The integration of multiple recognition technologies and artificial intelligence to facilitate EFL writing in authentic contexts

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Abstract—**English writing is a big challenge for the English as Foreign Language (EFL) learners due to the lack the lexical resources to inspire them for writing. However, we developed the mobile app, namely Smart UEnglish with the smart mechanisms by integrating multiple recognition technologies and artificial intelligence (AI) to help learners practice meaningful English writing in authentic contexts. Through the smart mechanisms like the integration of speech-to-text (STR), image-to-text recognition (ITR), and generative-AI, the learners could receive not only lexical resources but also sample sentences generated by AI (AI-GS) to inspire them to make meaningful writing. A total of 71 undergraduate students from two classes were assigned to two groups. The experimental group (EG) learns with Smart UEnglish including ITR, STR, and AI-GS. Meanwhile, the control group (CG) learns with ITR and STR only. The mix-method was used to analyze the study deeply. The results found that the EG outperformed the CG in the posttest. The ITR-generated texts as input for AI-GS could inspire the learners by giving the sample sentences before they write the essay. The use of ITR is the predictive variable in the post-test. In addition, the learners in EG have high positive perceptions towards Smart UEnglish. Hence, the integration of multiple recognition technologies and AI in the Smart UEnglish could facilitate EFL learners to learn meaningful writing in authentic contexts.**

Keywords: EFL writing, recognition technologies, image-to-text recognition, speech-to-text recognition, artificial intelligence

I. INTRODUCTION

The English writing is more challenging than speaking for English as foreign language (EFL) learners. The learners need to consider not only the grammar but also the content in their writing [1]. However, they learn lexical resources like vocabulary from the textbook to enrich their writing content. Moreover, it is also helpful to connect the authentic contexts in their surroundings to support the lexical resources. The new related lexical resources from the authentic contexts could inspire learners beside from the textbook and then enhance their writing content [2].

Several studies found that recognition technologies could be used to facilitate EFL learning [3]. For example, image-to-text recognition (ITR) could recognize the photos and then provide the ITR-generated texts like vocabulary and phrases related to the authentic contexts surrounding them. The study found that the ITR-generated texts could enhance their learning achievement by taking photos of their surroundings with ITR [4]. Another example, the speech-to-text recognition (STR) which could recognize and transcribe the learners' voices into texts. The study found that STR could be used to transcribe video or audio then the learners could read the meaning of the texts [3]. These two recognition technologies benefited the learners by providing the vocabulary with ITR and a convenient way to input the writing with STR. However, the provided vocabulary is not enough to help them to write essays, since the essays require longer content.

Further, the other study found that the generative-AI with GPT-2 could predict the new words based on the previous content [5]. Therefore, it has the opportunity to integrate the ITR that provides the vocabulary and phrases for the input to generative-AI. Hence, the generative-AI could generate the sample sentences for inspiration to learners. Thus, the researchers developed the "Smart UEnglish" app with the integration of the recognition technologies like ITR, and STR as input and the generative-AI to provide the learner not only the vocabulary but also the sample sentences for EFL learning. Furthermore, the learners' perceptions need to be explored towards our proposed "Smart UEnglish". Based on the aforementioned, the research questions in this study are as follows:

- What are the differences in the learning achievement between the experimental group (EG) with the recognition technologies and AI support, and the control group (CG) with the recognition technologies only?

- What are the correlations between the learning behaviors and the learning achievement of the EG?

- What are the learners' perceptions toward our proposed Smart UEnglish for EG?

II. Literature Review

A. EFL Writing in authentic contexts

Several studies related the EFL writing evaluate English writing on learning achievement with different perspectives and mechanisms. However, the studies mentioned that the content and the grammar in the English writing were important constructs [6]. The learners usually create the content based on their experiences, describing the objects, and obtained from the textbooks. However, the learners could make meaningful English writing when they understand the contexts well and have enough lexical resources. In addition, recognizing the authentic objects in their surroundings could be used to trigger learning and improve their lexical resources. On the other hand, several studies mentioned that grammar feedback could enhance the English writing for EFL learners [7]. Through the grammar feedback, learners could learn from the suggestion and then revise their essay draft.

