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The Effects of Learning Attributes on Students' Writing Performance

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Abstract

This research investigates how three students' learning attributes—attitudes, behavior, and English proficiency background contribute to the students' writing performance. Statistical methods explored three primary areas: (1) the influence of students' attitudes towards the students' choice of teaching methods and learning behavior, (2) the benefits of consultations in enhancing students' writing performance, and (3) the impact of the three factors—English proficiency background, online learning duration, and numbers of consultation—on students' writing performance. The study involved 29 first-year undergraduate engineering students. The results showed that the students with positive attitude towards English learning exhibited higher satisfactions and engagement, regardless of whether they followed a teacher-directed or self-directed method. This positive attitude had a substantial positive correlation with the satisfactions of both self-directed (r = 0.637) and teacher-directed (r = 0.447) methods. Additionally, the satisfactions of the self-directed method significantly correlated with the satisfactions of the teacher-directed method (r = 0.707) and with learning behavior through the teacher-directed method (r = 0.581). With notable differences in pre-test and post-test scores, the consultations were pivotal in enhancing writing performance of the students who participated in the optional extra-session (t = 8.846) when comparing to those who did not (t = 5.138). The data analysis using techniques namely Feature Importance and Univariate Selection indicated that online learning duration (the time spent on the teaching materials) had the most significant impact on the students' writing performance.

INTRODUCTION

Online platforms have gained unprecedented influence across various domains, enabling countless sectors to conduct business and activities on a global scale without constraints of time and location. Millions of individuals worldwide have adapted to working remotely and incorporating online applications into their daily lives. This pervasive shift extends to the realm

of education, where educators and learners alike are learning to harness the potential of online platforms, rendering traditional classroom settings non-essential. This transformation has prompted a meticulous examination of the myriad factors that impact online teaching and learning.

In response to this shift, diverse teaching methods, learning materials, and methods for assessing learner performance have emerged and been put into practice. Concurrently, the behavior exhibited by learners during online lessons has garnered significant attention due to its potential influence on learning outcomes.

In the context of Thailand, the educational landscape previously revolved around on-campus teaching and learning, wherein teachers could closely guide and support their students within the confines of a physical classroom. The vigilant gaze of instructors allowed for real-time monitoring of students' learning behaviors and performance, enabling immediate intervention in cases of potential learning challenges. However, this paradigm shifted dramatically a few years ago which prompted educational institutions at all levels to pivot towards online teaching and learning.

Subsequently, students found themselves learning from the comfort of their own homes, often facing suboptimal learning environments. Those accustomed to teacher-directed instructions may have struggled to maintain focus and engagement in the absence of in-person supervision. Consequently, observable shifts in students' learning behavior and performance became apparent across multiple dimensions. This research thus seeks to explore the factors that influence students' performance within the context of mixed-teaching methods, encompassing teacher-directed, self-directed and flipped-classroom, across both online and traditional classroom settings.

LITERATURE REVIEW

As traditional classrooms, particularly in higher education, have transitioned to online platforms, extensive research has been conducted to explore factors influencing the effectiveness of teaching and learning in this new paradigm. Abdallah and Abdallah (2022) identified several factors related to students, instructors, and administrative support that impact students' acceptance of e-learning. Weldon et al. (2021) highlighted the multifaceted nature of factors affecting satisfaction levels in online education, advocating for a tailored approach to ensure quality. Parker et al. (2021) underscored the importance of enhancing engagement and providing interactive experiences to promote academic success and sustained online learning.

However, the adoption of e-learning is not without its challenges, such as low training effectiveness and limited learner-instructor interaction, which can hinder learning performance (Im, 2021). Casey et al. (2021) emphasized the need for flexible, easily accessible online course delivery to ensure effective online education. Blended learning, a widely accepted approach combining traditional face-to-face instruction with technology-mediated elements, has gained popularity among educational institutions (Porter et al., 2014; Rasheed et al., 2020). The literature reveals

a spectrum of blended learning course designs, from incorporating online activities into traditional courses to developing entirely new blended learning experiences (Alammary et al., 2014). Banditvilai (2016) employed blended learning to enhance language skills and learner autonomy in an Asian university setting.

Flipped instruction, another effective approach, involves students independently studying course materials before class and utilizing in-class time for active learning and problem-solving (Lo & Hew, 2017). Recent studies (Akbarialiabad et al., 2021; Nouri, 2016; Zarrinfard et al., 2021) have demonstrated the effectiveness of flipped instruction compared to traditional in-class teaching. Web-based platforms have also revolutionized learning, enabling students to learn at their own pace and in their preferred environments. In the context of English language learning, these platforms facilitate interactions between teachers and students both inside and outside the classroom (Huiying, 2012; Wang, 2014; Zhi-ying & Hong, 2010).

