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Effects of Pigai.org on College English Writing Competency: The Complexity, Accuracy and Fluency

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***Abstract*—Online applications in teaching and learning have been widely used in recent years. Pigai.org has become extremely popular for second language learning in China, and the study aims to examine its application to enhance students' college English writing competency. Despite numerous studies on the use of Pigai.org, there has been rare research on its effects on college English writing competency in Chinese polytechnics. The current study investigates the effectiveness of its application over five weeks in a polytechnic college. Pigai.org has been applied in a College English Test-oriented writing class with 30 second-year students majoring in English. Sixty writing samples are collected in the first and fifth weeks, respectively, as the data analysis to evaluate writing complexity, accuracy, and fluency in pre-and post-tests. The study utilises a quantitative research approach, incorporating descriptive statistics, paired samples *t*-tests, and repeated measures ANOVA. The results show that the complexity, accuracy, and fluency significantly increased after applying Pigai.org in writing. Despite the decreases in very few items, most items measured in the study had higher scores in the post-test than in the pretest. The findings indicate that the use of Pigai.org positively affected college English writing and shed light on the pedagogical implications.**

***Index Terms*—Pigai.org, college English writing, complexity, accuracy, fluency**

I. Introduction

The remarkable advances in science and technology have led to a broad convergence of information technology in different industries (He et al., 2021). Technology and online applications in education have rapidly updated and expanded, significantly impacting the teaching and learning practice (Carrillo & Flores, 2020). In China, the 2017 publication of China's State Council's 'New Generation Artificial Intelligence (AI) Development Plan' emphasises the widespread implementation of AI in various industries nationwide, focusing on education fields (Roberts et al., 2021). In 2019, two significant plans to drive ongoing reform in China's education sector: China's Education Modernization 2035 and the Implementation Plan for Accelerating Education Modernization (2018-2022), were released by the Chinese State Council (Ding & Wu, 2024). These plans aim to modernise China's education system by expanding its digitalisation and leveraging AI and other emerging technologies to enhance teaching and learning.

The advent of the information era and its related educational policies in China have innovated teaching and learning English with online education tools (Dash, 2022). Teachers and learners are exposed to online tools that shape their teaching and learning styles and methods. They teach and learn through interaction by creating, editing, commenting, and sharing documents and ideas, all available through online application tools (Cabual, 2021).

The English proficiency level in China is below the world average according to statistics from the EF English Proficiency Index (EF EPI) and Global IETLS Test Taker Performance Report (TTPR). EF EPI seeks to rank countries and regions based on the English language abilities among people who have taken the EF tests (Li et al., 2022). The most recent report in 2023 indicated China was ranked 82nd out of 113 countries and 14th out of 23 countries in Asia. From 2011 to 2023, except for 2019, 2020, and 2021, China's English level was moderate, and the remaining years were low (EF EPI, 2023), while in 2022, the Global IELTS TTPR assessed on a 9-band scale for the 39 non-first language speaking countries was issued. China was ranked 29th with an overall average score of 6.1, which fell slightly below the global average of 6.3 and 28th with an average score of 5.8 in writing (IELTS TTPR Report, 2022). The gap

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in English proficiency between China and other countries calls for an overall improvement in English, especially in writing.

Writing is a significant productive skill crucial for strengthening students' autonomous learning ability and cultivating comprehensive English ability (Hafizah & Sayadi, 2022). However, most students cannot sustain their interest, and they generally lack confidence in their writing ability and have relatively low satisfaction with their writing scores (Yu et al., 2020).

In China, college English teaching aims to cultivate students' comprehensive English abilities, including listening, speaking, reading, and writing. Writing is one of the main compulsory parts of college English in Chinese Polytechnics. According to the teaching curriculum design in the sample school, College English Writing is merged with College English, which lasts for five weeks in writing practice. One primary purpose is to assist students with the College English Test (CET)[1].

This challenge concerns polytechnic students with insufficient language skills and timely feedback and guidance in college English writing (Tsai, 2022). It is also a challenge for the writing teachers. The teacher's feedback is crucial for students, but it takes a lot of time and effort to help students at different proficiency levels improve their writing. Additionally, constraints like large class sizes, limited time, and a shortage of teaching staff can make it challenging for teachers to give individualised feedback and support college-level English writing. As a result, students often do not get enough practice to develop their writing skills (Tsai, 2022). Thus, it is worth exploring the related English skills in a particular subject in teaching and learning, such as writing combined with an online application, to enhance writing competency.

II. Literature Review

Under technology-enhanced education in college English writing, Pigai.org is an online application developed by the National Language Intelligence Centre of China, launched in 2010 and introduced in 2011 as a commercial online assessment platform specifically for Chinese EFL learners (Bai & Hu, 2016). It provides writing correction services to improve English writing by helping users reduce grammatical errors and enhance writing complexity, accuracy, and fluency. As a result, there has been a significant increase in the number of studies on Pigai.org in teaching and learning over the last few years, and various educational benefits have been reported.