B. The multiple recognition technologies and artificial intelligence supported EFL writing

Multiple recognition technologies such as image-to-text recognition (ITR) and speech-to-text recognition (STR) have been used widely in educational research, especially in the EFL learning [3, 4]. The learners could retrieve the lexical resources from the images that they took in the mobile device. Afterward, the learners could learn the new ITR-generated texts like lexical resources that related to their surroundings. Hence, they could enrich their English writing content if they could deeply understand the lexical resources. In addition, the STR could help the learners to input the content easily with their voice. The learners record the voice and the STR could transcribe it into texts that could help them to make the longer content.

On the other hand, the generative-AI that has the ability to generate the sentences could empower multiple recognition technologies. The previous study proved that the generative-AI with GPT-2 could give the prediction words when the learners write the essay [5]. The previous words as the input for AI and then the AI produced the next prediction of the words. Hence, it could be helpful to integrate the multiple recognition technologies that recognize the image and the voice to texts as input for the AI. Thus, the generative-AI could generate the sample sentences that could inspire students to compose the lexical resources in the sentences.

III. System Design

We developed an Android app "Smart UEnglish" to facilitate EFL writing in authentic contexts. The main interface for practice writing in the app as shown in Figure 1. The app includes the recognition technologies like ITR and STR, and the generative-AI to generate the sample sentences (AI-GS). The learners could practice English writing in the four steps. First step, learners explored their surroundings to take photos based on the essay topic. The app recognized the photos with the ITR that produced lexical resources such as

vocabulary and a phrase. Afterward, learners could modify it with hand typing or voice by STR. Second step, learners could generate sample sentences with AI-GS based on the ITR texts as input to inspire them before writing an essay. Smart UEnglish has implemented the content filter for safety to prevent unsafe or harmful contents from AI-GS before showing the results to the learners. Third step, learners started to write a short first writing draft. There are four paragraphs in the one essay. Further, learners not only write the essay with hand typing but also, they could use STR with speech as an input. Fourth step, learners retrieved the grammar feedback to enhance their writing quality (GF) by click the grammar feedback button.
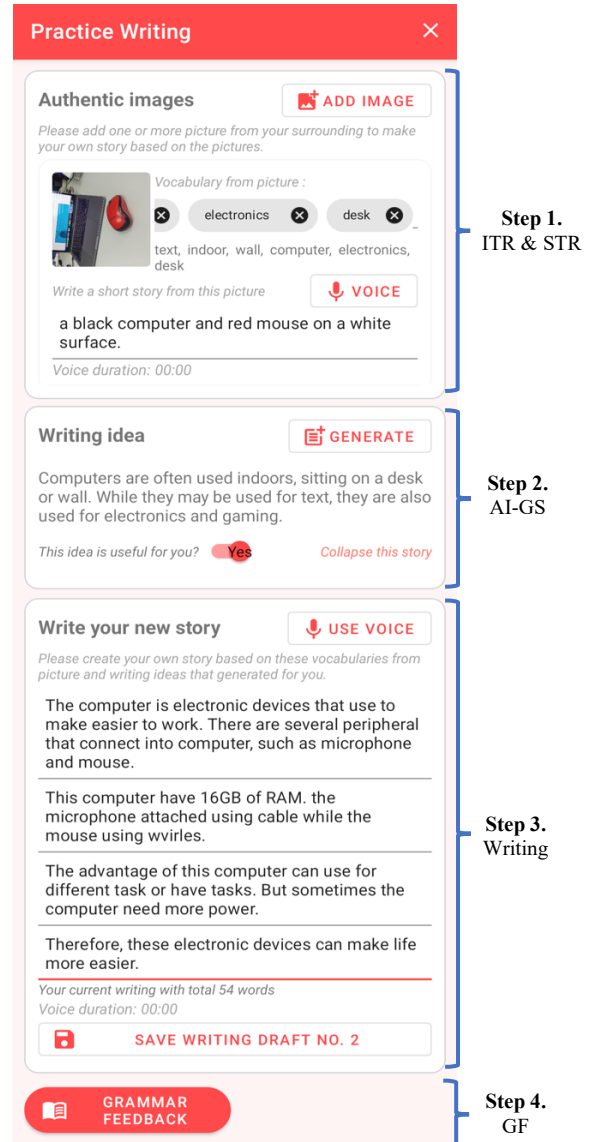

