Language Learning & Technology
ISSN 1094-3501 CC BY-NC-ND

2022, Volume 26, Issue 1
pp. 1–40

ARTICLE

Toward a flipped 5E model for teaching problem-solution writing in ESL courses: A two-year longitudinal experiment

Yau Wai Lam, *The University of Hong Kong*

Khe Foon Hew, *The University of Hong Kong*

Chengyuan Jia, *The University of Hong Kong*

Abstract

Many English-as-Second-Language (ESL) learners find it highly challenging to write problem-solution essays. This difficulty is partly caused by the pedagogies commonly used in traditional classroom settings, which have two major in-vivo constraints: time limits and low student engagement. This study proposes an innovative theory-driven instructional model for teaching problem-solution writing, namely the flipped 5E PSW (problem-solution writing) model. The flipped 5E PSW model is built upon three theoretical or conceptual models: (a) Jonassen's design theory for case/policy analysis problem-solving, (b) the flipped learning model, and (c) Bybee's 5E learning model. Two groups of 23 ESL secondary school students, both taught by the same teacher, were assigned to either the flipped or non-flipped versions of the instructional model. The students were assessed individually over a two-year longitudinal experiment to measure the impact of the intervention. The results, as measured by mixed ANOVAs, indicated that the flipped 5E PSW model was more effective than the non-flipped version for improving students' performance in problem-solution writing. This application of the flipped 5E PSW model in a two-year real-world school environment has demonstrated its capacity for overcoming traditional classroom constraints.

Keywords: *ESL Writing, Problem-Solution Writing, Flipped Classroom Approach, Longitudinal Study*

Language(s) Learned in This Study: *English*

APA Citation: Lam, Y. W., Hew, K. F., & Jia, C. (2022). Toward a flipped 5E model for teaching problem-solution writing in ESL courses: A two-year longitudinal experiment. *Language Learning & Technology*, *26*(1), 1–40. http://hdl.handle.net/10125/73467

Introduction

The problem-solution pattern of text organization appears quite consistently across various languages and cultures (Hoey, 2001; Flowerdew, 2008). This pattern is essentially constructed of four elements: situation, problem, solution, and evaluation (Flowerdew, 2008; Hoey, 2001; Jordan, 1984; Winter, 1977). Typically, the problem-solution pattern starts with describing the background situation. Then, an issue arising from that situation is identified. After that, possible ways to tackle the issue are discussed, along with assessments regarding the effectiveness of the proposed interventions (Nordquist, 2019).

Effective written communication using the problem-solution pattern is a fundamental competency for academic English writers (Phelan & Halpern, 2018), and a critical writing skill for English-as-Second-Language (ESL) learners (Flowerdew, 2008). Therefore, investigating this pattern as a writing genre (i.e., the problem-solution genre of writing) could be very valuable for both teachers and learners. In current teaching practice, at least two major in-vivo constraints make it difficult for teachers to help ESL learners in developing their problem-solution writing skills. These constraints include limited class time and low student engagement.

In this study, a theory-driven instructional model, the flipped 5E PSW (problem-solution writing) model, is proposed for the effective teaching of problem-solution writing. The flipped 5E PSW model is based on

three theoretical perspectives: (a) Jonassen's design theory for case/policy analysis and problem-solving, (b) the flipped classroom learning model, and (c) Bybee's 5E learning model. We hypothesize that the flipped 5E PSW model can more effectively teach problem-solution writing to ESL learners than the non-flipped version. To test this hypothesis, we conducted a two-year longitudinal experiment to compare the results from the flipped 5E PSW model and its non-flipped counterpart.

Before describing the flipped 5E PSW model in detail, we first present a brief overview of the current state of research on problem-solution writing, followed by an explanation of this study's main purpose and the research questions it seeks to answer.

Research on Problem-Solution Writing

The problem-solution pattern, as applied at the essay level, has been examined in previous studies of English language education. These studies have referred to this type of writing as the "problem-solution essay," the "problem/solution essay," or "problem-solution writing." These terms all describe the same genre, and they may be considered interchangeable for the purposes of this study. The following is an example of a problem-solution writing question:

> You are working on a project entitled 'Helping NEETs.' NEETs are young people who are not in education, employment or training. Many of these young people spend their time at home playing video games or surfing the Internet. Write a report to explain why the number of NEETs is rising and suggest what can be done to help these youths. Give reasons to support your suggestions. (Adapted from the Hong Kong Examinations and Assessment Authority, 2017)

For most students, learning to become a competent writer requires deliberate instruction, which usually occurs in a school setting. Although problem-solution essays have been of research interest for ESL educators around the world (e.g., Ander & Yıldırım, 2010; Hojeij & Hurley, 2017; Kırmızı, 2018; Tessema, 2005; Tiruchittampalam et al., 2018), few studies have explicitly investigated how to teach this genre of writing at the secondary school level. Kırmızı (2018) investigated lexical transfer in the ESL writing of Turkish university students by studying data from eight genres of essays, one of which was the problem-solution essay. Tiruchittampalam et al. (2018) measured the effectiveness of writing center consultations for improving the essay-writing skills of university ESL students at a university in the Gulf region. They did this by examining three genres of writing, one of which was the problem-solution essay. These previous studies, however, have offered little insight into the specific challenges of teaching problem-solution writing, particularly at the K-12 education level, and ways to circumvent these challenges.

Other studies have attempted to use technology-infused pedagogy such as flipped learning to enhance student problem-solution writing. Hojeij and Hurley (2017), for example, described a mobile flipped learning environment to help ESL pre-university female students in the United Arab Emirates write problem-solution essays. However, the actual strategy used by the researchers to instruct problem-solution writing was not elaborated. The study was also limited by the short duration of the pedagogical implementation—only one semester long. Learning to write strong problem-solution essays is not an easy task, especially for younger ESL students, and may take longer than one semester to master.

Prior scholars have suggested that many ESL learners find problem-solution writing to be one of the most difficult genres to perform. Common problems include the choice of vocabulary (Flowerdew, 2000; Flowerdew, 2003; Milton, 2001), organisation (Carrell, 1984; Meyer, 1982), and content (Cerbin, 1988; Jonassen, 2011; Marzano et al., 1988).

Choice of Vocabulary

ESL learners are especially weak in using language to express causal relationships (Flowerdew, 2003). Another major issue is problematic verb choice, as found by corpus-based studies on the use of English by tertiary students in Hong Kong (Flowerdew, 2000; Milton, 2001). For instance, students write "It rises a problem that…" instead of "It creates a problem that…" indicating confusion between cause and effect verbs.

Organisation

Concerning textual organisation, Carrell (1984) found ESL students have difficulties presenting their arguments logically and clearly. It is common to see students include "disorganized lists of ideas" (p. 7) in a paragraph, rather than express a main point and link it to relevant elaborations. Mayer (1982) also found ESL students to be weak in organising and structuring their text unless explicit instruction of text structures is given.

Content

Students tend to find that problem-solution writing is demanding in terms of content development. Jonassen (2011) argued that learners who are accustomed to examining facts and truths (of a type that Baxter-Magolda (1987) called "absolute knowing") are typically wary of reasoning in cases where there is no correct answer. Such caution is especially common among people who are writing in their second language. For ESL learners, problem-solving writing involves the "ambiguity implicit in any uncertain solution" (Jonassen, 2011, p. 125). This type of writing requires analyzing the viewpoints of different stakeholders and applying many complex cognitive processes (including interpretation, rationalization, analysis, and evaluation) to reach measured conclusions (Marzano et al., 1988). Unsurprisingly, many students tend to simply reiterate sources without thinking them through thoroughly (Cerbin, 1988).

Existing frameworks for teaching problem-solution writing

Historically, most research on problem-solution has focused on issues related to science, engineering, and mathematics. For example, in mathematical problem-solving, Polya's (1957) model used four steps to solve all types of mathematical problems: (1) understand the problem, (2) make a plan, (3) conduct the plan, and (4) evaluate its effectiveness. However, Polya's model, as well as other models of mathematical or scientific problem-solving, may not be applicable for teaching problem-solution writing to K-12 ESL learners (Jonassen, 2011).

One reason for this lies in the structuredness of the problems considered. Basically, mathematical problems are well-structured, but real-world problems are ill-structured (Jonassen, 2011). In well-structured problems, all the problem-related information can be presented. These problems simply require that a fixed number of principles be applied, and the questions have answers that can be proven correct and convergent. Ill-structured problems, however, do not present all of the relevant information (Wood, 1983), and these problems may have either many possible answers, or no presently feasible solutions (Kitchner, 1983). These kinds of problems usually require expressions of personal belief or intention concerning the problem at hand (Jonassen, 2011).

In secondary school curricula, ESL problem-solution writing topics generally feature *policy problems* extracted from newspapers or other media. Policy problems are ill-structured because they are complex. They require evaluation of multiple perspectives, and they have no single correct answer (Jonassen, 2011). Such problems cannot be approached in the same way as the well-structured problems that are taught in science and mathematics classes.

Several models exist for teaching students how to do policy problem-solution writing. Some examples of these models are the Patton and Sawicki (1986) six-step method and the eight-process method proposed by Bardach (2000). However, both methods are specifically designed for use by policy makers; they are not directly applicable for instruction on problem-solution writing in ESL classes.

Purpose of this Study and Research Questions

The main purpose of this study was to address the aforementioned gaps in instruction for problem-solution writing. We developed an instructional model for teaching problem-solution writing to ESL secondary school students, which we called the flipped 5E PSW (problem-solution writing) model. We then tested the effectiveness of this model using a quasi-experimental design approach. Our study was guided by the following research questions:

1. How do the writing scores of students using the flipped 5E PSW model compare with those using a non-flipped model?
2. How do students and their teacher perceive the flipped 5E PSW model?