The literature review is based on research from two primary databases: China National Knowledge Infrastructure (CNKI) and Google Scholar, focusing on writing on Pigai.org. Researchers mainly concentrated on the introduction, application, and suggestions for effective collaboration use (Zhu, 2019; Luo & Liang, 2022; Zhang, 2022), as well as its application in English writing to construct a multiple feedback writing mechanism (Liu, 2022; Yao, 2021; Wang & Bai, 2021). Case studies in one particular university were included, such as a combined teaching module, an assessment and evaluation method, or a tentative survey of its validity (Tan, 2019; Yan, 2019; Guo, 2020; Yang et al., 2022). Researchers are mainly from different educational backgrounds, and their research focuses vary from each other. The literature research also shows innovations in teaching methods and instructional design based on the flipped classroom in China and the world. However, most research has been conducted on Pigai.org English writing instruction at universities or colleges, highlighting the need to expand the research scope to lower-level colleges, such as polytechnics[2], to cultivate more applied foreign language talents.

Studies have found that Pigai.org is effective for college English writing and revision. However, most of them have only focused on the impact of Pigai.org on the writing product. Additionally, Pigai.org has been shown to improve the quality of college English writing, but it is unclear whether students also improve their English writing skills. For instance, although studies found that the quality of writing improved when using Pigai.org, they did not investigate the reasons behind this improvement (Li & Yan, 2020; Geng & Razali, 2020). Hence, the current study investigated the impact of Pigai.org on college students' English writing proficiency, analysing complexity, accuracy, and fluency by comparing students' writing samples before and after a certain period.

Language proficiency or writing competency is composed of multiple components, and it can be fully captured by the CAF framework, representing complexity, accuracy, and fluency (Skehan, 1998; Tahmouresi, 2021). Skehan (1989) proposed CAF and included it as one of the three principal language proficiency dimensions for the first time. Later, CAF got its working definitions and was perceived as a significant research variable in applied linguistic research, including research on writing assessment (Pallotti, 2009).

Complexity, accuracy, and fluency are complex and multifaceted concepts that can be assessed using various tools (Housen & Kuiken, 2009). Such as, subjective ratings, particularly analytical ratings, are employed to evaluate a composition's language complexity, accuracy, fluency, or organisation. Conversely, objective and precise assessments

[1] The College English Test (CET) is the world's largest English as a foreign language test and one of the language tests that has attracted the most public attention in China (Zhang, 2022). According to the latest version of the Test Specifications of the College English Test (National College English Testing Committee, 2016), the CET aims to assess general English proficiency and inform pedagogical improvement, graduate school admission, and employment in China. The CET consists of two tests, Band -4 and Band -6, and is delivered semi-annually to college non-English majors who have completed two years and four years of the National College English Teaching Syllabuses, respectively.

[2] The Chinese higher education system consists of four layers: research institutions, research and teaching institutions, teaching institutions, and application-oriented institutions (Cai & Yan, 2017). The four tiers of Chinese regular higher education institutions are arranged in a pyramid from top to bottom. In this research, polytechnics refer to the application-oriented institutions at the lowest level in the pyramid.

of a writer's writing ability are obtained by calculating quantifiable measures such as frequencies and ratios of specific language features in words and discourse. According to Wigglesworth and Storch (2009), the language features that can be measured quantifiably are categorised as the following.

Complexity can be measured through lexical sophistication and syntactic complexity (Skehan, 2009). Lexical sophistication is typically measured in average word length and type/token ratio of words. The average word length is calculated by dividing the number of characters by the number of words in a text. In contrast, the word type/token ratio is the number of different lexical words over the total number of words in a text. Syntactic complexity is commonly measured in three ways: the average number of words to T-units, the proportion of clauses to T-units, and the percentage of dependent clauses to total clauses (Wolfe-Quitero et al., 1998).

Accuracy can be measured using global measures, which include the proportion of error-free T-units (EFT/T) and error-free clauses out of all clauses (EFC/C) in a text. It can also be measured using local measures, considering the type and number of errors in a single clause (Wigglesworth & Storch, 2009). Ellis and Barkhuizen (2005) note that global and local accuracy measures are closely correlated, with global measures being more commonly used. Additionally, fluency can be assessed by examining the average number of words, sentences, and clauses per text (Skehan, 2009). Since a T-unit is an independent clause with all its dependent clauses (Storch & Wigglesworth, 2007), its functions are similar to a sentence in writing analysis, and the sentence information is automatically produced in the Pigai.org output report. Thus, the T-unit will be replaced by the sentence (S) for the data analysis in this study.

Based on the literature review of Pigai.org in writing and the CAF assessment suggested by Pallotti (2009), the CAF assessment was adopted to verify its effects on the Pigai.org application. It adequately addressed various dimensions of writing ability and has implications for evaluating written discourse produced in writing tests.

Thus, the study further explores the effect of applying Pigai.org in college English writing on writing competency by addressing the following questions in three essential dimensions: complexity, accuracy, and fluency through a pretest and a post-test. The research question and hypothesis are addressed as follows.

To what extent does the writing competency differ between those applying Pigai.org in CET-4 writing and those who do not?

1a. H_0. There is no significant difference ($p \leq .05$) in the writing scores between those applying Pigai.org in CET-4 writing and those who do not.

1b. H_0 There is no significant difference ($p \leq .05$) in the writing complexity between those applying Pigai.org in CET-4 writing and those who do not.