Furthermore, in addition to teaching and learning approaches, research has delved into students' behavior patterns in online blended learning courses, often monitored using Learning Management Systems (LMS) (Dobre, 2015). Li and Tsai (2017) categorized computer science students' learning behaviors into three patterns based on LMS data and found correlations with learning performance. Macfadyen and Dawson (2010) highlighted the potential of LMS data for identifying at-risk students. The COVID-19 pandemic compelled a widespread shift to online learning, with both benefits and drawbacks. Online learning can foster effective attitudes but also create barriers (Giannoulas et al., 2021; Karasneh et al., 2021). Researchers have leveraged LMS data to investigate the impact of social isolation and pandemic-related fears on students' English proficiency (Raza et al., 2020).

Attributes, as defined by Laer and Elen (2017), encompass various facets and viewpoints. They typically pertain to the observable, measurable, or descriptive characteristics and qualities of entities or individuals.

Based on our empirical findings, positive learning attitudes promote constructive learning behaviors, which subsequently enhance academic performance. A study by Díez-Palomar et al. (2020) also supports this, suggesting that students who perceive their teachers as caring and credible exhibit greater engagement and motivation to participate in learning activities, leading to improved academic outcomes. This study highlights the importance of fostering a positive classroom climate where students feel supported and motivated, directly impacting their academic achievements.

Consequently, in this study, the attitude was determined as an independent variable, and students' satisfactions and learning behavior that were counted as dependent variables. Throughout the teaching and learning journey, the data was collected systematically for analysis. This research addresses the following questions:

1. What correlations can be identified between students' attitudes, teaching methods (teacher-directed, self-directed, and flipped-classroom), and their learning behavior?

2. How does the students' involvement in an optional extra-session affect their writing performance compared to those who do not participate in?

3. Among the students' English proficiency background (as indicated by the prior semester grade result), online learning duration, and the numbers of consultations with the teacher, which factor has the most pronounced impact on their writing performance?

RESEARCH METHODOLOGY

The participants in this study were twenty-nine first-year undergraduate engineering students who enrolled in a writing course at a technological university in Thailand. Their average English proficiency ranged from A2 to B1 level of Common European Framework of Reference (CEFR). The participants were selected by the convenience sampling technique. The experiment was conducted with research preparations started four months earlier. The analysis of the data had been done three months after the experiment. In total, the research spanned eleven months.

The course was run both on campus and online with a coursebook called Pathways: Reading, Writing, and Critical Thinking (Blass & Vargo, 2018). In this course, the students got practice writing a paragraph composing of a topic sentence, supporting details and a concluding sentence. This research focused on the writing skill because it can be assessed objectively, and the writing performance is likely to be clearly observed after getting practice for some time.

The research process consisted of four steps: experimental design, survey, data collection, and data analysis, as shown in Figure 1.

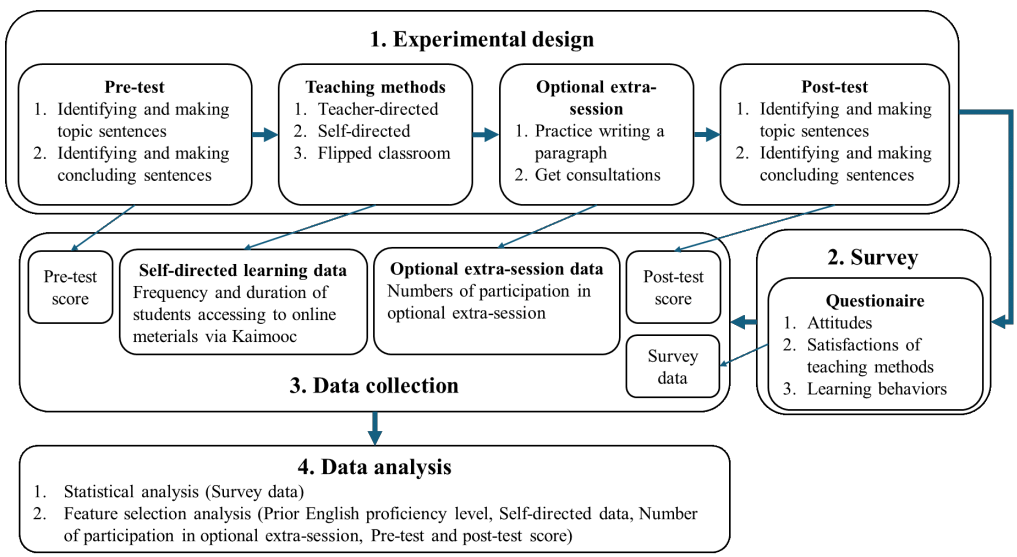

Figure 1 The research process

1. Experimental design

The experiment was mainly comprised of four activities: pre-test, teaching, optional extra-session, and post-test. The data from the experiment was collected and kept into the database together with the data from the survey which was conducted at the end of the course.