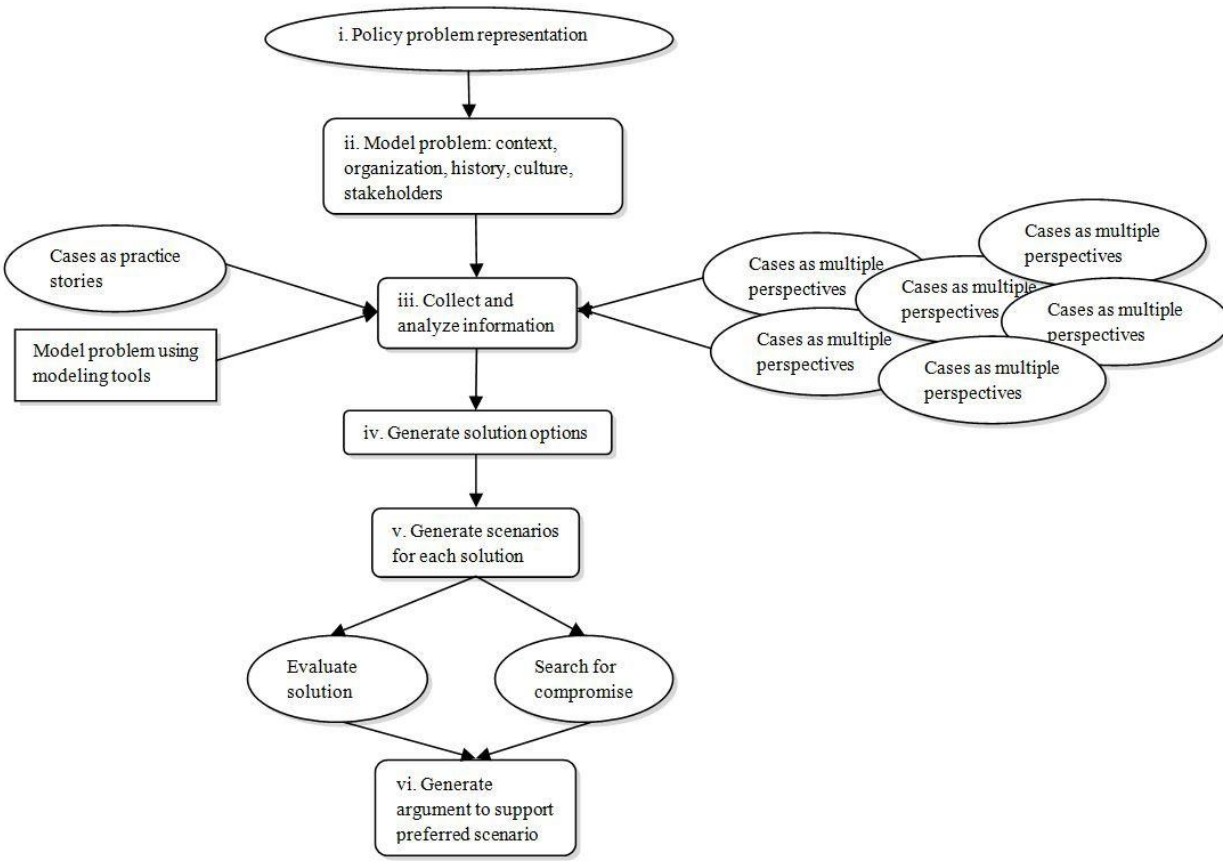
Toward a Flipped 5E PSW (Problem-Solution Writing) Model

The Jonassen Model for Case/Policy Analysis Problem-Solving

The first theoretical framework that informs the flipped 5E PSW model is Jonassen's model (2011) for case/policy analysis in a problem-solving environment. Jonassen (2011) investigated real-life policy problems and devised a broadened model for considering different perspectives and the need for compromise (see Figure 1). We chose Jonassen's (2011) model as the core foundation of the flipped 5E Problem-Solution Writing model based on the following two reasons. First, Jonassen's model for the case/policy analysis problem-solving environment facilitates learners' problem-solving process. The stepwise procedure of this method provides a sound instructional sequence to guide students in understanding and analysing problems, and generating solutions and arguments (Jonassen, 2011). Second, the model has been commonly used in educational settings to design problems, scaffold problem-solving, and foster argumentation (Jonassen & Cho, 2011; Kim & Hannafin, 2011). Therefore, we chose this model as the foundation of our flipped 5E PSW model.

Figure 1

Jonassen's (2011) Model for Case/Policy Analysis in a Problem-solving Environment



The six steps for analyzing the problem-solution environment, along with some short examples in each step, are detailed in Table 1 as follows:

Table 1

Summary of the Six Steps of the Jonassen's (2011) Model

Jonassen's (2011) model	**Description**	**Example (student tardiness as problem)**
i. Policy problem representation	Represent problems and cases as stories. Stories are better understood, better remembered, and more empathic than didactic representations.	Introduce the problem of student tardiness by telling a story of a boy who is always late for school.
ii. Model problem	Construct models of problems using modelling tools to gain a greater understanding of the relationships between problem elements.	Using online mind-mapping tools or flowchart tools, learners could be asked to construct a causal model (e.g., why are students late for school?)
iii. Collect and analyse information from multiple perspectives	Collect information through research and examine different interpretations and perspectives of the problem.	Learners could be asked to do research on the issue of student tardiness and strategies used to tackle the issue. They could also inspect the issue from different perspectives (e.g., the school perspective or the parents' perspective).
iv. Generate solution options	Generate proposed solutions.	Students proposed potential solutions, for example, schools rewarding punctual students.
v. Generate scenarios for each solution	Consider the circumstances of the scenarios and how each proposed solution might change those scenarios.	Questions such as "What if tardiness is caused by x? Does this solution really solve the problem?" can help guide learners to evaluate alternative solutions, and to develop cogent arguments to support their proposed solution.
vi. Generate arguments to support preferred solution	Provide relevant arguments to support a chosen solution. The solution may be a compromise or a best single solution.	

Although the stepwise procedure of the model can guide students in understanding and analyzing problems, this model has two limitations that prevent its effective implementation in secondary school classrooms: time constraints and low levels of engagement.

Time Constraints

In general, previous researchers (e.g., Lawson, 2002) have divided teaching into two phases: (1) the content attainment phase, where students first develop an understanding of the relevant concepts, and (2) the concept application phase, where students use their understanding to perform analyses and evaluations. Under common classroom practices, the content attainment phase occurs *during* class, and the concept application phase comes in the form of assignments to be completed *after* class. This model of learning restricts the opportunities for questions and discussions during the concept application phase, which is actually the more challenging phase. Although some teachers attempt to conduct both phases in class, due to the limits on class time it is unavoidable that the concept application phase is handled in an abbreviated way (Mason et al., 2013).

Low Levels of Engagement

In-depth discussions are difficult to achieve in a traditional classroom setting because the students need time to understand information and explore ideas, and time is typically not scheduled for this purpose. As a result, students are often poorly engaged in their learning activities. A further complication is that some students require more time for thinking or need individual attention. Without allowance for such personal needs, many students are inclined to abstain from discussions. In that case, participation in the discussion is commonly limited to a few of the higher-ability learners (Bhagat et al., 2016), and other learners are denied the chance to become engaged in the discussions.

Moreover, students are commonly afraid of making mistakes, and they often prefer to simply copy down what the teachers say, and "rote learn" those perspectives (Samuelowicz, 1987, p. 123). Such rote learning constricts learning to the content attainment phase. If the students simply repeat the modelled answers in their assignments, they cannot independently reach the concept-application phase. Therefore, the goal of problem-solution writing (which is to develop the students' capacity for independent thought) becomes very difficult to attain.

Clearly, Jonassen's model would work much better if it could be applied in conjunction with other instructional models that can address the aforementioned challenges. This study therefore suggests that two models, namely the flipped classroom learning model and Bybee's 5E learning model, can be incorporated into Jonassen's model to overcome the practical difficulties in the teaching of problem-solution writing.

Flipped Classroom Learning Model

Flipped learning was incorporated into the flipped 5E PSW model because it can potentially alleviate the aforementioned two in-vivo constraints (time restrictions and low engagement of students). First, the flipped model allows enough time for students to process new information without overloading their working memory, and it permits sufficient class time for student discussions (Abeysekera & Dawson, 2015). When a flipped classroom is used, learning can take place at home, and the self-paced pre-class video lectures can help students to manage their working memory, as they can replay the video content if they find it difficult to understand (Clark et al., 2005). Therefore, the face-to-face class time can be spent on applying the concepts that the students learned at home, rather than on direct lecturing. This approach can solve the time constraint problem.

Second, the flipped learning model can provide students more in-class time for active learning. Active learning methods such as problem solving and peer discussion can help students construct better understanding of the subject material (Bransford et al., 1999). Recent research has found that active learning can positively affect student outcome (Deslauriers et al., 2019).

To maximize the effectiveness of the flipped classroom in our experiment, we followed certain guidelines that were grounded on previous flipped learning studies: (a) using instructor self-created videos, (b) setting optimal lengths of videos, and (c) providing content notes to prompt note-jotting.

In general, videos are found to be more appealing to students than reading materials (Herreid & Schiller,

2013). In addition, instructor self-created videos are found to be more effective than videos that do not feature the instructor (Williamson, 2018). As young learners have short attention spans, the length of an instructional video has to be short. Guo et al. (2014) found that the optimal length of one instructional video is no longer than six minutes. It should also be noted that students often have a certain amount of other homework and extra-curricular activities after school. Therefore, it is important to avoid overburdening learners with pre-lesson tasks. The combined time needed to go through all videos for lesson preparation should not exceed 20 to 25 minutes (Lo & Hew, 2017).

To help learners consolidate what they have learned from the instructional videos, it is also helpful to provide content notes. Such brief summaries can make a significant difference for learning effectiveness (Lo & Hew, 2017; Snyder et al., 2014). Some students have a tendency to daydream or lose track of the videos they are watching if they are not taking notes. Thus, providing learners with content notes prompts them to write down the key points they have learned. Furthermore, this process allows teachers to assess their students' note-taking and evaluate their pre-lesson learning at the beginning of the class (Clark, 2015).