1c. H_0. There is no significant difference ($p \leq .05$) in the writing accuracy between those applying Pigai.org in CET-4 writing and those who do not.

1d. H_0. There is no significant difference ($p \leq .05$) in the writing fluency between those applying Pigai.org in CET-4 writing and those who do not.

III. Method

A. Participants

The primary data includes 60 writing samples (pretest and post-test) from 30 second-year Chinese polytechnic students during the first semester of the 2023 to 2024 academic year. Their English proficiency was tested before the experiment, and they were at a basic level, approximately an A2 in CEFR or lower. As most students could not write a complete CET-4 essay in English, Pigai.org was introduced to assist their writing. Their CET-4 writing performances in the pretest and post-test were to examine the effects of the Pigai.org application.

B. Task Description

The students wrote two English essays on CET-4 writing topics: a pretest before using Pigai.org and a post-test after the application without additional resources. Each test required the students to write about 120 words within 30 minutes. After that, the teacher introduced the Pigai.org assisted instruction in line with the pretest and an in-built systematical output report (e.g., correcting lexical and syntactic errors, sentence complexity and fluency) for each writing. Then, students were trained to practice writing under the Pigai.org application and submitted the final edition as a post-test after four weeks of treatment. These two tests allowed the researchers to measure the effectiveness of Pigai.org in college English writing more accurately, and both were conducted under the teacher's supervision in classroom practice.

C. Ratings

The English writing tests were scored on a scale from 0 to 100 using a holistic scoring rubric. Two professional raters conducted manual work to address the output report, including a polytechnic English writing teacher with several years of experience as a CET examiner and a linguistics professor. This work involved counting errors, evaluating the content, and assessing the number of clauses and sentences, as the Pigai.org output report indicated.

The Pigai.org system can also generate an overall essay score by comparing the essay to the texts in its database in four key areas: vocabulary, sentence structure, organisation, and subject relevance (Wang & Bai, 2021). Students can submit and resubmit their drafts based on the feedback they receive. Pigai.org can track the amount of time and effort

students dedicate to their writing by monitoring the number of revisions they have made. This allows teachers to provide guidance tailored to each student's online and offline performance. The quantitative analysis is based on the following CET-4 writing task for the pretest and post-test, as shown in Table 1.

TABLE 1
DESCRIPTION OF CET-4 WRITING TASK

Items	Description
Task	Candidates are required to express personal views on familiar topics.
Words	Write a short essay of at least 120 words.
time	30 mins
Topic	Online Shopping
Marking Criteria	CAF based
	The main idea is clear, the structure is complete, the words are more appropriate, the sentences are smooth, the meaning is coherent, and the primary writing strategies can be used.

D. Data Analysis

The study compared the student's English writing test results for complexity, accuracy, and fluency based on the CAF measurements of language competency. For writing complexity, the average word length, type/token ratio of words, average number of words per sentence, proportion of clauses per sentence, and percentage of dependent clauses of total clauses were measured. As for accuracy, error analysis in each test was conducted based on sentence and clause analysis to determine the percentage of error-free clauses and sentences. Here, errors include punctuation, spelling, vocabulary, or grammar errors in each sentence. For writing fluency, an average number of words, sentences and clauses was calculated (Yang et al., 2023). Table 2 shows the ten quantitative measures based on CAF.

TABLE 2
TEN QUANTITATIVE MEASURES OF CAF

CAF Measures	Items	Code	Definition
Complexity	The average word length	WL	# of characters/#of words
	type/token ratio of words	TRW	# of academic words+ # words above CET-4 level/ # of words
	average number of words per sentence	W/S	# of words/ # of sentence
	Clause per sentences	C/S	# of clauses/#of sentences
	percentage of dependent clauses of total clauses	DC/C	# dependent clauses/ # clauses
Accuracy	percentage of error-free sentence	EF/S	# error-free sentence/# of sentences
	percentage of error-free clauses	EF/C	# error-free T-units/# of clauses
	average number of words	NW	# of words per test
Fluency	average number of sentences	NT	# of sentences per test
	the average number of clauses	NC	#of clauses per test

The automated in-built Pigai.org output report presented the related items to measure writing complexity, accuracy, and fluency. Before the conduction of data analysis, any disagreements on the three measurements were addressed to reach a consensus by the two raters. After collecting the initial data, a comparative data analysis using inferential statistics was conducted to find the differences between these items. IBM SPSS 27 was used to calculate the data. Descriptive statistics were used to investigate the overall pattern of the data, while repeated measures ANOVA was used to examine whether the differences were statistically significant. Also, paired t-tests were used to determine whether there were substantial differences in various items between the pre-test and the post-test.

IV. RESULTS

Before the descriptive statistics and paired t-test analysis, Mauchly's test of Sphericitya was conducted within-subjects effect on scores of the tests in repeated measures ANOVA as is shown in Table 3, and Mauchly's test indicated that the assumption of Sphericitya had been violated, x2(2) = [52.46], p= [<.001].

TABLE 3
RESULTS OF REPEATED MEASURES ANOVA

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Score	.970	52.460	2	.000	.971	.972	.500

A. Scores

Descriptive statistics and paired samples *t*-tests were conducted to compare the total scores and examine the effect of using Pigai.org after the application, as is shown in Table 4.