Figure 1. The interface of practice writing in the Smart UEnglish

IV. Methodology

A. Participants

A total of 71 undergraduate EFL learners from two classes of engineering faculty in a university were assigned into two groups. They have similar experienced to use the English language and they are

not native English language because English language as their second language. The experimental group (EG) consists of 33 and the control group (CG) consists of 38 learners. Both groups were taught by the same English teacher of an English engineering course that has five years of teaching experience. The EG learns EFL writing with the Smart UEnglish app including the multiple recognition technologies and AI. On the other hand, the CG learns EFL writing with the UEnglish app including the multiple recognition technologies only.

B. Experimental procedure

The quasi-experiment lasted six weeks. The learners learn at their home because of the Covid-19 pandemic situation in their university that caused them to prohibit learning in the classroom. Hence, the learning activities were conducted with our mobile app and the teacher monitored their progress once a week through online meetings. They learn EFL writing by describing the real objects surrounding them at their home. The writing topics for pretest, posttest, and practices were related to engineering courses like hardware and software in their surroundings.

The learning activities were listed and scheduled inside the app. The learners need to follow the schedule starting to complete the pre-test in the app on the first week. Further, they cannot move to the next task if they did not accomplish the previous task or not in the same week as schedule. In details, learners conducted a pretest within one hour in the first week. Afterward, the teacher and researchers trained learners to use the Smart UEnglish and UEnglish. After, they practiced EFL writing based on the topics within two weeks in authentic contexts. The learners could practice many times to make at least four essays and then submit them to the teacher. They could take the picture of their surroundings with the app and then start to write the essay. In the fifth week, the learners did the posttest within one hour. In addition, the interview was conducted for EG to know their perceptions towards Smart UEnglish.

C. Data collection and measurement

The instrument of the learning achievement with the pre-test and the post-test consists of three questions to make an essay based on authentic photos provided by the teacher. Both pre-test and the post-test question items were similar. The instrument is based on a previous study that in the pre-test and post-test, the teacher provides four authentic photos related to the topics [2]. The learners could answer the three questions: 1) the learners need to provide the vocabulary that related to the first photo, 2) the learners need to make the description based on the vocabulary that they answered in the first answer, and 3) create an essay based on the three last photos. On the other hand, the learning behaviors data were collected in the app such as the revision history and the use of ITR, STR, AI-GS, and GF. The learning behaviors data were counted by the quantity of words included in the essay.

The writing evaluation for the pre-test and the post-test is based on the scoring rubric following TOEFL independent writing rubric [8]. The three experienced individual raters evaluate the learners' writing by giving one to five scores based on each criterion. We analyze the acceptable level agreement of the tester with the intraclass correlation coefficients (ICC) [9]. The three raters reached an acceptable level of agreement with the high inter-rater reliability for pre-test ($ICC = .890$) and post-test ($ICC = .799$). In addition, the semi-structured interview with the five questions was conducted with 20 learners randomly from EG.