1.1 Pre-test

A pre-test was prepared in a paper-based version. It aimed at measuring the student's ability in a. identifying and making topic sentences and b. identifying and making concluding sentences. Therefore, the test was designed separately into two versions. Each version had two parts: A and B. There were six items in Part A. For each item, the students read a paragraph, and then they selected the best topic sentence or concluding sentence from the four choices provided. In Part B, there were two items. For each item, the students read a paragraph and created an appropriate topic sentence or concluding sentence by themselves. The reading paragraphs were taken from several writing coursebooks (Folse et al., 1999; Hogue, 1998; Savage & Shafiei, 2016).

1.2 Teaching methods

According to Muljana and Luo (2019), there are several factors contributing to student retention in online learning such as course design, at-all-times support for students, high-quality instructional feedback, and strategies. Some of those are integrated in this research started from course design, teaching methods, and data collection.

The selected coursebook contains five units, but only the first four units with different themes were presented. Each unit has two reading passages with the vocabulary preparation session at the beginning. The students read the passages and practiced identifying the main ideas and details of the paragraphs. This helped them get some ideas of how each paragraph was composed so that they would be able to create a well-organized paragraph in the later stage of the semester. In addition to the coursebook, the teaching materials were also prepared for studying online.

For writing skills, the focus was mainly on writing a strong topic sentence supported by logical details and writing a concluding sentence. Consequently, the students were required to complete a task—writing a paragraph containing at least one hundred words regarding the topic provided with the elements mentioned beforehand. To enable the students to complete this task individually, several steps including brainstorming, organizing ideas, writing a draft, revising, and editing were introduced to the class. An extra writing session was offered as an optional activity for the students who would like to have more practice outside the class hours. At the same time, several exercises were provided online via Learning Management System (LMS) program called Kaimooc.

During the semester, several teaching methodologies were implemented to find out whether they have any correlations with the students' writing performance. The architecture of the

online teaching was designed as presented in Figure 2. In the design, a technologist was appointed as a technological assistant such as Kaimooc program configuration, contents posting, data preparation, and data collection.

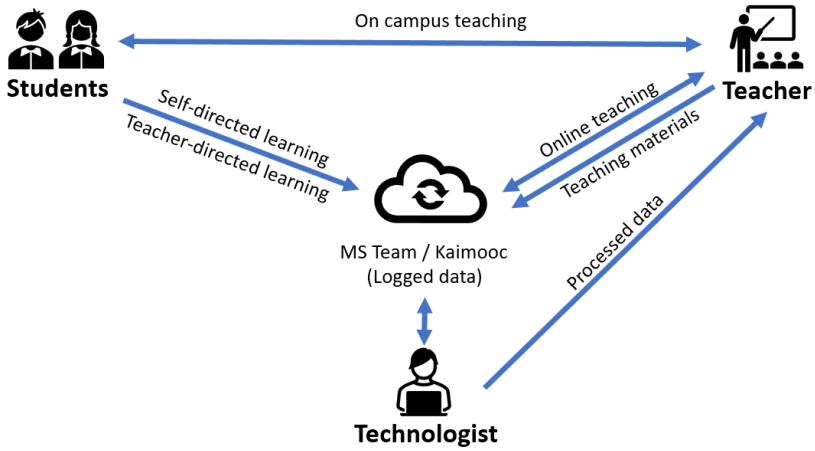

Figure 2 The architecture of the online teaching

A teacher-directed method was implemented in the early stage of teaching. The activities of the first unit were organized in the classroom on campus. After that, those of the second unit were run via an online platform called MS Teams which was still under the teacher's control. The students were all together and went through the activities step by step as similar as those managed in the typical classroom. Starting with the vocabulary preparation, a list of vocabulary was provided followed by exercises to check the students' understanding. The students were encouraged to participate in sharing the answers, and they were sometimes asked to pronounce the words, or read the sentences from the list. After building vocabulary, they studied the reading passage with the explanation given by the teacher, and the structure of the paragraphs was analyzed. At the end of the unit, the students got practice on writing skills.

Another teaching approach, flipped classroom, was applied after finishing the second unit. It was a combination of the teacher's instruction and the students' self-study. Before starting the third unit, the teacher prepared the teaching materials by recording video clips explaining the contents of the unit followed by the practice activities step by step, similar to those in Unit 1 and Unit 2. These video clips were posted on Kaimooc three days before the class schedule. The students were informed and asked to study the lessons and work on some activities of both reading and writing skills by themselves before attending the online class where the answers were shared and explained.