TABLE 4
DESCRIPTIVE STATISTICS AND RESULTS OF PAIRED SAMPLE T-TEST ON THE SCORES

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pretest - Post-test	-15.50	7.59	1.38	-18.33	-12.67	-11.19	29	.000

Note: The numbers were normalised for each comparison.

Paired Samples Statistics on Scores

		Mean	N	Std. Deviation	Std. Error Mean
Scores	Pretest	57.73	30	6.04	1.10
	Post-test	73.23	30	5.68	1.04

Note: The numbers were normalised for each comparison.

The results in Table 4 clearly showed variations among the measured tests, indicating that the students produced significantly higher-quality writing after utilising Pigai.org. The results from the [pre-test] (M= [57.73], SD= [6.04]) and the [post-test] (M= [73.23], SD= [5.68]) indicate that the application of Pigai.org in writing resulted in an improvement in the total score, *t* ([29]) = [11.19], p= [<.001]. There was a significant increase after the four-week application training in the post-test compared to the pre-test. The 95% confidence interval between the means range from [-18.33] to [-12.67] indicates a difference between the means of the samples. Therefore, we reject the null hypothesis that there is no difference between the means and conclude that the application affects a test score.

To further investigate the effects on writing, descriptive statistics and three paired sample t-tests were conducted to find the differences in writing complexity, accuracy, and fluency (measured in numerical forms) [before] and [after the application of Pigai.org] in the pretest and post-test.

B. Complexity

Based on the CAF framework, there are five means to test writing complexity: WL, TRW, W/S, C/S, and DC/S. Table 5 provides descriptive statistics and a paired samples t-test on complexity between pretest and post-test.

TABLE 5
DESCRIPTIVE STATISTICS AND PAIRED SAMPLES T-TEST ON COMPLEXITY

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
WL	Pretest - Posttest	-0.54	0.45	0.08	-0.71	-0.37	-6.48	29	<.001
TRW	Pretest - Posttest	0.02	0.09	0.02	-0.01	0.05	1.35	29	.186
W/S	Pretest - Posttest	-6.09	3.97	0.72	-7.58	-4.61	-8.42	29	<.001
C/S	Pretest - Posttest	-1.07	0.83	0.15	-1.38	-0.76	-7.09	29	<.001
DC/S	Pretest - Posttest	0.10	0.27	0.05	0.00	0.20	1.97	29	.058

Paired Sample Statistics on Complexity

		N	Mean	Std. Deviation	Std. Error Mean
WL	Pretest	30	4.52	0.34	0.06
	Posttest	30	5.06	0.31	0.06
TRW	Pretest	30	0.15	0.06	0.01
	Posttest	30	0.13	0.05	0.01
W/S	Pretest	30	9.76	1.76	0.32
	Posttest	30	15.86	3.78	0.69
C/S	Pretest	30	0.69	0.41	0.07
	Posttest	30	1.76	0.75	0.14
DC/S	Pretest	30	0.29	0.25	0.05
	Posttest	30	0.19	0.11	0.02

Table 5 shows that a paired samples t-test was performed to evaluate whether there was a difference between the [writing complexity in the forms of WL, TRW, W/S, C/S and DC/S] (measured in numerical forms) [before] and [after the application of Pigai.org]. All aspects under investigation showed significant differences, except for TRW and DC/S.

The results showed no significant differences between the [TRW] [before] (M= [0.15]), SD= [0.06]) and [after the application of Pigai.org] (M= [0.13], SD= [0.05]), and minor differences between the DC/S [before] (M= [0.29], SD= [0.25]) and [after the application of Pigai]. org] (M= [0.19], SD= [0.11]).

The [WL] [after the application of Pigai.org] (M= [5.06], SD= [0.31]) was significantly higher than [before] (M= [4.52], SD= [0.34], *t* ([29]) = [6.48], p= [<.001]. Also, the [W/S] [after the application of Pigai.org] (M=[15.86], SD=[3.78]) was significantly higher than [before] (M= [9.76], SD=[1.76], *t* ([29])=[8.42], p=[<.001], and this increase also went to the [C/S] [after the application of Pigai.org] (M=[1.76], SD=[0.75]), which was significantly higher than [before] (M=[0.69], SD=[0.41], *t* ([29])=[7.09], p=[<.001]. Therefore, we reject the null hypothesis that there is no difference between the means and conclude that the application affects writing complexity.

C. Accuracy

Based on the CAF measurement, writing accuracy was tested on the EF/S and EF/C. Table 6 shows the descriptive statistics and a paired samples *t*-test on writing accuracy between the pretest and post-test.

TABLE 6
DESCRIPTIVE STATISTICS AND PAIRED SAMPLES *T*-TEST ON ACCURACY

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
EF/S	pretest - posttest	-0.42	0.21	0.04	-0.50	-0.34	-10.72	29	.000
EF/C	pretest - posttest	-0.47	0.30	0.06	-0.58	-0.35	-8.45	29	.000

Paired Samples Statistics on Accuracy

		Mean	N	Std. Deviation	Std. Error Mean
EF/S	pretest	0.42	30.00	0.23	0.04
	posttest	0.84	30.00	0.21	0.04
EF/C	pretest	0.35	30.00	0.30	0.06
	posttest	0.82	30.00	0.26	0.05

As is shown in Table 6, the results indicated the significant differences in EF/S and EF/C under investigation. The [EF/S] [after the application of Pigai.org] (M= [0.84], SD= [0.21]) was significantly higher than [before] (M= [0.42], SD= [0.23], *t* ([29])= [10.72], p= [<.001], and the significant increase also goes to the [EF/C] [after the application of Pigai.org] (M= [0.82], SD= [0.26]), which is higher than [before] (M= [0.35], SD= [0.30], *t* ([29])= [8.45], p=[<.001]. Therefore, we reject the null hypothesis that there is no difference between the means and conclude that the application affects writing accuracy.