A mix-method analysis was used in this study to deeply understand the reason behind the results. In the quantitative analysis, we used SPSS to analyze the data, such as ANOVA to compare the difference between two groups in the pre-test. The analysis of covariance (ANCOVA) to compare the difference between two groups in the post-test and the pre-test scores was assigned as covariate variable. There are several parameters in the ANOVA and ANCOVA such as the total number of participants (N), mean score of each group (M), standard deviation (SD), standard deviation error (Std. Error), the significant value with the F-value (F) and the p-value (p), and the partial eta squared (η) which show the effect size of the variable [10]. The Pearson correlation to analyze the correlation between the learning behaviors and the learning achievement in the EG only. There are two parameters of the Pearson correlation, the correlation coefficient (r) which show the direction and the relationship of between two variables; and the p-value (p) which show the probability of the correlation coefficient that measure the significant of the result [10]. Further, stepwise multiple linear regression was used to predict the most influential variables in the post-test. In addition, a descriptive statistic with data coding was used to analyze the interview data.

V. RESULT AND DISCUSSION

A. Learning achievement of the EFL writing between two groups

The ANOVA analysis results in Table 1 shows that no significant difference between EG and CG in the pre-test ($F = .315$, $p > .05$). It indicated that both groups were not significantly different about the writing ability in the test.

Further, the pre-test score was used as the covariate variable for ANCOVA analysis in the post-test. The homogeneity of variance was satisfied and allowed to continue analysis ($p > .05$). The ANCOVA analysis results in Table 2 shows there was a significant difference between EG and CG in the post-test ($F = 12.37$, $p < .01$, $\eta = .157$). In addition, the mean value of EG ($M = 30.81$) was higher than the CG ($M = 24.92$). Both groups were increased but the EG was superior to the CG since the EG learned and practiced with the Smart UEnglish that provides sample sentences to them besides ITR-generated texts, STR, and grammar feedback. The other reason might be the EG got inspired when practicing from ITR-generated texts, the sample sentences that could enrich their writing content, and the grammar feedback which make them revise many times during the practices. Further, the

learners could learn deeply to use the vocabulary and the correct grammar in their post-test, hence, they could enhance their learning achievement.

Table 1. The ANOVA analysis results of the pre-test between two groups.

Group	N	Mean	SD	Std. Error	F	p
EG	33	14.42	6.33	1.10	.315	.577
CG	38	15.21	5.47	.887		

Table 2. The ANCOVA analysis results of the post-test between two groups.

Group	N	Mean	SD	Std. Error	F	η
EG	33	30.81	7.62	1.32	12.37**	.157
CG	38	24.92	8.89	1.44		

Note. **$p < .01$

B. Learning behaviors of the experimental group

The Pearson correlation analysis results found that there were several correlations between the learning behaviors and the learning achievement in the EG when they practiced EFL writing. Interestingly, the total revisions were significantly correlated with the post-test ($r = .359$, $p = .040$). It indicated that the learners who revise their essay several times could enhance the quality of the essay, hence, their post-test score will increase. Further, the total practice did not correlate with the post-test which indicates the number of revisions the essay is more important rather than how much they could finish their practice. Hence, they could focus on enhancing their essay on each practice.

Regarding the recognition technologies, the total use of the ITR was significantly correlated with the post-test ($r = .374$, $p = .032$). It indicated that the ITR technology could help learners to enhance their writing content in the post-test. It is because ITR-generated texts could provide them with the vocabulary related to their surroundings that made learners use the vocabulary to enrich the writing content. The result was similar to the recent study that the ITR-generated texts could enhance the learners' learning achievement [11].

Regarding the AI, the total use of the AI-GS was significantly correlated with the post-test ($r = .346$, $p = .049$). It indicates that learners were inspired from sample sentences generated by the AI before they wrote the essay. The ITR-generated texts were the input in the AI that could generate the sample sentences related to the vocabulary and their surroundings as well in authentic contexts. The sample sentence could stimulate learners to compose the vocabulary related to their surroundings into the sentences. After learners got the vocabulary from ITR-generated texts and the sample sentences by AI, they could write the essay on their own which could make learners understand deeply to use and compose the vocabulary related to the authentic contexts.