Lastly, a self-directed method, was applied only to the vocabulary and reading sessions of the last unit—Unit 4. With this method, the students totally managed the whole process of the study by themselves. After the teaching materials, video clips of the unit, were posted on Kaimooc, the students were informed and encouraged to study the lessons, work on the exercises and check for the answers provided in the answer key. Fifty-one videos as the teaching

materials were prepared and posted on Kaimooc. In addition, twenty-nine links to the YouTube channels with content related to the topics of the lessons were provided as a supplementary: twelve links for writing skills, thirteen links for reading skills and four links for describing graphs.

Therefore, the students were able to study at their learning pace and convenient time. Nonetheless, the students were still required to spend their time together with the teacher on the writing session to get some guidelines and feedback on the ideas and the language accuracy.

1.3 Optional extra-session

As mentioned above, for the students who wanted to improve their writing skills, they could participate in the extra writing session outside the class hours. There were five topics to work on. For each topic, the students wrote one paragraph containing at least 100 words. This session was not a compulsory of the course; therefore, the students could decide whether to attend or not. Furthermore, once they chose to get involve in this session, they could select as many topics as they would like to work on.

The writing process started by generating ideas. Then the ideas were organized in an outline format containing a topic sentence, supporting ideas with details and a concluding sentence. After that each student could come and get some advice on their ideas from the teacher before developing a first draft. Another feedback was given later when the students finished their paragraph, but it focused more on the vocabulary used, how the ideas connected, and the language accuracy. Also, these consultation sessions were optional.

1.4 Post-test

The post-test was used to evaluate the student's writing performance after learning and having some practices. The students took this post-test nearly at the end of the semester when they had finished the lessons related to the process of writing a paragraph. Like the pre-test, it measured the writing ability in two areas: a) identifying and making topic sentences and b) identifying and making concluding sentences. The post-test were designed in similar patterns as those of the pre-test, and the reading paragraphs were taken from the same resources. Unfortunately, this post-test was prepared and run online because of the pandemic situation.

2. Survey

The survey was conducted at the end of the semester. A questionnaire consisting of six parts was designed and distributed to each student via the Internet. In Part 1, the students stated their background including English grade result of the prior semester as well as the grade point average (GPA) of all subjects they have taken.

Part 2 explored the students' attitude towards English learning before enrolling in the university. The items are related to teachers, contents, teaching style, and experience in English usage. This attitude was determined as an independent variable which could have influence over the

students' satisfactions and learning behavior that were counted as dependent variables. The satisfaction of learning English via online teaching materials through self-directed method and the satisfaction of learning English through teacher-directed method (teaching preparation and supports) were investigated in Part 3 and Part 4 respectively by using Likert's five rating scale (Rensis, 1932).

Looking in more details, Part 3 clarified the satisfaction of learning English via online teaching materials through self-directed method. It was composed of three main issues: a) a program called Kaimooc – an introduction of a program, a format of the program and ways to access the program, b) video clips of the course contents – the uploading period, the length of each video clip, the quality of pictures, and the communication style, and c) the usage of materials via the program – re-accessibility, promoting of self-learning, being able to access at any time, the flexibility of content orders, the ease of getting to the suggested links, the relevancy of the links provided to the course contents, the relevancy of the exercises to the students' needs, the numbers of exercises, the usefulness of feedback, ways to contact the teacher, and the waiting time for getting feedback.

The satisfactions of learning English through teacher-directed method was clarified in Part 4. It included the document preparation, teaching materials, the appropriateness of teaching materials, giving clear explanation and easy to understand, offering opportunity to ask questions, providing clear answers, encouraging learning, checking understanding during the lessons, providing enough exercises, ways to contact the teacher, giving useful feedback, and having good reactions towards students.

In Part 5, the students specified their learning behavior when they studied the online teaching materials through self-directed method. This consisted of the average time spent when they had access to the lessons, the frequency of the access per week, the number of video clips they studied, and the activities they did while watching the video clips.

The data concerning class attendance, participating in the class activities, being focused on the lessons, working on exercises and homework was collected in Part 6 as the students' learning behaviors while learning online through teacher-directed method.

The statistical analysis of the questionnaire data was conducted meticulously, considering various measures to ensure the trustworthiness of the results, despite the limited number of participants. These analytical methods included the utilization of frequency distribution, percentage calculations, mean and standard deviation calculations, Pearson product-moment correlation coefficients, and t-tests for dependent samples. Furthermore, the reliability of the questionnaire was rigorously assessed using Cronbach's alpha coefficient. The results of this assessment provided valuable insights into the consistency and dependability of the questionnaire across different dimensions:

A. For attitudes towards English learning, the questionnaire demonstrated a reliability coefficient of 0.663.
B. Regarding students' satisfactions of the self-directed learning method, an impressive reliability score of 0.946 was obtained.