D. Fluency

Based on the CAF measurement, writing fluency is tested on the NW, NS, and NC. Table 7 provides descriptive statistics and a paired samples *t*-test between the pretest and post-test.

TABLE 7
DESCRIPTIVE STATISTICS AND PAIRED SAMPLE *T*-TEST ON FLUENCY

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
NW	Pretest - Post-test	-13.70	25.68	4.69	-23.29	-4.11	-2.92	29	.007
NS	Pretest - Post-test	-0.03	2.76	0.50	-1.06	1.00	-0.07	29	.948
NC	Pretest - Post-test	-1.37	2.57	0.47	-2.32	-0.41	-2.92	29	.007

Paired Samples Statistics on Fluency

		Mean	N	Std. Deviation	Std. Error Mean
NW	Pretest	117.90	30.00	28.53	5.21
	Post-test	131.60	30.00	24.91	4.55
NS	Pretest	12.43	30.00	3.73	0.68
	Post-test	12.47	30.00	2.85	0.52
NC	Pretest	7.73	30.00	4.14	0.76
	Post-test	9.10	30.00	4.33	0.79

As is shown in Table 7, descriptive statistics and a paired samples *t*-test were performed to evaluate whether there was a difference between the [writing fluency in the forms of NW, NS, and NC] [before] and [after the application of Pigai.org]. There were significant differences in NW and NC under investigation, except for NS.

The results indicated that there were no significant differences between the [NS] [before] (M= [12.43]), SD= [3.73]) and [after the application of Pigai.org] (M= [12.47], SD= [2.85]). The [NW] [after the application of Pigai.org] (M=

[131.60], SD= [24.91]) was significantly higher than [before] (M= [117.90], SD= [28.53], *t* ([29]) = [2.92], p= [<.008]. The significant increase also goes to the [NC] [after the application of Pigai.org] (M= [9.10], SD= [4.33]), which is higher than [before] (M= [7.73], SD= [4.14], *t* ([29]) = [2.92], p= [<.008]. Therefore, we reject the null hypothesis that there is no difference between the means and conclude that the application affects writing fluency.

The descriptive statistics and paired *t*-tests indicated significant improvement in writing competency, specifically in the overall quality of writing (score) between the pretest and the post-test, including complexity (proportion), accuracy (proportion) and fluency (word count), despite the minor decreases in [TRW] and [DC/S] in complexity and the almost unchanged [NS] in fluency after the treatment of Pigai.org application.

V. Discussion

The current study demonstrated that utilising Pigai.org enhanced various facets of writing skills, such as writing complexity (measured by WL, TRW, W/S, C/S, and DC/S), accuracy (measured by EF/S and EF/C), and fluency (measured by NW, NS, and NC). The repeated measures ANOVA indicated statistical disparities in writing competency.

According to Chang et al. (2022) and Tsai (2022), low-proficiency students benefited from utilising Pigai.org in the study. Before using Pigai.org, the students struggled to write compositions within a 120-word limit in English, but with the assistance of Pigai.org, their average composition length increased to 131.6 words. It is suggested that some students may have directly relied on the output from Pigai.org without critically evaluating it.

This finding aligns with prior research in college English writing, indicating that learners' attitudes and strategies toward corrective feedback and revision differ based on learner variables, such as language proficiency, motivation, and engagement (Han & Hyland, 2015). Even if Pigai.org provides one-on-one feedback, students with lower English proficiency still struggle to identify and correct errors by comparing their writing with the Pigai.org in-built output report. Therefore, those who performed better may have directly implemented the outputs from Pigai.org in the post-test. However, the post-tests conducted after applying Pigai.org still scored higher than that in the pre-test regarding complexity, accuracy and fluency. The student's English writing might be improved for other reasons, but using Pigai.org contributes to the improvement over five weeks.

In complexity, the results show a significant increase in WL, W/S, and C/S, rising from [pre-test] (M= [4.52]) to [post-test] (M= [5.06]) in length of words, from [pre-test] (M= [9.76]) to [post-test] (M= [15.86]) in the number of words per sentence, and from [pre-test] (M= [0.69]) to [post-test] (M= [1.76]). All the difference indicates the increase in the writing complexity. In contrast, the study also showed that TRW remained relatively steady and decreased DC/S in the post-test; they were not statistically significant in the type ratio words and dependent clauses per sentence. Previous research suggests that Pigai.org is more effective at correcting lexical errors than syntactic errors, as vocabulary mistakes are more noticeable in students' writing than sentence structure errors when using Pigai.org (Lee, 2022a; Niño, 2008). As Pigai.org represents the words in the written text equivalent to the words in the post-test, it is easy to understand why the type ratio words remain steady in the post-test, and the automatic output report of Pigai.org assists the students in revising and clarifying the sentence patterns in the post-test. This explains the slight decrease in the dependent clauses per sentence from [pre-test] (M= [0.29]) to [post-test] (M= [0.19]). Moreover, a good command of dependent clauses in writing requires understanding a string of words, grammatical rules and other more complicated English knowledge which cannot be settled with the help of Pigai.org.