In addition, the total use of GF was significantly correlated with the post-test ($r = 346$, $p = .049$). It indicated that the learners use grammar feedback to enhance their writing content. Further, the grammar feedback that could give several corrective feedbacks to learners makes them revise their essays frequently (r = .843, $p < .01$). By revising, they could deeply understand the correct grammar, thus, they could enhance their learning achievement.

Further analysis with the stepwise multiple regression found that the total use of ITR is the most influential variable to the post-test ($R^2 = .140$, $\beta = .374$, $t = 2.246$, $p = .032$). It indicated that the vocabulary related to the learners' surroundings is important to enhance their learning achievement. It is because the ITR technology could provide several related vocabulary from the photos taken by the learners with the Smart UEnglish app on their smartphone. Hence, learners could use ITR-generated texts like the vocabulary to enrich the content of the essay in the post-test.

C. The learners' perceptions toward Smart UEnglish

Table 3 shows the interview results with the data coding from 20 learners in EG. The learners have a high positive perception of the Smart UEnglish for writing because they can practice and learn the new vocabulary using their mobile device (IV-3). In addition, they felt that the user interface is easy to use and the tutorial easy to understand allowing them to learn independently in their home (IV-2). Further, they think that the vocabulary and the sample sentences could inspire them before they write the essay on their own (IV-1). Hence, they want to continue to use the app to learn and practice to enhance their writing quality (IV-4). In addition, they felt healthy because they learned by exploring their surroundings to take pictures that related to the topic (IV-5).

Table 3. The learners' perceptions with data-coding from the interview results

Code	Themes	Freq (n=20) N	Freq (n=20) %
IV-1	I need to have inspiration like vocabulary or sample sentences before writing (ITR; AI-SS).	18	90
IV-2	The user interface is easy to use and the tutorial is easy to understand.	14	70
IV-3	The app is useful because we can practice and learn new vocabulary with mobile devices (ITR).	20	100
IV-4	I will continue to use the app to learn and practice enhance my writing quality by myself	16	80
IV-5	I feel like exercising because I have to move around looking at my surroundings.	18	90

VI. CONCLUSION

The integration of multiple recognition technologies and AI could help learners in EG to practice and then enhance their EFL writing in the post-test. Besides the learners inspired by the ITR-generated texts, the EG also benefited from the sample sentences by AI that provide sentences based on the ITR-

generated text as the input. Hence, the recognition technologies like ITR combined with AI could empower the app for facilitating EFL writing.

Besides ITR and AI-GS help EG learners to enrich and enhance their post-test, the revisions and the grammar feedback also help them to enhance the post-test. The corrective feedback from the grammar feedback could trigger learners to do more modifications to their draft essays that could enhance the writing quality. After several revisions of the writing essay, they understand how to use the vocabulary with correct grammar which could enhance their learning achievement. Further, the use of ITR is an important variable that could predict learning achievement. Since the ITR-generated texts could provide the vocabulary and help the AI to generate the sample sentences in authentic contexts.

The learners in EG have high positive perceptions towards our proposed Smart UEnglish. They felt that Smart UEnglish was helpful because it could provide the vocabulary and sample sentences related to their surroundings and it was easy to use. Hence, the learners want to use it again in the future to learn writing by exploring the objects surrounding them.

However, this study has limitations and suggestions for future study. The learning achievements were scored by the total in the scoring rubric. In the future, it might use detailed evaluation criteria to assess the writing quality like content, cohesion, consistency, and grammar. The learners need to be encouraged to use the voice by STR rather than typing for the input when writing the essay. In the future, it might be integrated with other recognition technologies like to recognize their location by using a GPS, then it could provide the vocabulary based on their location. The study was conducted in their home due to the Covid-19 pandemic situation that might affect their learning activities.

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