C. Similarly, the reliability score for students' satisfactions of the teacher-directed learning method was notably high at 0.916.
D. The reliability of the questionnaire in measuring students' learning behavior through the self-directed method yielded a commendable coefficient of 0.749.
E. Finally, for students' learning behavior through the teacher-directed method, the reliability score stood at a robust 0.872.

It is worth noting that, following the criteria established by George and Mallery (2003), items B and C demonstrated excellent reliability, items E and D showed good and acceptable reliability, respectively. While the reliability score for the attitudes towards English learning was deemed questionable, it remained above the threshold of unacceptability (which is typically set at less than 0.50). This comprehensive approach to assessing reliability, coupled with the adherence to established standards, contributes to the credibility and trustworthiness of the statistical results, even within the context of a limited sample size.

3. Data collection

When the class was run online via the program called MS Teams, the lessons were recorded and kept in the program. Thus, the students could watch the lessons again by themselves if there were anything they could not catch in the class. Also, this program recorded the data of the students' class attendance. It showed the exact time the students accessed the online class.

Kaimooc was used as a platform for the students to have access to the course materials which were prepared in two formats: the document files and video clips. The course description and the assessment criteria were provided at the beginning of the list followed by the documents of the lesson and video clips which were grouped into categories according to the contents of each unit. At the end of the unit, an extra exercise was also provided.

At the beginning of the course, a username and password used to access Kaimooc were distributed to each student. The system log data including the frequency of the access and the amount of time that each student spent on the teaching materials was collected throughout the course.

The data was collected through the entire period of the semester. It consisted of pre-test and post-test score, the learning log from Kaimooc: self-directed learning data which were the frequency and duration of students accessing to the online teaching materials. The teacher recorded the frequency of the students' participation in the optional extra-session. In the questionnaire, the students were asked to answer the questions about their attitude towards English learning, the satisfaction of the teaching methods and their behaviors during their learning.

4. Data analysis

There were two methods that we used to analyze the data: statistical analysis and feature importance analysis.

Prior to the data analysis related to the students' three main attributes, Table 1 presents the details of the students engaged in online teaching materials, focusing on the ways they accessed to the teaching materials and types of the teaching methods they preferred. A significant majority of students (69%) actively utilized the Kaimooc platform, with an additional 13.80% choosing to engage in collaborative learning by viewing lessons alongside their peers. In contrast, 10.30% of students reported accessing to the YouTube channel for learning purposes, while a smaller percentage (6.90%) indicated that they had not yet ventured into the realm of online teaching materials.

Table 1

Access to the online teaching materials and preference for teaching methods

Items	N	Percentage
Ways to access the online teaching materials		
- Access via Kaimooc (LMS)	20	69.00
- Access via YouTube	3	10.30
- View the materials with the classmates	4	13.80
- Never have access to the materials	2	6.90
Preferences for teaching methods		
- Self-directed	11	37.90
- Teacher-directed	5	17.20
- Combination of self-directed and teacher-directed	13	44.80

About the preferences for the teaching methods, it becomes evident that the students exhibited diverse inclinations. A substantial portion (44.80%) expressed a preference for a balanced approach, valuing both teacher-directed and self-directed methods.

4.1 Statistical analysis

Statistical Analysis was used to analyze the data from the survey about the students' attitudes and the effects of the optional extra-session.

For the students' attitude, five factors were considered: a) the attitude towards English language learning, b) the satisfaction of self-directed method, c) the satisfaction of teacher-directed method, d) learning behavior when studying through a self-directed method, and e) learning behavior when studying through a teacher-directed method.

For the effects of the optional extra-session, we investigated how the following two factors: the participation in the optional extra-session and the frequency of receiving consultations contribute to their writing performance.

4.1.1 Student's attitudes

As depicted in Table 2, the average scores for attitudes towards English learning, encompassing teachers, contents, teaching methods, and prior experience, were notably high. Additionally, the average scores for the satisfactions of both self-directed and teacher-directed methods, as well as learning behavior through teacher-directed learning, also exhibited high ratings.

Table 2

Level of attitudes towards English learning, satisfactions and learning behavior when studying through the different methods

Factors	$\bar{x}$	S.D.	Value
Attitudes towards English learning	3.793	0.495	High
Satisfactions of self-directed method	3.936	0.523	High
Satisfactions of teacher-directed method	4.132	0.517	High
Learning behavior through self-directed method	2.577	0.807	Low
Learning behavior through teacher-directed method	4.009	0.541	High

To explore the relationships among these five factors—(A) attitudes towards English language learning, (B) satisfactions of self-directed methods, (C) satisfactions of teacher-directed methods, (D) learning behavior through self-directed methods, and (E) learning behavior through teacher-directed methods—the Pearson product-moment correlation coefficient was employed. The resulting correlations are presented in Table 3.