As for accuracy, significant differences were witnessed in the EF/S and EF/C, rising from [pre-test] (M= [0.42]) to [post-test] (M= [0.84]) in the proportions of average error-free sentences and from [pre-test] (M= [0.35]) to [post-test] (M= [0.82]) in average error-free clauses. As the Pigai.org output report addresses the errors and suggestions for correction, students could quickly identify them, such as embedded sentences and clauses. Thus, with the help of Pigai.org, their writing accuracy improved significantly in the post-test.

In fluency, there was a significant difference in terms of NW and NC; the number of words was enlarged from [pre-test] (M= [117.90]) to [post-test] (M= [131.60]), and this met the criteria of the limited word number in CET-4 writing. Also, the number of clauses was expanded from [pre-test] (M= [7.73]) to [post-test] (M= [9.10]), and this indicates the students could write more fluent words and expressions within 30 minutes for a CET-4 writing practice. Conversely, there is no noticeable change in the NS. That is to say, the proportion of the number of sentences remains almost the same with [pre-test] (M= [12.43]) to [post-test] (M= [12.47]). This result indicates that the application of Pigai.org expands the number of words and clauses while it has little effect on sentence variation.

This study demonstrated that the use of Pigai.org has a lasting impact on writing competency. The students wrote a similar CET-4 topic, possibly leading to more refined syntactic complexity. The discrepancy in accuracy might result from the varied accuracy checking reminders from the Pigai.org in-built output report. As for fluency, the number of sentences in this study is not as significant as the requirement of writing a designated CET-4 essay within the time limits.

The results of the present study present a varied picture when compared with previous studies on Pigai.org. On the one hand, this study is consistent with prior research demonstrating that the use of Pigai.org impacts the English writing proficiency of students, particularly in terms of complexity, accuracy, and fluency (Zhang & Hyland, 2023). In contrast, while Lu and Li (2016) did not observe a significant increase in word count with Pigai.org, the word count in the

post-test in our study showed a significant increase. This difference could be due to variations in the language proficiency levels of the participants in the two studies. The subjects in Lu and Li's (2016) study were university students with a higher English level, while the participants in the present study were polytechnic students, many of whom struggled to write a CET-4 essay. Moreover, the findings that students could write significantly longer responses when using Pigai.org aligns with previous studies by Han et al. (2021) and Wang and Bai (2021), who also observed improvements in complexity, fluency, and lexical diversity when utilising Pigai.org, but lexical diversity in this study after the intervention of Pigai.org in the post-test showed no significant increase, which differed from the previous study.

According to the results, this study has pedagogical implications. Tsai (2022) stated that Pigai.org can be an effective tool for translingual computer-assisted language learning. It can benefit the college English writing classroom by offering initial support with writing and revision. The study indicates that Pigai.org helps students write more complex sentences with fewer errors in grammar and vocabulary. However, merely using technology does not guarantee learning. Teacher intervention is also necessary (Haleem et al., 2022). Pigai.org can help students with their writing and reduce the teacher's workload by providing corrective feedback, but it cannot fully substitute teacher feedback. This study shows that some students, especially those with lower English proficiency, struggle to learn grammar from Pigai.org reports. Therefore, it is essential to have follow-up Q&A sessions as Pigai.org does not offer specific corrective feedback for certain errors, such as dependent and independent clauses and grammatical rules for each sentence. The teacher's explanations are necessary to clarify and improve their writing by offering additional feedback.

Teachers are encouraged to use Pigai.org to identify common errors in students' writing and provide more targeted feedback. However, it is essential to remember that writing is more than achieving complexity, accuracy, or fluency for exams. It also involves logical thinking, content, and organisation of ideas, which are areas where only a human teacher can provide guidance. Students can benefit from using Pigai.org through proper training, including learning to write essays correctly, critically assessing Pigai.org's feedback, and cross-referencing it with other resources rather than relying solely on Pigai.org for language learning. Ultimately, teachers should aim to help students build autonomy and confidence in their English writing. As utilising Pigai.org as a one-time practice tool will not significantly impact students' writing development or proficiency, teachers must implement a long-term Pigai. org-assisted writing curriculum to support the ongoing development of students' writing skills.

The study has a few limitations. First, the student's progress was analysed four weeks after using Pigai.org, but this timeframe might not have been long enough to measure the long-term impact. Additionally, the study only looked at the effect of using Pigai.org without considering other teaching and learning influences during this period. The students were asked to write a similar CET-4 composition in the post-test to assess the effects of Pigai.org directly, but the study did not explore whether the learning transferred to other subsequent writing tasks. Therefore, future research should investigate the impact of using Pigai.org over more extended periods to see if language learning becomes internalised and can be applied to new writing tasks.