Bybee's 5E Learning Model

Third, we chose Bybee's 5E learning model as a last framework for the proposed flipped 5E PSW model. The 5E model was influenced by the constructivist theoretical perspective on learning, and it encourages students to independently interpret issues or phenomena, rather than being explicitly told what to think by their teachers (Bybee, 1997). In the 5E model, students are given the opportunity to explore and form initial understanding on their own before the teacher provides more direct guidance or offers explanations that the students could not be expected to discover independently. The focus is on active learning, which can increase student understanding of the topic (Deslauriers et al., 2019). The 5E model emphasizes five key stages, namely *Engagement*, *Exploration*, *Explanation*, *Elaboration*, and *Evaluation*. The details of these stages are as follows:

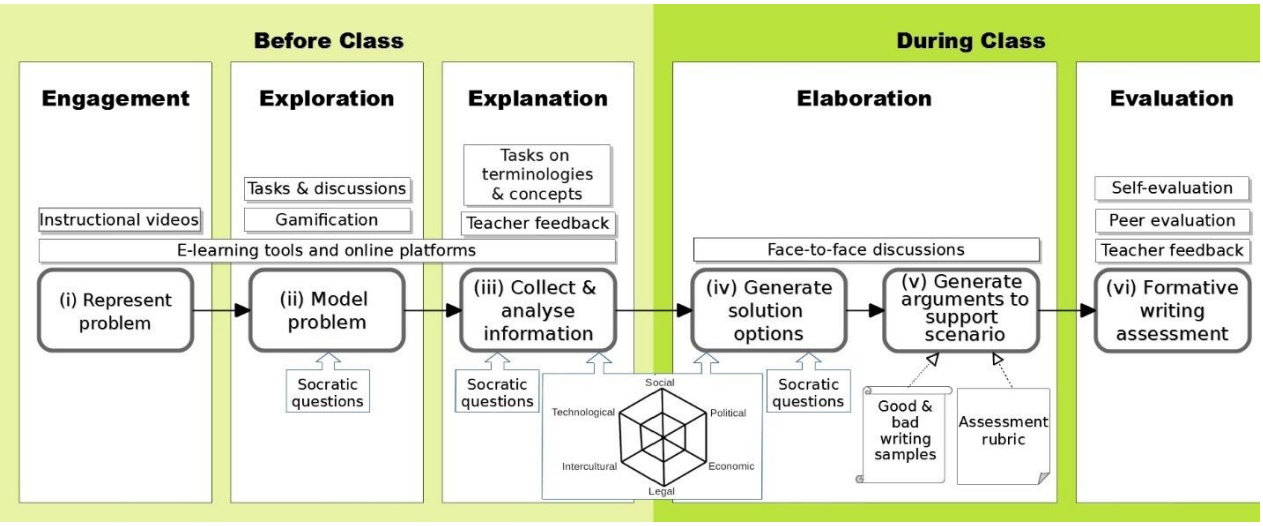
1. Engagement—Activate students' prior knowledge and generate interest through raising questions and eliciting responses.
2. Exploration—Clarify misconceptions through describing common, concrete experiences.
3. Explanation—Allow the understanding of information, concepts. Encourage listening and questioning of others' explanations.
4. Elaboration—Draw comparisons, extend understanding, and consider alternatives.
5. Evaluation—Conduct formal assessments that include open-ended questions or demonstrations.

The Flipped 5E PSW Model

The flipped 5E PSW model (Figure 2) combines the three models mentioned above: (1) Jonassen's model for the case/policy analysis problem-solving environment, (2) the flipped learning model, and (3) Bybee's 5E learning model.

Figure 2

The Flipped 5E PSW Model



For phase one, *Engagement*, the teacher represented a problem through stories and examples via videos to engage the students' attention. The teaching materials presented were instructional videos posted on EdPuzzle, an online platform.

In phase two, *Exploration*, the students were assigned learning tasks and discussion topics to help them model the problem and explore the topic. Through asynchronous online discussion platform, the students could interact with their peers. The teacher also provided guidance by asking relevant questions about the topic. We incorporated the use of Socratic questions, as this style of questioning is commonly considered the most effective to promote student critical thinking (Yang et al., 2005). The following six types of Socratic questions may be utilized:

1. Questions about the question—to identify or understand the question or the issue.
2. Questions of clarification—to ask for verification or additional information.
3. Questions that probe assumptions—to ask for an explanation or validity of an assumption.
4. Questions about viewpoints—to ask for alternatives or differences among viewpoints.
5. Questions that probe reason or evidence—to ask for additional examples and reasons for a stance or position.
6. Questions that probe implications—to ask for a description of the implication of what is done or the possible cause-and-effort of an action or suggestion.

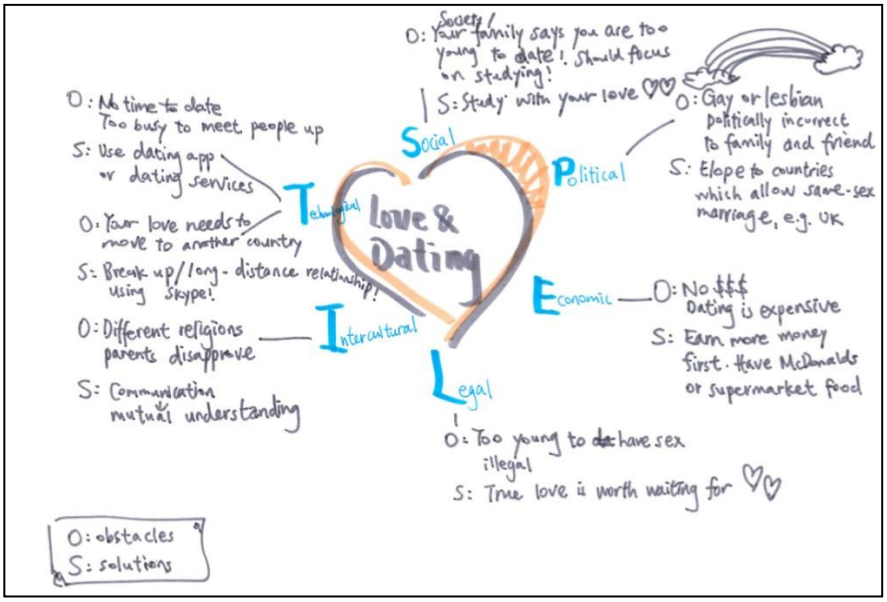
To encourage learners to participate actively in the learning tasks online, we applied gamification, which refers to the use of game elements in non-game contexts. In this study, we employed points and leaderboards since they were the most commonly employed game elements (Dicheva et al., 2015). A point-based system awarded students points for meaningful contributions and for peer communication. Meaningful contributions were contributions submitted in English that were relevant to the question or topic being discussed. For example, "Where should we go to have lunch?" would not be considered a meaningful contribution to the question "What advice would you give to the girls in the video?" A leaderboard displayed the points that the students had gained from their online participation. Their performances in class were also ranked. The leaderboards were updated every two weeks.

Phase three, *Explanation*, required students to collect and analyze information before class. Conceptual terminologies were introduced through the learning tasks to explain the problem or topic further. Socratic

questions were used to stimulate critical thinking. Moreover, the SPELIT power matrix was used in the flipped 5E PSW model as a way to guide students toward re-examining the session topics through different perspectives and disciplinary lenses (Schmieder-Ramirez & Mallette, 2007). SPELIT is an acronym for Social, Political, Economic, Legal, Intercultural, and Technological. These six elements can help an individual to systematically analyse an environment, in its broadest sense. As the students often found it difficult to understand the various perspectives related to a problem, the SPELIT matrix was selected to make this task more manageable (see Figure 3 for an example of student work).

Figure 3

An Example of Student Analysis of "Love & Dating" Using the SPELIT Power Matrix



In phase four, *Elaboration*, the students were asked to elaborate on what they had learned from the videos. For students in the flipped group, this phase occurred during the face-to-face sessions. The students' comments and answers on the e-learning platforms were used "as a springboard" (Kim et al., 2014, p. 44) to guide discussions. Through collaborative mind-mapping with the help of the SPELIT power matrix, the students worked with their peers to generate different options for solutions, and to develop their arguments for their preferred solutions. The teacher supervised the brainstorming process and asked Socratic questions to the different groups to stimulate them for elaborating on and analyzing their ideas. Good and bad writing samples taken from a previous class taught by the same teacher (Appendix A) and an assessment rubric (Appendix B) were provided as further guidance for their writing tasks.

In phase five, *Evaluation*, formative writing assessments took place in class as a means to evaluate student learning. The students completed their problem-solution essays individually. Then after their writing tasks, the students each completed a self-evaluation form (Appendix C). Next, each student evaluated a piece of work from a peer, with reference to a peer-evaluation form (Appendix C). Last, the teacher gave feedback on content, language, and organization for each of the students' essays. To illustrate how the five phases were implemented, an example of a writing lesson for the flipped group is shown in Appendix D.

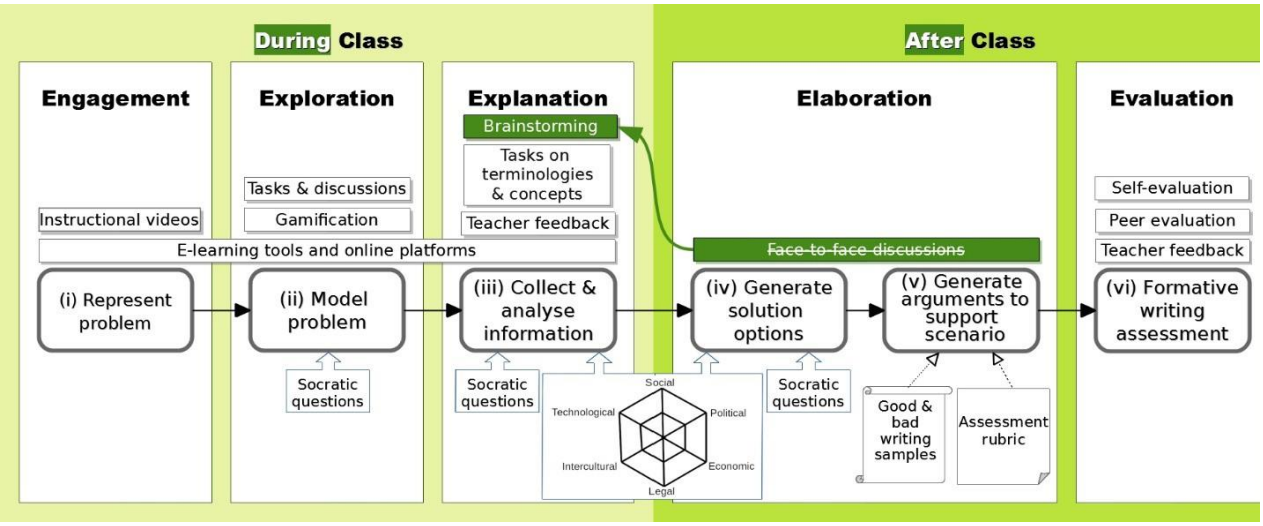
The Non-Flipped Version of the 5E PSW Model

To evaluate the effectiveness of the flipped 5E PSW model, a non-flipped version of the model was

introduced in another classroom as a comparison group. This non-flipped version of the 5E PSW model was similar to the flipped version, but with two key differences: (a) *phases one to three* took place *during* class, and (b) *phases four and five* took place *after* class, rather than during class. Minor adjustments were made to accommodate these changes (see Figure 4). An example of a writing lesson for the non-flipped group can be found in Appendix E.

Figure 4

The Non-flipped 5E PSW Model



Note. The phases of Engagement, Exploration, and Explanation occurred during class, and the phases of Elaboration and Evaluation happened after class.

Methodology

Study Design

A longitudinal quasi-experimental design study was conducted with two intact classes of secondary school ESL students. Longitudinal studies, unlike short-term or cross-sectional studies, employ repeated measures to follow the same individuals over a prolonged period of time (Caruana et al., 2015). Individual students were not randomised to either the experimental group (flipped) or the comparison group (non-flipped), because the students were already in their intact classes. The class teacher randomly assigned one intact class to be the experimental group, and the other intact class to be the comparison group. To determine whether the two groups were equivalent in terms of the students' initial problem-solution writing, a pre-test was carried out at the beginning of the study.