Table 3

Correlations among five factors

Factors	A	B	C	D	E
A		0.637**	0.447*	-0.276	0.341
B			0.707**	-0.003	0.581**
C				0.135	0.586**
D					0.167
E					

Note. A = Attitudes towards English language learning, B = Satisfactions of self-directed method, C = Satisfactions of teacher-directed method, D = Learning behavior through self-directed method, E = Learning behavior through teacher-directed method

**. Correlation is significant at the 0.001 level (2-tailed).

*. Correlation is significant at the 0.050 level (2-tailed).

The results showed that the attitudes towards English language learning had a significantly positive correlation to the satisfactions of self-directed method (r = 0.637) and the satisfactions of teacher-directed method (r = 0.447) at statistical level 0.001 and 0.050 respectively. It can be said that the students with positive attitudes towards English learning will have satisfactions of both self-directed and teacher-directed methods.

The satisfactions of self-directed method had a significantly positive correlation to the satisfactions of teacher-directed method (r = 0.707) and to the learning behavior through teacher-directed method (r = 0.581) at statistical level 0.001, but it did not show a significant correlation to the learning behavior through self-directed method. It means that the students who had the satisfactions of self-directed learning method also had the satisfactions of learning with the teacher and they behaved well when being with the teacher.

Additionally, the data indicates that the satisfactions of teacher-directed method had significantly positive correlation to the learning behavior through teacher-directed method (r = 0.586) at statistical level 0.001. With the satisfaction of learning with the teacher, the students paid

more attention to the lesson and actively participated in the activities. Lastly, it can be noticed that the attitudes towards English language learning had insignificantly correlation to the learning behavior through self-directed method.

In summary, students with favorable attitudes towards learning English tend to derive satisfactions from various learning methods. Furthermore, those who find self-directed learning satisfying also tend to be content with teacher-directed learning and display positive learning behaviors.

4.1.2 Effects of the optional extra-session

To investigate the impact of participation in the optional extra-session on writing performance, the students were categorized into two groups: Group 1, who engaged in the extra writing activity with consultations, and Group 2, who participated in the activity without consultations, as outlined in Table 4. Additionally, Table 5 illustrates the correlations among non-participation in the extra-session, participation in this extra-session with consultations, and participation in the session without consultations.

Table 4

Comparison of writing performance between having consultations and not having consultations

Test	N	Score				*t*	*p*
		Pre-test		Post-test			
		$\bar{x}$	S.D.	$\bar{x}$	S.D.		
Topic: Making topic sentences							
Overview	29	2.070	1.746	6.560	1.909	10.136**	.000
Group 1	19	1.840	1.415	6.240	1.966	8.846**	.000
Group 2	10	2.500	2.273	7.180	1.724	5.138**	.001
Topic: Making concluding sentences							
Overview	29	2.950	1.617	6.000	1.397	8.908**	.000
Group 1	19	2.500	0.957	5.930	1.343	10.700**	.000
Group 2	10	3.800	2.251	6.130	1.560	3.059*	.014

Note. Group 1 = Participation in the activity with consultations, Group 2 = Participation in the activity without consultations

**$p \leq 0.001$, *$p < 0.050$

As can be seen from Table 3, the overview mean score of the pre-test of the first topic, making topic sentences, was 2.070, and the post-test mean score was 6.560 ($t = 10.136$, $p \leq 0.001$). It can be noticed that the score of the students who participated in the activity with consultations indicates the higher difference ($t = 8.846$) than of those who participated in the activity but did not get consultations ($t = 5.138$) at the statistical level of 0.001.

When looking at the writing performance of the second topic, making concluding sentences, the overview mean score of the pre-test was 2.950, and that of the post-test was 6.000 ($t = 8.908$, $p \leq 0.001$). For more details, the score of the participants who attended in the activity with consultations showed the difference $t = 10.70$ which was higher than the ones who did not get consultations ($t = 3.059$) at the statistical level of 0.001 and 0.050 respectively.

Table 5

Correlations among three variations concerning the optional extra-session

Variations	Not participated in the session	Participated in the session without consultations	Participated in the session with consultations
Writing performance	-0.528**	-0.251	0.564**

Note. ** Correlation is significant at the 0.001 level (2-tailed).