VI. Conclusion

The current study demonstrates that Pigai.org has helped students improve their English writing skills over five weeks. Compared to the pretest, students produced much higher-quality writing in the post-test after using Pigai.org. This improvement was seen across three aspects of writing: complexity, accuracy, and fluency, and the effectiveness of Pigai.org varied for different linguistic items. Online technologies like Pigai.org and other ChatGPT and machine learning continue significantly impacting teaching and learning, and more technologies will be used in language classrooms. Language teachers should carefully assess and explore the benefits and drawbacks of using these applications to enhance student learning.

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References

[1] Bai, L. & Hu, G. (2016). In the face of fallible AWE feedback: How do students respond? *Educ. Psychol, 37*, 67-81. https://doi.org/10.1080/01443410.2016.1223275

[2] Cabual, R. A. (2021). Learning styles and preferred learning modalities in the new normal. *Open Access Library Journal*, *8*(4), 1–14. https://doi.org/10.4236/oalib.1107305

[3] Cai, Y. & Yan, F. (2017). Universities and higher education. In *Handbook of Education in China* (pp. 169-193). Edward Elgar Publishing. https://doi.org/10.4337/9781783470662.00018

[4] Carrillo, C. & Flores, M. A. (2020). COVID-19 and teacher education: a literature review of online teaching and learning practices. *European journal of teacher education*, *43*(4), 466-487. https://doi.org/10.1080/02619768.2020.1821184.

[5] Dash, B. B. (2022). Digital tools for teaching and learning English language in 21st century. *International Journal of English and Studies*, *4*(2), 8–13.

[6] Ding, L. & Wu, S. (2024). Digital transformation of education in China: A review against the backdrop of the 2024 World Digital Education Conference. *Science Insights Education Frontiers*, *20*(2), 3283–3299. https://doi.org/10.15354/sief.24.re340
[7] *EF EPI*. (2023). Retrieved March 30, 2024, from https://www.ef.com/ca/epi/regions/asia/china/.
[8] Ellis, R., & Barkhuizen, G. P. (2005). *Analysing Learner Language.* Oxford University Press Oxford.
[9] Geng, J.X, & Razali, A. B. (2020). Tapping the potential of Pigai automated writing evaluation (AWE) program to give feedback on EFL writing. *Universal Journal of Educational Research*, *8*(12B), 8334-8343. https://doi.org/10.13189/ujer.2020.082638
[10] Guo, L. (2020). A Study on the Application of Pigai. org Software in Teaching University-level English Writing-Taking a Freshman Class in Chongqing as an Example. *Theory and Practice in Language Studies*, *10*(8), 952–958. https://doi.org/10.17507/tpls.1008.14
[11] Hafizah Adnan, N., & Sayadi, S. S. (2022). ESL students' readiness for self-directed learning in improving English writing skills. *Arab World English Journal (AWEJ)*, *12*. https://doi.org/10.31235/osf.io/cswtz
[12] Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable operations and computers*, *3*, 275-285. https://doi.org/10.1016/j.susoc.2022.05.004
[13] Han, Y., & Hyland, F. (2015). Exploring learner engagement with written corrective feedback in a Chinese tertiary EFL classroom. *Journal of Second Language Writing*, *30*, 31-44. https://doi.org/10.1016/j.jslw.2015.08.002
[14] Han, Y., Zhao, S., & Ng, L. L. (2021). How technology tools impact writing performance, lexical complexity, and perceived self-regulated learning strategies in EFL academic writing: A comparative study. *Frontiers in Psychology*, *12*, 752793. https://doi.org/10.3389/fpsyg.2021.752793
[15] He, W., Zhang, Z. J. & Li, W. (2021). Information technology solutions, challenges, and suggestions for tackling the COVID-19 pandemic. *International journal of information management*, *57*, 102287. https://doi.org/10.1016/j.ijinfomgt.2020.102287
[16] Housen, A., & Kuiken, F. (2009). Complexity, accuracy, and fluency in second language acquisition. *Applied linguistics*, *30*(4), 461-473. https://doi.org/10.1093/applin/amp048
[17] IELTS TTPR Report. (2022). *Overall Academic IELTS scores for 39 non-first language-speaking countries*. Retrieved September 18, 2024, from https://ielts.org/researchers/our-research/test-statistics#Test_performance.
[18] Li, Y., Teng, W., Tsai, L. & Lin, T. M. (2022). Does English proficiency support the economic development of non-English-speaking countries? *The case of Asia. International Journal of Educational Development*, *92*, 102623. https://doi.org/10.1016/j.ijedudev.2022.102623
[19] Li, Z., & Yan, D. (2020). Effect of pigai.org on English majors' writing self-efficacy and writing performance. In *Journal of Physics: Conference Series* (pp.042086). IOP Publishing. https://doi.org/10.1088/1742-6596/1533/4/042086
[20] Liu, L. (2022). A Study on the English Writing Teaching of TEM-4 Based on Pigai Platform. *Pacific International Journal*, *5*(4), 169–174. https://doi.org/10.55014/pij.v5i4.277
[21] Lu, Z., & Li, Z. (2016). Exploring EFL learners' lexical application in AWE-based writing. Call communities and culture-short papers from *EUROCALL* (pp.295-301). https://doi.org/10.14705/rpnet.2016.eurocall2016.578
[22] Luo, Y., & Liang, W. (2022). *Application of POA in Teaching Mode of College English Writing Based on Artificial Intelligence*. In 2022 IEEE 5th Eurasian Conference on Educational Innovation (ECEI). (pp. 105-109). https://doi.org/10.1109/ECEI53102.2022.9829466
[23] National College English Testing Committee. (2024). *National CET Test Specifications: Band 4 and 6* (2016 Revised ed). http://www.cet.edu.cn.
[24] Pallotti, G. (2009). CAF: Defining, refining and differentiating constructs. *Applied linguistics*, *30*(4), 590–601. https://doi.org/10.1093/applin/amp045
[25] Roberts, H., Cowls, J., Morley, J., Taddeo, M., Wang, V., & Floridi, L. (2021). *The Chinese approach to artificial intelligence: an analysis of policy, ethics, and regulation* (pp. 47-79). Springer International Publishing. https://doi.org/10.1007/978-3-030-81907-1_5
[26] Skehan, P. (1998). *A cognitive approach to language learning*. Oxford University Press. https://doi.org/10.1177/003368829802900209
[27] Storch, N., & Wigglesworth, G. (2007). Writing tasks: Comparing individual and collaborative writing. In M. P. Garcia-Mayo (Ed.), *Investigating tasks in formal language learning* (pp. 157–177). London: Multilingual Matters. https://doi.org/10.21832/9781853599286-011
[28] Tahmouresi, S. (2021). On the Role of Individual Differences in the L2 Writing Achievement. *The Florida State University. Journal of English Linguistics*, *11*(2), 68-84. https://doi.org/10.5539/ijel.v11n2p68
[29] Tan, X. (2019). Research on college English writing teaching under the background of big data: taking Leshan Normal University as an example. *Theory and Practice in Language Studies*, *9*(1), 60. https://doi.org/10.17507/tpls.0901.09
[30] Tsai, S.-C. (2022). Chinese students' perceptions of using Google Translate as a translingual CALL tool in EFL writing. *Computer Assisted Language Learning*, *35*(5-6), 1250–1272. https://doi.org/10.1080/09588221.2020.1799412
[31] Wang, J., & Bai, L. (2021). Unveiling the Scoring Validity of Two Chinese Automated Writing Evaluation Systems: A Quantitative Study. *International Journal of English Linguistics*, *2*(2), 56-60. https://doi.org/10.5539/ijel.v11n2p68
[32] Wigglesworth, G., & Storch, N. (2009). Pair versus individual writing: Effects on fluency, complexity and accuracy. *Language Testing*, *26*(3), 445-466. http://doi.org/10.1177/0265532209104670
[33] Wolfe-Quintero, K., Inagaki, S., & Kim, H. (1998). *Second language development in writing: Measures of fluency accuracy and complexity*. Honolulu, HI: University of Hawaii at Manoa.
[34] Yan, W. (2019). Functions, Values & Inadequacies---An Evaluative Discussion of Pigai Intelligent Online English Writing Correction System in View of Second Language Acquisition. *In Journal of Physics: Conference Series*, *1237*(4) (pp. 042002). IOP Publishing. https://doi.org/10.1088/1742-6596/1237/4/042002