The pre-test was conducted one-month before the formal commencement of the research study. After the pre-test, four written assessments took place in the first year, and three written assessments took place in the second year, with an approximate 1.5-month interval between written assessments, not counting the usual school breaks (e.g., Christmas holiday; see Table 2 for research timeline). Altogether, the students were tested seven times over a two-year period to measure the impact of the instructional models on their problem-solution writing performances.

Table 2

Timeline of the Research Study

		Pre-test
Year 1 (Procedures for both flipped and non-flipped groups)	Cycle 1	writing assessment 1
		writing assessment 2
		Teacher's reflection + Evaluation of student performance
	Cycle 2	writing assessment 3
		writing assessment 4
		Teacher's reflection + Evaluation of student performance + Student focus group
Year 2 (Procedures for both flipped and non-flipped groups)	Cycle 3	writing assessment 5
		writing assessment 6
		Teacher's reflection + Evaluation of student performance
	Cycle 4	writing assessment 7
		Teacher's reflection + Evaluation of student performance + Student focus group

The students' writings were marked by the teacher, using the same assessment rubric for both classes. To examine the reliability of the marking, an independent marker was recruited to mark one set of the students' work. The independent marker is an ESL graduate student with a score of 9 on the IELTS Academic Test. The marker had previous experience in marking student essays. The flipped writing assessment 5 was graded by the independent marker, as this was the time the independent marker was available. The overall Kappa coefficient was 0.753, which can be regarded as substantial agreement.

To allow multi-layer evaluation of the effectiveness of the flipped 5E PSW model, two rounds of focus group interviews with students were carried out. Focus group discussion sessions were conducted at the end of each year for both the flipped and non-flipped groups. Each group had one focus group discussion session after the first two cycles, and another after all four cycles (see Table 2). Altogether, 15 students in the

flipped and non-flipped groups were randomly chosen to participate in the focus group discussion sessions. They were interviewed by the instructor face-to-face in an empty classroom. Examples of questions in the focus group discussion sessions included:

- Do you like learning through watching videos and performing online tasks [before class/during class]? Why?
- What did you find most helpful to your learning?
- What did you find least helpful to your learning?

The focus group discussion method was utilized as it can "generate information on collective views" (Gill et al., 2008, p. 293). Another advantage of focus group discussions is that students tend to be more relaxed and comfortable, and more inclined to express their opinions when in a group, as found in a pilot study preceding the present study. Krueger and Casey (2000) especially recommend focus groups as a means to "determine the perceptions, feelings, and thinking of people" (p. 12) through the creation of "a comfortable, permissive environment" (p. 9). The instructor's observations and reflections were also collected. Thematic analysis was applied to generate themes according to the research questions and study aims (Braun & Clarke, 2006).

Participants

The study was carried out in an all-girls' secondary school, and it involved two classes of 16- to 17-year-old students for two consecutive years. The classes were Secondary 4 level (equivalent to grade 10). The focus of the class was on English Language writing, with the goal of preparing them for public examinations. The participants had average proficiency in the English language according to the class teacher. The participants could generally express their meaning adequately in writing and speaking activities. Typically, students were able to write 350- to 450-word essays. They could make simple arguments supported by explanations. The participants were very exam-focused, and they were used to the "spoon-feeding" learning paradigm. They preferred copying model answers from the teacher to solving problems independently. The original number of students in both classes was 30. However, due to drop-outs between the first and second year, the final number was reduced to 23 for each class. All of the participants were of Chinese ethnicity, and they shared a similar cultural background. Their first language was Chinese (Cantonese), and English was their second language.

Two classes of consecutive years were taught by the same class teacher in order to control the confounding effects of different instructors. This was considered to be the most important variable to control, as different teachers may have vastly different teaching styles, which would have made interpretation exceedingly difficult. The class teacher worked with a full-time researcher from a local university to plan and conduct the present study. The class teacher had three years of teaching experience at the Secondary Form 4 (grade 10) level. Ethical approval for conducting research with students in the teacher's classroom was given by the researcher's university institutional review board.

Results

RQ 1: How do the Writing Scores with the Flipped 5E PSW Model Compare with Those Using a Non-Flipped Model?

First, we performed an independent sample *t*-test to check for pre-existing differences in writing proficiency between the flipped and non-flipped groups. The measurement we used for this test was the students' pre-test scores, which was administered to the students before any of the writing sessions. We chose the independent *t*-test because it compares two groups on the mean value of a continuous normally distributed variable (i.e., participants' pre-test writing scores). According to a Shapiro-Wilk test, there was no significant deviation from normality in the flipped group participants' pre-test scores ($p = 0.158$), and the non-flipped group participants' pre-test scores ($p = 0.090$). A two-tailed test was used since we wanted to determine if there was any positive or negative difference between the groups. We did not presume that one group would score higher than the other group. The results of this *t*-test were non-significant, $t(44) = 0.23$,

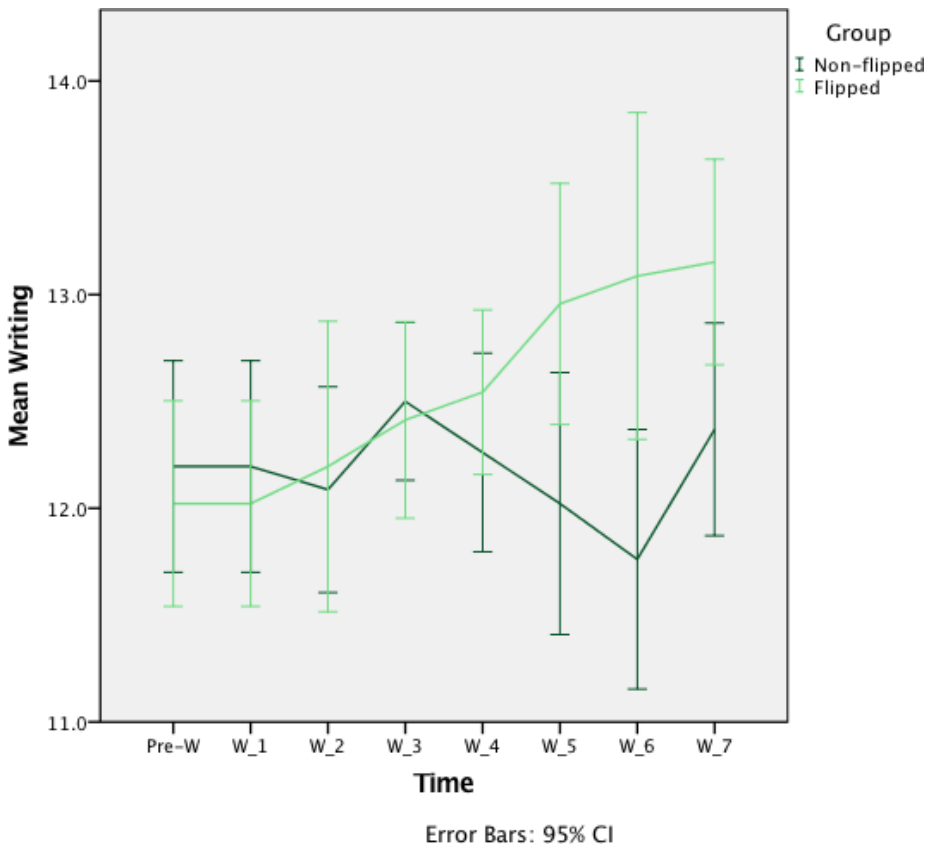
p = 0.818, which suggested that the initial levels of writing proficiency for the two study groups were similar.

In the absence of significant differences in the pre-writing test results, a mixed ANOVA was conducted to explore the effects of the instructional model on the participants' writing scores. The assessment times (the pre-writing test and formative writing assessments 1 to 7) were the within-subject factors, and the study groups (flipped and non-flipped groups) were the between-subject factors. In short, we carried out a mixed ANOVA to test whether there was any difference in the formative writing assessment scores between the flipped and non-flipped groups. We tested for and dealt with possible outliers (see Appendix Ia for details), normality of the dependent variable (Appendix Ib), homogeneity of variances (Appendix Ic), and assumption of sphericity (Appendix Id).

From the descriptive statistics on the writing scores, it can be seen that the flipped group's mean writing scores rose steadily over the two-year study period, starting from 11.83 (*SD* = 1.49), and improving to 12.02 (*SD* = 1.11), 12.20 (*SD* = 1.57), 12.41 (*SD* = 1.06), 12.54 (*SD* = 0.89), 12.96 (*SD* = 1.30), 13.09 (*SD* = 1.77), and finally to 13.15 (*SD* = 1.11) (Appendix F). In contrast, the mean writing scores of the non-flipped group fluctuated over the period of the study, starting from 11.91 (*SD* = 1.01), then shifting up and down to 12.20 (*SD* = 1.15), 12.09 (*SD* = 1.11), 12.50 (*SD* = 0.85), 12.02 (*SD* = 1.42), 11.76 (*SD* = 1.41), and ultimately 12.37 (*SD* = 1.15) (Figure 5).

Figure 5

Mean Writing Scores on the Pre-writing Test and on each Assessment (w_1 to w_7)



A significant interaction effect was found between assessment time and study group, $F(7, 308) = 5.09$, $p <$

0.001, partial 17^2 = 0.104. The descriptive statistics suggested that the flipped group increasingly outperformed the non-flipped group over the two-year course of successive formative writing assessments. There was a statistically significant effect of time on writing scores for the flipped group, $F(7, 154) = 8.87$, $p < 0.001$, partial $17^2 = 0.287$. However, no significant effect of time on writing scores for the non-flipped group was found, $F(7, 154) = 1.77$, $p = 0.096$, partial $17^2 = 0.075$. These results implied that the flipped group's writing scores improved more over time than those of the non-flipped group.

To delineate the nature of the significant interactions, we performed a series of post-hoc tests. These tests checked for significant differences between the writing scores of the flipped and non-flipped groups. Since multiple *t*-tests increase the likelihood of Type I errors, the Sidak-Bonferroni procedure was used to calculate the adjusted alpha level. The adjusted alpha is 0.006. By comparing the *p*-values in the *t*-tests to the new adjusted alpha of 0.006, instead of the typical 0.05, we found some of the results lost their significance. Nevertheless, there was a clear trend in the data showing the flipped 5E PSW model producing more marked improvement on writing scores over time. For example, we can see in Table 3 that the last three tests (Writing_5, Writing_6 and Writing_7) yielded larger effect sizes (0.70, 0.85, 0.71) than those in the earlier tests. In all three cases, the descriptive statistics indicated superior performance by the flipped group.