The results in Table 5 revealed that not participating in the extra writing activity has a negative correlation with writing performance (r = -0.528), whereas participating in the activity with consultations demonstrates a positive correlation with writing performance (r = 0.564) at a statistical significance level of 0.001. In other words, the students who engaged in the activity with consultations showed improvements in their writing performance, while those who did not participate experienced a decline.

Both Table 4 and Table 5 consistently suggest that the students who attended the optional extra-session with consultations achieved higher scores in post-tests and displayed enhanced writing performance.

4.2 Feature importance analysis

A feature importance analysis of machine learning method was used to find out that among these three factors: a) English proficiency background, b) online learning duration, and c) the number of consultations, which one affects the students' writing performance most.

In this study, a machine learning technique known as feature importance analysis was used to investigate three factors that are likely to have influence on their progress in writing performance. These three factors are:

a) English proficiency background: This factor indicates the student's level of proficiency in the English language which is determined by their grade result from the previous semester.
b) Online learning duration: It quantifies the amount of time each student dedicates to accessing online teaching materials.
c) Numbers of consultation: This factor measures how often each student seeks consultations with their teacher.

To determine which of these factors holds the highest importance in predicting English writing progress which is determined by the score change calculated from the differentiation between the post-test score and pre-test score. We employed three distinct techniques:

1. Feature Importance Analysis: We conducted feature importance analysis using three classifiers from the sklearn library. This approach helps identify the most influential features in predicting outcomes.
2. Chi-Square Univariate Selection: We applied a Chi-square analysis, a statistical method, for univariate selection. It helps pinpoint which feature(s) exhibit the most significant associations with the outcomes.

3. ANOVA Univariate Selection (Analysis of Variance): ANOVA, another statistical method, was utilized for univariate selection. Similar to the Chi-square method, it assists in identifying the feature(s) with the most substantial impact on the outcomes.

The data for these three factors of each student can be found in Table 6. Specifically, the students' proficiency is represented by their prior semester's grade results, which are mapped to a numerical scale, ranging from A (equivalent to 8) to D (equivalent to 2). The "Online Learning Engagement Time" feature indicates the duration, in minutes, that each student spent accessing online teaching materials. The "Numbers of consultation" reflects how often each student sought consultations with their teacher. Lastly, "Score Change" represents the difference between pre-test and post-test scores, serving as a measure of their progress.

Table 6

Data set for feature importance analysis

N	English proficiency background	Online learning duration	Numbers of consultation	Score change
1	2	173	6	20
2	8	76	0	0
3	5	0	6	46
4	3	94	3	47
5	7	0	0	11
6	4	68	4	24
7	6	31	0	49
8	3	106	2	22
9	5	108	6	32
10	3	3	0	21
11	8	229	0	19
12	6	181	2	37
13	6	118	6	30
14	2	492	7	20
15	4	19	3	42
16	4	50	2	24
17	3	77	4	22
18	2	88	2	50
19	8	106	0	35
20	3	145	3	29
21	2	46	2	46
22	2	61	0	31
23	2	19	0	60
24	4	112	0	32
25	3	230	4	24
26	6	259	0	34
27	3	86	4	22
28	2	101	5	28
29	2	296	3	30

Table 7

Feature importance analysis result

Techniques	English proficiency background (Rank)	Online learning duration (Rank)	Numbers of consultation (Rank)
Feature Importance	0.290 (2)	0.473 (1)	0.236 (3)
Univariate Selection (Chi-Square)	8.496 (2)	711.145 (1)	2.847 (3)
Univariate Selection (ANOVA)	1.780 (2)	2.220 (1)	0.240 (3)

Table 7 illustrates an analysis of three influential factors on writing performance. These factors encompass the students' English background knowledge, which is determined by their prior semester grades. Online Learning Engagement Time is the amount of time dedicated to the online learning materials within the educational program, and Numbers of Consultation indicates the frequency of consultations sought. The ranking of score changes highlighted a consistent pattern: the most significant impact on students' writing performance is attributed to Online Learning Engagement Time (indicated in column 3), followed by English proficiency background (column 2), and Numbers of Consultation (column 4).

DISCUSSION

Based on the data analysis, the results indicated that the students with positive attitudes towards English learning tend to have more satisfactions of various teaching methods (Table 3). In Table 1, preferences can be considered a part of attitude, especially in the context of psychology and decision-making research. Attitudes are evaluations of an object, person, or concept that can include positive or negative feelings. Preferences, on the other hand, are a specific type of attitude where a person favors one option over another (Betsch, 2011). Studies suggest that preferences are a stable form of attitude (Ding & Yang, 2023). The results showed that most students preferred a combination of teacher-directed and self-directed learning methods. This preference is further confirmed by the results in Table 2, which showed that students were satisfied of both self-directed and teacher-directed methods. In addition, when learning through a teacher-directed method, they exhibited positive learning behaviors that could be clearly observed such as active participation in the activities, showing regular attendance, and completion of exercises. Notably, the detailed responses from the questionnaire revealed that the average learning behavior score was lower when students adopted a self-directed method. Some students acknowledged occasional lapses in focus during lessons and frequent online conversations with friends as potential distractions.

