of Grammarly and they could also be demonstrated in other classification terms, as Fu et al. (2024) argued, including language-related, content-related, organization-related and genre-related products.

For the WTSE part, this research finds that Correctness, Clarity, Engagement, Delivery have a significant impact on improving writing self-efficacy, indicating students are in need of multiple facets modification of the essay to accomplish the tasks. Since various functions are utilized in the process, it is proved that the Grammarly have a great perceived usefulness, which positively affects their psychological status (Hwang et al., 2019).

Rewrite function is shown crucial for the WSSE part and mostly related to students' writing self-efficacy in this study, but this function is controversy. As the AI technology gained rapid advancements, the AWE systems nowadays are equipped with the AI generators to help rewrite, prolong, simplify them essay for users. AI-generated rewrite provide students with abundant writing resources and provoke their thoughts (Guo & Wang, 2023), and further facilitate their writing. However, concerns regarding the plagiarism and academic integrity to this function is a controversy as well, awaiting for further discussion and improvement in the software (Okonkwo & Ade-Ibijola, 2021).

## 6. Conclusion

### 6.1 Theoretical and practical implications

In the present study, we elaborate on the impact of the AWE writing system on EFL learners' writing self-efficacy in self-regulated learning. Specifically, we sampled Grammarly as the platform and conducted a quantitative analysis using SPSS and AMOS to investigate their self-efficacy level. Findings in the present study corroborate the previous studies indicating that AWE writing systems have the potential to enhance users' writing self-efficacy in multiple facets. Also, the study further steps into a point for the discussion to reveal the underlying relationship of how the AWE writing system application affects writing self-efficacy. The discoveries of the present study support the idea that technology-integrated language writing assistants can have a positive impact on the writing psychology of EFL learners. These findings can contribute to the development of technology-enhanced language learning software, especially the AWE systems.

There emerged essential implications for the area of AWE system development as well as the AWE system-assisted EFL writing education and self-regulated learning. Firstly, this study noted the application of Grammarly was positively related to writing self-efficacy in an EFL context, adding to the growing body of research that supports the application of technology in language learning. Therefore, college students are encouraged to nurture their writing skills and writing self-efficacy through the application of Grammarly and other AWE systems owing to the study mode in college and limitations in instruction resources. Secondly, as the results indicated the positive correlation of the application frequency with writing self-efficacy, students should apply them regularly and receive proper guidance to effectively engage with it in their self-regulated learning, which means teachers could promote the use of Grammarly and other AWE systems and offer systematic training to facilitate students in the context of college education.

Secondly, to keep up with the rapid development of technology in the era of AI, it is essential to continuously improve and innovate the AWE systems to meet the evolving needs of EFL writing education and students' self-regulated learning needs. In the present study, it is revealed that students laid more emphasis on correcting grammar and spelling mistakes (Correctness), improving language clarity (Clarity), improving the accuracy of words (Engagement), and improving the overall expression (Delivery) when finishing written tasks. Hence, advancements including improving the accuracy of the provided suggestions, and better developing natural language processing technology shall be anticipated to help students with essay writing. Also, the results showed that correcting grammar and spelling mistakes (Correctness) and using AI to rewrite (Rewrite) are two fundamental skills to facilitate students' writing skills self-efficacy. So, it is crucial to continue to invest in research and better develop the AI rewrite technology to satisfy students' demands. In addition, it is expected that the forthcoming advancements including developing more functions for users, and promoting cross-platform support, will improve its functionality and applications in English writing.

### 6.2 Limitations and further directions

Although this study sought the possibility to uncover the impact of the AWE writing system on EFL learners' writing self-efficacy in a general scientific way, there are still several limitations that should be addressed, which can blaze a trail for future research to better explore the topic. Firstly, the sample size of the present study is small with only 336 people that was relatively small. Future studies could benefit from enlarging the sample size and improving the generalizability of the research. Secondly, the present study conducted quantitative research by doing a questionnaire investigation. As writing self-efficacy can be measured in various approaches, researchers

could extend the research boundary by using qualitative methods like interviews and reflective journals to provide a more complete insight into the field.

#### **Data sharing agreement**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

#### **Declaration of Conflicting Interests**

The author(s) declared no potential conflicts of interest with respect to the research, author-ship, and/or publication of this article.

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