Table 3

Results of Post-Hoc Tests for the Flipped and Non-Flipped Groups

Comparing Flipped and Non-Flipped Groups	***t***	***df***	***p***	**Effect Size (Cohen's *d*)**	**95% Confidence Interval of the Difference**	
					Lower	**Upper**
Pre-writing test	0.23	44	0.818	-0.07	-0.67	0.84
Writing assessment 1	0.52	44	0.604	-0.16	-0.50	0.85
Writing assessment 2	-0.27	44	0.788	0.08	-0.92	0.70
Writing assessment 3	0.31	44	0.761	-0.09	-0.49	0.66
Writing assessment 4	-0.97	44	0.337	0.29	-0.87	0.30
Writing assessment 5	-2.33	44	0.025*	0.70	-1.74	-0.13
Writing assessment 6	-2.82	44	0.007*	0.85	-2.28	-0.38
Writing assessment 7	-2.35	44	0.024*	0.71	-1.46	-0.11

Note. *significant using $p < 0.05$, not significant using an adjusted-alpha of 0.006 (Bonferroni adjustment).

RQ 2: How do Students and Their Teacher Perceive the Flipped 5E PSW Model?

Students' Interview Results

Focus group discussions were conducted with students of both the flipped and non-flipped groups. Interviewees from the flipped group only expressed positive feedback, while 18% of the comments from interviewees of the non-flipped group was negative. See Appendix G for details regarding the coding frequencies of findings.

Thematic analysis found around half of the comments from the flipped group expressed the benefits of learning using the Flipped 5E PSW model (49%), around one-third of the comments reflected an enhancement of interest through this model (32%), and around one-sixth emphasized effective feedback (15%). These three advantages were also considered the most important features of the model by the non-flipped group. A fourth theme was also identified—enhanced group interaction—but this was not considered a major feature because it was only mentioned in two comments. Details regarding student interviewees' top three comment items on the Flipped 5E PSW model are discussed below.

Learning Benefits

Interviewees reported that learning is more effective using the flipped 5E PSW model. They explained that by learning from videos at home before class, class time was used more effectively, and they had more thinking time to process new information. The contexts and examples in the videos also helped them "understand and memorize new words and concepts." By making notes on the worksheets and working on the mini-tasks as they watched the videos, they were guided to summarize what they had learnt.

Enhanced Interest

Student interviewees reported that the video learning task on the e-learning platform, EdPuzzle, was engaging. They considered videos "more memorable than listening to lectures and jotting notes," and they were also motivated by bonus marks and the sense of achievement as they became more knowledgeable through the videos and mini-tasks.

Effective Feedback

Students found the immediate feedback from the automatic marking system in EdPuzzle helpful for learning. They could quickly identify misconceptions and problems they had, and could track their learning progress. Peer evaluation was another form of formative feedback that students enjoyed. Interviewees reported that they enjoyed reading their peers' comments and found reading others' work helpful as a method of reviewing vocabulary items. Additionally, all interviewees felt encouraged by their teacher's feedback on their final writing tasks and said that it guided them to improve their writing skills.

Teacher's Reflection Results

The teacher's reflection notes revealed positive comments for both the flipped and non-flipped groups. See Appendix H for details regarding the coding of findings.

The top three benefits with the Flipped 5E PSW model were as follows. Over half of the teacher's comments were about the advantages offered by technology in facilitating student learning (57%). Around one-third of the comments were related to learning benefits (29%), and around one-sixth were about the enhancement of student interest. For the Non-Flipped 5E PSW model, the teacher's comments showed equal appreciation of the technological advantages and learning benefits (38%), followed by the model's ability to enhance student interest (25%). Details regarding the teacher's top three comment items on the Flipped 5E PSW model are discussed below.

Technological Advantages

The teacher found the EdPuzzle platform easy to use and that the statistics generated by EdPuzzle provided

useful analytical data on students' performances on individual questions of the video tasks. These data allowed follow-up questions by the teacher to test student understanding of the content.

Learning Benefits

The teacher found the EdPuzzle video tasks helpful for identification of students' prior knowledge based on their answers, and this facilitated teaching. The inspection of worksheet tasks prior to discussing answers was also found to improve students' work quality.

Enhanced Interest

The teacher reported that students were engaged and focused using EdPuzzle as the e-platform, and they readily completed their learning tasks.

To summarize, the study's qualitative results—both the student focus group discussion interviews and the teacher's reflection notes—revealed that students were consistently more engaged by learning through the Flipped 5E PSW model.

Discussion

Student Achievement

The flipped 5E PSW model was more effective than the non-flipped model for improving students' problem-solution writing proficiency over a two-year period. In the *short term*, the effects of the flipped and non-flipped models were similar. One possible reason for the similar short-term effects may be that both the flipped and non-flipped models used new technology. Several previous studies have found that introducing new technology in the classroom tends to cause a sudden, short-term boost to engagement and achievement (Clark, 2015; Kirvan et al., 2015). However, the flipped 5E PSW model produced more marked improvement on writing scores with *continuous exposure* over time, whereas the non-flipped model did not. This outcome suggested that the effect of the flipped 5E PSW model could not be attributed solely to fresh exposure to new technology. Some of the reasons for the cumulative effects of the flipped 5E PSW model are sustained higher levels of engagement, more opportunities for active "hands-on" practice in the face-to-face class sessions, and that this model better enabled self-paced learning,

The on-demand accessibility of online learning resources in the flipped learning group enabled students to replay the videos and learn at their own pace. They could review materials as much as required. Students in the flipped learning group had the opportunity to interact with the online learning resources before coming to class, but their counterparts in the non-flipped group had only a fixed amount of in-class time to watch the videos and complete the same tasks. The flipped group had better opportunities than the non-flipped group for self-paced learning. As mentioned previously, students from the flipped group enjoyed re-watching parts of the videos, and they had more time to think when doing the learning tasks at home. From the perspective of cognitive load theory, self-paced learning helped the flipped learning group to better manage their cognitive loads (Abeysekera & Dawson, 2015). This cognitive advantage allowed the flipped learning group to better digest and internalize their learning, which made the flipped model more effective in the long run.

One further factor was that students in the flipped classroom had more chances to engage in active learning. In the non-flipped class, the in-class time was mainly used to provide information about problem-solution writing. This focus left little time for the students to practice or apply what they learned. In contrast, the flipped class allowed the teacher more time to check the students' levels of understanding by discussing their comments from the online discussion forum and their answers in the pre-lesson tasks. The teacher also had more time to discuss each topic and use different types of Socratic questions to analyze the problems. Due to the greater availability of class time, more time could be allocated for face-to-face discussions. Building on these advantages over time, the flipped group was able to perform better than the non-flipped group.

Main Lessons Learned

In this section, we summarize the main lessons drawn from the qualitative data (the student focus group discussions and teacher's reflections). We also highlight several suggestions to improve problem-solution writing instruction through flipped learning in ESL education.

Manage Student Workload

Comments

According to the class teacher, incentives and careful management of workload are needed for students to work on pre-lesson preparation tasks at home (Lo & Hew, 2017; Kim et al., 2014). In the present study, some students in the flipped group failed to prepare for class because they were unhappy about what they perceived as extra assignments. Similar observations were reported by DeSantis et al. (2015), as well as Bond (2020), that students responded unfavourably toward the change of learning approach, skipped the class preparation, and were unable to adequately contribute to class discussions.

Through communicating with the students over time, the teacher realized that these issues could be attributed to a lack of understanding regarding the class goals and expectations. During the first focus group discussion, the students from the flipped group indicated that they were unsure about the purpose of flipped learning. They suggested that their teacher should replay the video in class, as they might not remember what they had learned from the videos at home. However, by the second focus group discussion, the interviewees indicated that they understood the purpose of flipped learning. They expressed a preference for flipped learning, as it allowed a more effective use of class time for discussions. This shift showed that the students' perceptions of their learning program could change if they understood the purpose behind it.

In addition, the content of the pre-class materials and activities needed to be carefully chosen to avoid placing excessive burden on students. The workload for both groups was the same in our study. The difference between the two groups was that phases one to three of the 5E PSW model took place during class in the non-flipped group, but before class in the flipped group. Phases four to five took place after class in the non-flipped group, but during class in the flipped group (see Figure 2 and Figure 4 for comparison). In other words, the flipped group was asked to do pre-class assignments, whereas the non-flipped group received post-class assignments.

Suggestions

Although extrinsic motivation can play a role in the students' learning, it is also true that establishing clear goals and expectations from the beginning can go a long way in managing student behavior. Herreid and Schiller (2013) explained that it is normal for students to experience initial apprehensiveness and to express reluctance when a flipped classroom approach requires them to do extra work at home. However, if the teacher makes the goals and benefits of the learning task explicit, the students are more likely to attempt it, instead of simply doing it for the sake of meeting a requirement. Furthermore, teachers can make their expectations clear by giving concrete examples or demonstrations. This approach can improve comprehension of task instructions, and the examples provided can serve as guidelines for the students to emulate. The pre-class materials and activities also needed to be carefully chosen to avoid exerting excessive burden on the flipped class students.

Use Technology for Feedback

Comments

Both the students and their teacher identified EdPuzzle as the most helpful e-learning platform used in this study. The main reason they reported was that EdPuzzle's automatic grading and feedback system enabled instant feedback.

The students found it helpful to immediately find out whether they had answered questions correctly. For open questions, the suggested answers could provide them with deeper understanding of the concepts

relevant to each topic. Unlike the delay in grading when doing quizzes on paper, the instant feedback provided by EdPuzzle allowed students to learn from their mistakes as soon as they made them. Then they could immediately apply their new knowledge to the other questions, rather than only realizing their misunderstandings a week later, after the teacher finished marking their work.

The teacher also found the automatic grading and feedback system helpful, as this system generated useful learning analytics data that assisted the teaching task. First, the system allowed the teacher to identify which questions gave students the most difficulty. The teacher could then focus on dealing with these difficulties and offer further explanations or follow-up questions. Second, the system immediately provided data on which students were falling behind as soon as they finished a task. By identifying struggling students in a timely manner, the teacher could provide individual help to minimize the frustration and helplessness experienced by weaker learners who need greater support.

Suggestion

Computerized assessments enhance efficiency in marking, and they provide immediate feedback for both highly constrained questions (e.g., multiple choice) and for intermediate or less-constrained open-response questions. The system's suggested answers can help to instantly address the most common errors or confusions (Meir et al., 2019). An automatic system makes the feedback timelier, and it allows teachers to focus on the less constrained questions. Therefore, any application of the 5E PSW model should continue to use e-learning platforms or any other technological tools that allow automatic grading and instant feedback. In cases where teachers or students have no access to appropriate technological tools, an analogous substitute is to prepare a physical answer key as a form of immediate feedback to learners.