Both Table 4 and Table 5 consistently demonstrate that students who participated in the optional extra-session with teacher consultations achieved higher post-test scores and exhibited enhanced writing performance. On average, the students who received consultations showed a greater improvement between pre-test and post-test scores compared to those who did not. However, it is important to note that high-proficiency students, having already performed well,

exhibited minimal differences between their pre-test and post-test scores. This group typically favored self-study, whereas lower-proficiency students benefited more from consultations with teachers, which significantly improved their post-test scores indicated by the correlation score. Research by Ferris (2003) also highlighted that regular writing consultations can contribute to long-term improvement in students' writing abilities, as they gain a better understanding of the writing process and how to apply feedback. Therefore, consultations appear particularly valuable for students with lower language proficiency, contributing significantly to their overall performance. Another study by Goldstein and Conrad (1990) found that students who participated in one-on-one writing conferences with their teachers showed significant improvements in writing accuracy and coherence.

Finally, the data in Table 6 were analyzed to determine which of the three factors—English proficiency background, online learning duration, and frequency of teacher consultations—had the most substantial influence on writing performance, as measured by the 'score change'. The findings provided valuable insights into the key determinants of student success in writing performance. The results in Table 7 revealed that the students who invested more effort and time in studying teaching materials tend to experience greater improvements in their writing performance. This underscores the critical role of dedicating time to studying, which significantly enhances students' writing performance.

CONCLUSION

This research followed four steps: experimental design, survey, data collection, and data analysis. Throughout these steps, comprehensive data were systematically recorded, accompanied by a survey that captured the students' attitudes towards English learning, satisfactions of three teaching methods: teacher-directed, self-directed, and mixed methods via flipped classroom and the student's learning behavior. The data gained from the questionnaire was analyzed to find the correlations among the five factors of the students' attitudes. Despite the relatively small sample size, the analysis of questionnaire data was conducted systematically to ensure the reliability of the findings.

Twenty-nine students participated in the experiment, with nineteen actively engaging in the optional extra-session. This extra-session assessed the impact of participation in consultations on the students' writing performance compared to those who did not participate in the session.

Additionally, the study employed machine learning techniques, specifically feature importance analysis, to explore the influence of three key factors on students' English learning progress: a) English proficiency background, b) online learning engagement time, and c) numbers of consultation.

In the first part of the research, we examined students' attitudes towards English learning. The results revealed that nearly 80% of students had access to online materials. Most students expressed satisfaction with a blend of teacher-directed and self-directed approaches. Among the five factors analyzed—attitudes towards English learning, satisfactions of self-directed

methods, satisfactions of teacher-directed methods, learning behavior in self-directed methods, and learning behavior in teacher-directed methods—the satisfactions of self-directed learning exhibited the highest positive correlation with the satisfactions of teacher-directed learning. These findings highlighted the students' preference for a combination of self-directed and teacher-guided methods, which allows for both autonomy and guidance.

The second segment of the research emphasized the positive impact of consultations on the students' writing performance. Given the complexity of the writing process, from brainstorming to editing, it is recommended that students receive training in idea development early on, followed by language accuracy feedback in later stages. Teachers are encouraged to have students document common errors identified during consultations to foster attention to detail, especially for lower-proficiency students. Several studies, such as Hyland (2013), have shown that consultations and teacher feedback are particularly beneficial for low-proficiency learners, who often require more direct support and instruction.

In the final section, the study examined three factors influencing writing performance. While the students with stronger academic backgrounds tend to learn more quickly and grasp lessons better, consultations can still significantly enhance their performance, particularly in the writing tasks. However, feature importance analysis clearly demonstrated that the time dedicated to studying teaching materials had the most significant impact on writing performance.

The challenges of teaching and learning in the digital age persist. Although online resources are abundant, it remains essential for teachers to tailor materials to the curriculum and students' proficiency levels. Alongside varied teaching methods, teachers should curate resources from diverse sources, categorize them, and encourage students to utilize them. Feature importance analysis reinforces the importance of effort and time invested in studying materials for learning improvement. Moreover, teacher consultations are particularly valuable for students with lower proficiency, as they may struggle to comprehend materials independently.

In conclusion, to enhance writing performance, a balanced blend of teacher-directed and self-directed methods should be integrated into the teaching process. Additionally, fostering positive learning attitudes, encouraging students to allocate time to studying materials, and providing feedback on their work are critical.

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