[35] Yang, F., Li, K., Zhu, Y., & Li, R. (2022). Educational Technology in Language Assessment: Enhancing Writing Assessment Literacy Through the Pigai AES System. In *Proceedings of the 8th International Conference on Frontiers of Educational Technologies* (pp. 41-45). https://doi.org/10.1145/3545862.3545869
[36] Yao, D. (2021). Automated writing evaluation for ESL Learners: A case study of Pigai system. *Journal of Asia TEFL*, *18*(3), 949. https://doi.org/10.18823/asiatefl.2021.18.3.14.949
[37] Yu, S., Jiang, L., & Zhou, N. (2020). Investigating what feedback practices contribute to students' writing motivation and engagement in Chinese EFL context: A large scale study. *Assessing Writing*, *44*, 100451. https://doi.org/10.1016/j.asw.2020.100451
[38] Zhang, F. (2022). Research on the Application of Pigai AWES in College English Composition Writing. *International Journal of Education and Humanities*, *4*(2), 92–95. https://doi.org/10.54097/ijeh.v4i2.1523
[39] Zhang, Q. (2022). Impacts of world Englishes on local standardized language proficiency testing in the expanding circle: A study on the College English Test (CET) in China. *English Today*, *38*(4), 254-270. https://doi.org/10.1017/S0266078421000158
[40] Zhang, Z., & Hyland, K. (2023). The role of digital literacy in student engagement with automated writing evaluation (AWE) feedback on second language writing. *Computer Assisted Language Learning*, 1-26. https://doi.org/10.1080/09588221.2023.2256815
[41] Zheng, Y. & Cheng, L. (2008). Test review: College English Test (CET) in China. *Language Testing*, *25*(3), 408-417. https://doi.org/10.1177/0265532208092433
[42] Zhu, W. (2019). *A study on the application of automated essay scoring in college English writing based on Pigai*. 5th International Conference on social science and higher education (ICSSHE 2019) (pp. 451–454). Atlantis Press. https://doi.org/10.2991/icsshe-19.2019.188

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