Use Worksheets for Consolidation

Comments

One of the goals of using instructional videos was to introduce vocabulary items relevant to each lesson's topic. During the first round of focus group discussions, some interviewees reflected that they were unlikely to remember the new vocabulary by merely watching the videos. After receiving this feedback, the teacher added questions that focused on vocabulary, both in the online tasks and on the worksheets. During the second round of focus group discussions, the interviewees reported that the contexts and examples given in the videos helped them to understand and memorize new words. They also reported that completing the worksheets required them to write down content-based vocabulary and encouraged them to review those words.

Suggestions

Revision is essential to improve writing skills (Li & Chu, 2018). Having a worksheet for the students to complete after watching each instructional video is a good way to help them learn new words through note-taking and summarizing. It is hard for students to retain any information that they learn from a video simply by watching it once, especially when the video contains new information. Having a worksheet to fill in helps focus learner attention to the video's details, as does possibly watching it multiple times. In addition, the teacher can design the worksheet in a way that requires the students to take notes or complete a summary of the video's main ideas. The introduction of such worksheets has two purposes: guiding students to think about what they learn, and training students to take notes and write summaries. To further encourage students to review their notes, the teacher can also organize quizzes or dictations on the new content.

Guide Discussions with Socratic Questions and the SPELIT Power Matrix

Comments

One of the areas where the students required support was formulating ideas and arguments for their writing tasks. In their focus group discussions, the students reflected that they found face-to-face discussions with their classmates growing easier as they became more knowledgeable about the lesson topics through the videos and mini-tasks. The students also reported that the SPELIT power matrix was a useful tool for

brainstorming and that it helped them to organize their ideas. Nonetheless, they sometimes found it difficult to formulate ideas for all six perspectives (i.e., social, political, economic, legal, intercultural, and technological). Therefore, the teacher's guidance through Socratic questions was helpful, especially for students who had not been trained to think from multiple perspectives or who lacked understanding of the six knowledge fields.

Suggestions

Face-to-face discussions allow students to verbalize their thoughts and understandings, but this can be challenging for learners who are accustomed to rote-memorization. Simply asking students to discuss a topic without sufficient scaffolding is often ineffective, as they may be unclear on how to proceed. Hence, a thinking framework, such as the SPELIT power matrix, can give students a guide for considering a problem or a topic. In the process of thinking and discussion, students may "become stuck" and find themselves unable to formulate new ideas. In that case, instead of directly telling students the correct answer, which ends the discussion and leads the students to simply copy down a solution without further processing, it is more helpful if the teacher uses Socratic-style questions to guide the students toward arriving at their own ideas or conclusions. In this manner, the students are not merely acquiring facts and knowledge to memorize but are gaining the thinking skills to analyze other problems.

Analyze Good and Bad Writing Samples

Comments

Students from both the flipped and non-flipped groups reported that the provision of good and bad writing samples was useful in helping them to improve their writing. They also commented that they were best able to learn from the samples when the teacher guided them to analyze these samples. The teacher observed that using Socratic questions helped to guide the students toward explaining the strategies used in the good samples and discussing the problems and mistakes in the bad writing samples. Some students were able to recognize their own previous mistakes by examining the bad writing samples.

Suggestions

The participants wanted the teacher to analyze the good and bad writing samples with them, rather than simply presenting the samples to read. Without the process of guided analysis, it was quite likely that the students would either ignore the samples or simply copy chunks of text from the good samples in an attempt to produce good writing. In discussing the writing samples, the teacher could use Socratic questions to guide the students toward understanding of what made the writing samples good or bad. Not only did this process of analysis allow students to learn from the samples, but it also taught them how to critique their own writing and to improve it.

Role of the Teacher

The teacher's role is indispensable in the success of a flipped classroom approach. A considerable amount of time and effort is often needed in preparing the pre-class videos and activities (Lo & Hew, 2017). As observed by Bond (2020), finding third-party pre-class learning videos that perfectly match the learning need is difficult, and creating instructional videos from scratch is time-consuming. Unless support is available at school, production or editing of such videos is likely to be done by the teacher at home since "long stretches of undisturbed time" (Snyder et al., 2014, p. 314), as well as a quiet environment for audio recording, is critical. In the present study, the teacher spent approximately three hours to plan and produce a six-minute pre-lesson video from scratch. Although a teacher may shorten the video preparation time by editing existing video resources, third-party videos, such as those found on YouTube, do not offer personalization or specificity unlike custom videos made by the instructor (Alpert, 2016). While a significant amount of instructor start-up effort is required to create the video resources, it is important to note that these resources can be reused in subsequent semesters, which makes the preparation of a flipped course more cost-effective in the long run.

Limitations of the Study

It is important to highlight two limitations of the present study. First, the sample size of this study was small. There were only 23 participants in each group. Second, this study was conducted in only one all-girls' secondary school, and this may affect the generalizability of the data. Future investigations should therefore include a greater number of participants to test the generalizability of the findings. Further research in other educational modes is also necessary to examine the model's effectiveness in different contexts.

Conclusion

Although the number of studies on flipped learning has grown exponentially during the last decade, the majority of these studies have been conducted in universities, higher education institutions, or post-secondary schools. These previous studies have also mainly focused on learning in technical fields such as engineering, mathematics, and science. In addition, most previous research on K-12 flipped classrooms have involved short-term studies, usually lasting only a few weeks. As new innovations can bring about sudden but brief improvements in engagement and achievement, a longitudinal study is better suited to investigate whether the effects of the learning model can be sustained over a longer period of time.

In this study, the flipped 5E PSW model was adopted in a series of problem-solution writing lessons that spanned two years. The flipped 5E PSW model was developed based on three theoretical or conceptual models: (a) Jonassen's design theory for case/policy analysis problem-solving, (b) the flipped learning model, and (c) Bybee's 5E learning model. This longitudinal study was the first of its kind to chart the effects of flipped learning over an extended time period and to do so in a secondary school ESL context. Our study showed that the flipped 5E PSW model can significantly improve ESL students' problem-solution writing skills. The application of the flipped 5E PSW model in a two-year real-world school environment has demonstrated its capacity for overcoming traditional classroom constraints. Feedback from students and the class teacher indicated generally positive perceptions toward the flipped 5E PSW model.

References

Abeysekera, L., & Dawson, P. (2015). Motivation and cognitive load in the flipped classroom: Definition, rationale and a call for research. *Higher Education Research and Development*, *34*(1), 1–14. https://doi.org/10.1080/07294360.2014.934336

Alpert, F. (2016). Revitalizing the live lecture class with instructor-created videos. *Sage Open*, *6*(4). https://doi.org/10.1177/2158244016680686

Ander, S. & Yıldırım, O. (2010). Lexical errors in elementary level EFL learners' compositions. *Procedia Social and Behavioral Sciences*, *2*(2), 5299–5303. https://doi.org/10.1016/j.sbspro.2010.03.864

Bardach, E. (2000). *A practical guide for policy analysis.* Chatham House.

Baxter-Magolda, M. B. (1987). Comparing open-ended interviews and standardized measures of intellectual development. *Journal of College Student Personnel*, *28*(5), 443–448.

Bhagat, K. K., Chang, C. N., & Chang, C. Y. (2016). The impact of the flipped classroom on mathematics concept learning in high school. *Educational Technology & Society*, *19*(3), 134–142. https://www.j-ets.net/collection/published-issues/19_3

Blanca, M. J., Alarcón, R., Arnau, J., Bono, R., & Bendayan, R. (2017). Non-normal data: Is ANOVA still a valid option? *Psicothema*, *29*(4), 552–557. https://doi.org/10.7334/psicothema2016.383

Blanca, M. J., Alarcón, R., Arnau, J., Bono, R., & Bendayan, R. (2018). Effect of variance ratio on ANOVA robustness: Might 1.5 be the limit? *Behavior Research Methods*, *50*(3), 937–962. https://doi.org/10.3758/s13428-017-0918-2

Bond, M. (2020). Facilitating student engagement through the flipped learning approach in K-12: A systematic review. *Computers & Education*, *151*, 103819. https://doi.org/10.1016/j.compedu.2020.103819

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (1999). *How people learn: Brain, mind, experience, and school*. National Academy Press.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Bybee, R. W. (1997). Improving instruction. In R. W. Bybee (Ed.), *Achieving scientific literacy: From purposes to practice* (pp. 167–186). Heinemann.

Carrell, P. L. (1984). *Text as interaction: Some implications of text analysis and reading research for ESL composition* [Paper presentation]. Annual Meeting of the Teachers of English to Speakers of Other Languages, Houston, TX. https://files.eric.ed.gov/fulltext/ED243313.pdf

Caruana, E. J., Roman, M., Hernández-Sánchez, J., & Solli, P. (2015). Longitudinal studies. *Journal of Thoracic Disease*, *7*(11), E537–E540. https://doi.org/10.3978/j.issn.2072-1439.2015.10.63

Cerbin, B. (1988). *The nature and development of informal reasoning skills in college students* [Paper presentation]. 12th Annual National Institute on Issues in Teaching and Learning, Chicago, IL. https://eric.ed.gov/?id=ED298805

Clark, K. R. (2015). The effects of the flipped model of instruction on student engagement and performance in the secondary mathematics classroom. *Journal of Educators Online*, *12*(1), 91–115. https://doi.org/10.9743/JEO.2015.1.5

Clark, R. C., Nguyen, F., & Sweller, J. (2005). *Efficiency in learning: Evidence based guidelines to manage cognitive load.* Pfeiffer.

DeSantis, J., Van Curen, R., Putsch, J., & Metzger, J. (2015). Do students learn more from a flip? An exploration of the efficacy of flipped and traditional lessons. *Journal of Interactive Learning Research*, *26*(1), 39–63.

Deslauriers, L., McCarthy, L. S., Miller, K., Callaghan, K., & Kestin, G. (2019). Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom. *Proceedings of the National Academy of Sciences of the United States of America*, *116*(39), 19251–19257. https://doi.org/10.1073/pnas.1821936116

Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015). Gamification in education: A systematic mapping study. *Educational Technology & Society*, *18*(3), 1–14.

Ferreira, E. B., Rocha, M. C., & Mequelino, D. B. (2012). Monte Carlo evaluation of the ANOVA's F and Kruskal-Wallis tests under binomial distribution. *Sigmae*, *1*(1), 126–139.

Field, A. (2005). *Discovering statistics using SPSS* (3rd ed.). Sage Publications.

Flowerdew, L. (2000). Using a genre-based framework to teach organisational structure in academic writing. *ELT Journal*, *54*(4), 369–378. https://doi.org/10.1093/elt/54.4.369

Flowerdew, L. (2003). A combined corpus and systemic-functional analysis of the problem-solution pattern in a student and professional corpus of technical writing. *TESOL Quarterly*, *37*(3), 489–511. https://doi.org/10.2307/3588401

Flowerdew, L. (2008). *Corpus-based analyses of the problem-solution pattern.* John Benjamins. https://doi.org/10.1075/scl.29

Gray, J. B., & Woodall, W. H. (1994). The maximum size of standardized and internally studentized residuals in regression analysis. *The American Statistician*, *48*(2), 111–113. https://doi.org/10.2307/2684258

Guo, P. J., Kim, J., & Rubin, R. (2014). How video production affects student engagement: An empirical study of MOOC videos. *Proceedings of the first ACM conference on Learning @ scale conference*, 41–50. ACM Digital Library. https://doi.org/10.1145/2556325.2566239

Herreid, C. F., & Schiller, N. A. (2013). Case studies and the flipped classroom. *Journal of College Science Teaching*, *42*(5), 62–66.

Hoey, M. (2001). *Textual interaction: An introduction to written discourse analysis.* Routledge.

Hojeij, Z., & Hurley, Z. (2017). The triple flip: Using technology for peer and self-editing of writing. *International Journal for the Scholarship of Teaching and Learning*, *11*(1). https://doi.org/10.20429/ijsotl.2017.110104

Hong Kong Examinations and Assessment Authority (HKEAA). (2012–2018). *Hong Kong diploma of secondary education examination: Examination report and question papers (with marking schemes).* Hong Kong Examinations and Assessment Authority.

Jonassen, D. H. (2011). *Learning to solve problems: A handbook for designing problem-solving learning environments.* Routledge. https://doi.org/10.4324/9780203847527

Jonassen, D. H., & Cho, Y. H. (2011). Fostering argumentation while solving engineering ethics problems. *Journal of Engineering Education*, *100*(4), 680–702. https://doi.org/10.1002/j.2168-9830.2011.tb00032.x

Jordan, M. P. (1984). *Rhetoric of everyday English texts.* Allen & Unwin.

Khan, A., & Rayner, G. D. (2003). Robustness to non-normality of common tests for the many-sample location problem. *Journal of Applied Mathematics and Decision Sciences*, *7*, 187–206. https://doi.org/10.1155/S1173912603000178

Kim, M. C., & Hannafin, M. J. (2011). Scaffolding problem solving in technology-enhanced learning environments (TELEs): Bridging research and theory with practice. *Computers and Education*, *56*(2), 403–417. https://doi.org/10.1016/j.compedu.2010.08.024

Kim, M. K., Kim, S. M., Khera, O., & Getman, J. (2014). The experience of three flipped classrooms in an urban university: An exploration of design principles. *Internet and Higher Education*, *22*, 37–50. https://doi.org/10.1016/j.iheduc.2014.04.003

Kırmızı, G. D. (2018). Lexical errors and linguistic calques as lexical transfer in EFL writing: A case study. *Başkent University Journal of Education*, *5*(2), 99–106.

Krueger, R. A., & Casey, M. A. (2000). *Focus Groups: A Practical Guide for Applied Research* (3rd ed.). Sage Publications.

Kirvan, R., Rakes, C. R., & Zamora, R. (2015). Flipping an algebra classroom: Analyzing, modeling, and solving systems of linear equations. *Computers in the Schools*, *32*(3–4), 201–223. https://doi.org/10.1080/07380569.2015.1093902

Kitchner, K. S. (1983). Cognition, metacognition, and epistemic cognition: A three-level model of cognitive processing. *Human Development*, *26*(4), 222–232. https://doi.org/10.1159/000272885

Lawson, A. E. (2002). *Science teaching and development of thinking.* Wadsworth/Thompson Learning.

Li, X., & Chu, S. K. W. (2018). Using design-based research methodology to develop a pedagogy for teaching and learning of Chinese writing with wiki among Chinese upper primary school students. *Computers & Education*, *126*, 359–375. https://doi.org/10.1016/j.compedu.2018.06.009

Lo, C. K., & Hew, K. F. (2017). A critical review of flipped classroom challenges in K-12 education: Possible solutions and recommendations for future research. *Research and Practice in Technology Enhanced Learning*, *12*(1), 4. https://doi.org/10.1186/s41039-016-0044-2

Marzano, R. J., Brandt, R. S., Hughes, C. S., Jones, B. F., Pressisen, B. Z., Rankin, S. C., & Suhor, C. (1988). *Dimensions of thinking.* ASCD.

Mason, G. S., Shuman, T. R., & Cook, K. E. (2013). Comparing the effectiveness of an inverted classroom to a traditional classroom in an upper-division engineering course. *IEEE Transactions on Education*, *56*(4), 430–435. https://doi.org/10.1109/TE.2013.2249066

Meir, E., Wendel, D., Pope, D. S., Hsiao, L., Chen, D., & Kim, K. J. (2019). Are intermediate constraint question formats useful for evaluating student thinking and promoting learning in formative assessments? *Computers & Language*, *141*, 1–21. https://doi.org/10.1016/j.compedu.2019.103606

Meyer, B. J. F. (1982). Reading research and the composition teacher: The importance of plans. *College Composition and Communication*, *33*(1), 37–49. https://doi.org/10.2307/357843

Milton, J. (2001). *Elements of a written interlanguage: A computational and corpus-based study of institutional influences in the acquisition of English by Hong Kong Chinese students*. Hong Kong University of Science and Technology, Language Centre.

Nordquist, R. (2019, February 6). Composition type: Problem-solution essays. *ThoughtCo.* https://www.thoughtco.com/problem-solution-composition-1691539

Patton, C. V., & Sawicki, D. S. (1986). *Basic methods of policy analysis and planning.* Prentice-Hall.

Phelan, J. & Halpern, F. (2018, May 16). Writing effective journal essay introductions. *Inside Higher Education*. https://www.insidehighered.com/advice/2018/05/16/how-craft-introductions-journal-essays-opinion

Polya, G. (1957). *How to solve it* (2nd ed.). Princeton University Press.

Samuelowicz, K. (1987). Learning problems of overseas students: Two sides of a story. *Higher Education Research & Development*, *6*(2), 121–133. https://doi.org/10.1080/0729436870060204

Schmider, E., Ziegler, M., Danay, E., Beyer, L., & Bühner, M. (2010). Is it really robust? Reinvestigating the robustness of ANOVA against violations of the normal distribution assumption. *Methodology*, *6*(4), 147–151. https://doi.org/10.1027/1614-2241/a000016

Schmieder-Ramirez, J. H., & Mallette, L. A. (2007). *The SPELIT power matrix: Untangling the organisational environment with the SPELIT leadership tool*. BookSurge.

Silvestrini, R. T., & Burke, S. E. (2018). *Linear regression analysis with JMP and R.* ASQ Quality Press.

Snyder, C., Paska, L. M., & Besozzi, D. (2014). Cast from the past: Using screencasting in the social studies classroom. *The Social Studies*, *105*(6), 310–314. https://doi.org/10.1080/00377996.2014.951472

Tessema, K. A. (2005). Stimulating writing through project-based tasks. *English Teaching Forum*, *43*(4),22–28.

Tiruchittampalam, S., Ross, A., Whitehouse, E., & Nicholson, T. (2018). Measuring the effectiveness of writing center consultations on L2 writers' essay writing skills. *Languages*, *3*(1), 1–13. https://doi.org/10.3390/languages3010004

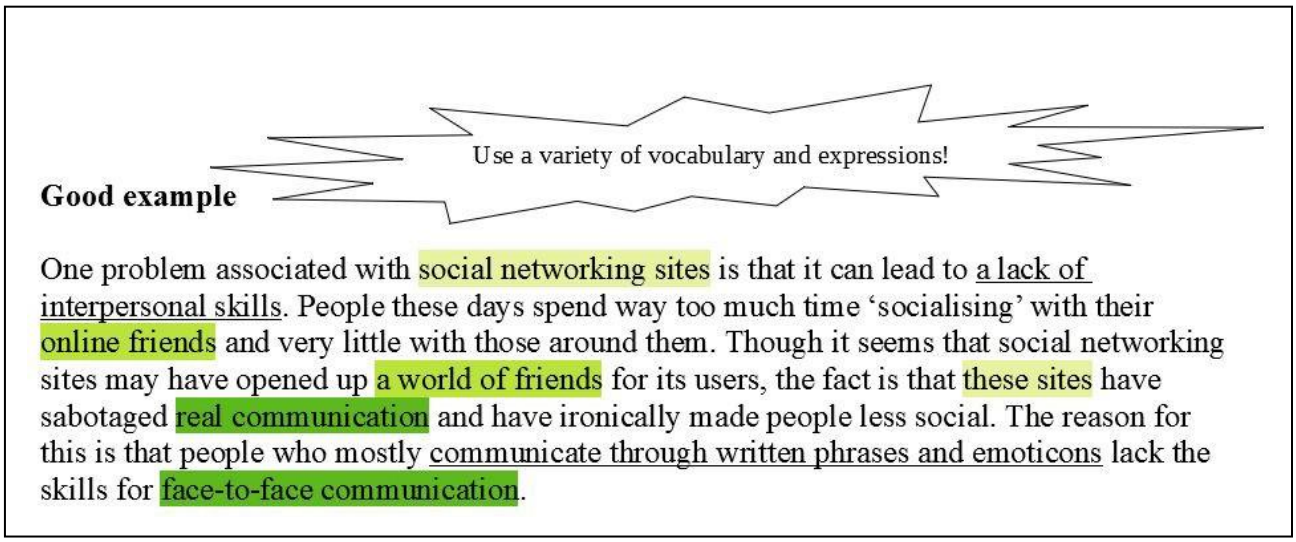
Williamson, B. (2018). Three stages of student engagement in a flipped-classroom environment. *Journal of Learning and Student Experience*, *1*(2). https://jolase.bolton.ac.uk/index.php/jolae/article/view/16

Winter, E. O. (1977). A clause-relational approach to English texts: A study of some predictive lexical items in written discourse. *Instructional Science*, *6*(1), 1–92. https://doi.org/10.1007/BF00125597

Wood, P. K. (1983). Inquiring systems and problem structure: Implications for cognitive development. *Human Development*, *26*(5), 249–265. https://doi.org/10.1159/000272887

Yang, Y.-T. C., Newby, T. J., & Bill, R. L. (2005). Using Socratic questioning to promote critical thinking skills through asynchronous discussion forums in distance learning environments. *The American Journal of Distance Education*, *19*(3), 163–181. https://doi.org/10.1207/s15389286ajde1903_4

Appendix A. Good and Bad Examples of Problem-solution Writing.



Bad example

1. Can you correct the underlined parts?
2. Can you solve the problems mentioned in the brackets?

First, students are easy to become addicted to social networking site, for example, Instagram and Facebook. ***(Is this a topic sentence?)*** They would ignore their homework and their family. ***(Can you explain how social media lead to ignoring homework and family?)*** Very often, they end up spending hours on their phone. Moreover, looking at other's posts could make you feel jealous and unhappy. ***(Is this a different point? Can it be better linked to the topic – social media?)***

Appendix B. Assessment Rubric

Marks	Performance Descriptors
Content _____/7	➢ Stating the problem with background information in the introduction ➢ Explaining the relevant causes and effects of the problem ➢ Offering relevant solutions with details provided ➢ Restating the problem and summarising the solutions in the conclusion
Language & Style _____/7	➢ Using correct tenses – present tense for facts/thoughts/beliefs ➢ Using conditional sentences ➢ Using a wide range of vocabulary and sentence patterns appropriately ➢ Adopting a formal tone
Presentation & Organisation _____/7	➢ Using proper paragraphing (one point per paragraph) ➢ Giving a clear topic sentence to indicate the point ➢ Showing good cohesion between sentences and paragraphs

Total: _____/21

Appendix C. Self- and Peer-evaluation Forms

Self-evaluation form

After you finished your writing, read your work again.
Tick the boxes if you have achieved the following:

- ☐ 1. I have elaborated on the main points.
- ☐ 2. I have made constructive suggestions in response to the issue.
- ☐ 3. I have made use of examples to support the points.
- ☐ 4. I have shown good understanding on the issue discussed.
- ☐ 5. I have organised ideas in separate paragraphs.
- ☐ 6. I have let the readers know the aim/purpose/direction of the essay in the introduction.
- ☐ 7. I have used appropriate connectives/ sign-posting to link ideas.
- ☐ 8. I have used a topic sentence to state the main idea of a paragraph.
- ☐ 9. I have written with appropriate format and style.

Peer Evaluation Form

Name of writer: _____ *Class:* _____ ( )
Name of marker: _____ *Class:* _____ ( )
Topic: _____

Areas	Performance Descriptors	Performance	Marks	Comments
Content	1. can summarize the main points collected from the articles	☹ 😐 ☺		
	2. can summarize the points concisely	☹ 😐 ☺	___ 7	
	3. can describe the cause of the issue	☹ 😐 ☺		
	4. can state the impact of the issue	☹ 😐 ☺		
	5. can analyse the issue from different perspectives	☹ 😐 ☺		
	6. can make constructive suggestions in response to the issue	☹ 😐 ☺		
	7. can use examples to support the points	☹ 😐 ☺		
	8.can show good understanding of the issue	☹ 😐 ☺		
	9. can show critical thinking in the reflection	☹ 😐 ☺		
Language	1. can show accuracy in grammar	☹ 😐 ☺		
	2. can use different sentence patterns correctly	☹ 😐 ☺	___ 7	
	3. can use a wide range of vocabulary correctly	☹ 😐 ☺		
	4. can spell words correctly	☹ 😐 ☺		
Organisation	1. can organise ideas in separate paragraphs	☹ 😐 ☺		
	2. can use appropriate connectives to link ideas	☹ 😐 ☺	___ 7	
	3. can use a topic sentence to state the main idea of a paragraph	☹ 😐 ☺		
	4. can use appropriate format and style	☹ 😐 ☺		
			Total: ___ 21	

Appendix D. An Example of a Lesson Outline for the Flipped Group

		Topic: Potential dangers of social-networking sites
Before Class	Engage	Students were instructed to watch a video prepared by the teacher, in which the teacher role-played different victims of abuse on social-networking sites, and acted out different scenarios.
	Explore	Use of Socratic questions in guiding students to explore the issue Students were instructed to complete the task below in an online discussion forum: On the comment column, write down the answer to the following questions: What are the risks of social networking sites? *(Question about the question)* What advice would you give to the girls in the video? What are some possible solutions to their problems? *(Questions that probe implications and consequences)*
	Explain	Students were instructed to read a short passage uploaded online, which explained the terms and concepts relevant to the writing topic (e.g., cybercrime, fraud, cyber security). As the students read, they were required to complete a worksheet received from their teacher on the vocabulary items and concepts they had learned. The writing topic was presented to the students: **Writing Topic:** Recently, you have read an article about a teenage girl named Mary being cyber-bullied on Facebook. One of Mary's classmates "stole" her photo from her Facebook account and created another account under Mary's name. Others left offensive comments on the fake account to attack Mary. Despite the popularity of social networking websites, there are a number of potential risks. Write a letter to the editor of the *Hong Kong Post* explaining the problems and potential risks of using social networking websites, and give two suggestions for preventing these problems. Sign your letter "Chris Wong."
During Class (70 minutes)	Elaborate	The teacher checked the students' understanding of the issue by discussing their comments on the online discussion forum and the students' answers on the worksheets for the pre-lesson tasks. Following Jonassen's problem-solving model, the teacher discussed the topic using various types of Socratic questions with the students, to further analyze the problem critically. Instant feedback was given to students. **Some possible Socratic questions:** What are some of the most commonly used social networking sites? *(Question about the question)* What does "freedom of speech" mean for you? Do you think it includes the freedom to say whatever you want on the Internet? *(Questions of clarification)* Are social networking sites necessarily harmful? Is it possible that the risks of social media come from the irresponsible actions of the users? *(Questions that probe assumptions)* Who should take the responsibility to stop cyber-bullying? What would be the most effective way? *(Questions about viewpoints or perspectives)* Why is avoiding social networking sites not a realistic solution? *(Questions that probe reason and evidence)*

		The students were instructed to work in pairs or groups to create a mind-map for the writing task by using the SPELIT power matrix, and to share their mind-maps with the class. The teacher discussed good and bad writing samples with students. The assessment rubric was distributed to the students for their reference.
During Class (90 minutes)	Evaluate	The students were given 70 minutes to complete their writing task individually. They were then instructed to fill in their self-evaluation forms. The students were asked to exchange their work with a peer, and fill in the peer evaluation form after reading their peer's writing. Teacher feedback was given to the students within two weeks.

Appendix E. An Example of a Lesson Outline for the Non-flipped Group

		Topic: Potential dangers of social-networking sites
During Class (160 minutes)	Engage	The students were instructed to watch a video prepared by the teacher, in which the teacher role-played different victims of social-networking sites and acted out different scenarios.
	Explore	Use of Socratic questions in guiding students to explore the issue Students were instructed to complete the task below in an online discussion forum: On the comment column, write down your answer to the following questions: What are the risks of social networking sites? *(Questions about the question)* What advice would you give to the girls in the video? What are some possible solutions to their problems? *(Questions that probe implications and consequences)*
	Explain	The students were instructed to read a short passage uploaded online, which explained the terms and concepts relevant to the writing topic (e.g., cybercrime, fraud, cyber security). As the students read, they were required to complete a worksheet received from their teacher on the vocabulary items and concepts they had learned. The writing topic was presented to the students: **Writing Topic:** Recently, you have read an article about a teenage girl named Mary being cyber-bullied on Facebook. One of Mary's classmates "stole" her photo from her Facebook account and created another account under Mary's name. Others left offensive comments on the fake account to attack Mary. Despite the popularity of social networking websites, there are a number of potential risks. Write a letter to the editor of the *Hong Kong Post* explaining the problems and potential risks of using social networking websites, and give two suggestions for preventing these problems. Sign your letter "Chris Wong." To ensure that the students were clear on the concepts and terms, the teacher asked followed-up Socratic questions related to the students' comments on the online discussion forum. Then they discussed the answers they had written on their worksheet. The teacher guided the students to brainstorm ideas on the writing topic by using Socratic questions and the SPELIT power matrix. Through elicitation, the teacher guided the class to create a mind-map on the blackboard.
After Class	Elaborate	The students were instructed to read the good and bad writing samples uploaded online. The assessment rubric was distributed to the students for their reference.
	Evaluate	The students were instructed to give themselves 70 minutes to complete their writing tasks individually after class. The students were instructed to fill in the self-evaluation forms after completing their writing tasks. They were asked to exchange their work with a peer, and fill in the peer evaluation form after reading their peer's writing. Teacher feedback was given to students within two weeks.

Appendix F. Descriptive Statistics for Writing Scores between the Flipped and Non-Flipped Groups

Groups		***n***	***M***	***SD***
Pre-writing Test	Total	46	11.87	1.26
	Flipped	23	11.83	1.49
	Non-flipped	23	11.91	1.01
Writing assessment 1	Total	46	12.12	1.12
	Flipped	23	12.02	1.11
	Non-flipped	23	12.20	1.15
Writing assessment 2	Total	46	12.14	1.35
	Flipped	23	12.20	1.57
	Non-flipped	23	12.09	1.11
Writing assessment 3	Total	46	12.46	0.95
	Flipped	23	12.41	1.06
	Non-flipped	23	12.50	0.85
Writing assessment 4	Total	46	12.40	0.99
	Flipped	23	12.54	0.89
	Non-flipped	23	12.26	1.08
Writing assessment 5	Total	46	12.49	1.43
	Flipped	23	12.96	1.30
	Non-flipped	23	12.02	1.42
Writing assessment 6	Total	46	12.42	1.72
	Flipped	23	13.09	1.77
	Non-flipped	23	11.76	1.41
Writing assessment 7	Total	46	12.76	1.19
	Flipped	23	13.15	1.11

	Non-flipped	23	12.37	1.15

Appendix G. Summary of Focus Group Discussion Findings

	Example Quotes	
	Flipped	**Non-Flipped**
	Positive Themes	
Enhanced interest	"videos are more memorable than listening to lectures and jotting notes," "motivated by bonus marks" (*n* = 13)	"makes the topics more engaging for me" (*n* = 7)
Learning benefits	"can rewatch the video to review content," "thought of the story and you remember the word," "give you more space and time to think and consider what you have learnt" (*n* = 20)	"helps me build up ideas," "Compared with just listening to the teacher's explanation, this helps us remember it for longer" (*n* = 7)
Enhanced group interaction	"make discussion richer and easier because we know more about the topic after watching the video" (n = 2)	"have more information to discuss when we organize our ideas on the SPELIT power matrix mind-map" (*n* = 2)
Effective feedback	"EdPuzzle allows you to see what we know and don't know very quickly," "can find out exactly what you are doing right and what you need to improve on" (*n* = 6)	"find out how we are performing and whether we have improved" (*n* = 7)
	Negative Themes	
Time issues	N/A	"less time for discussion in class… The writing lessons are actually quite rushed," "don't have enough time to talk about all the writing samples in class" (*n* = 2)
Technological disadvantages	N/A	"some of us are just too lazy to download [the supplementary materials] from the Internet" (*n* = 3)

Note. 15 students were interviewed. *n* = number of student comments in the category

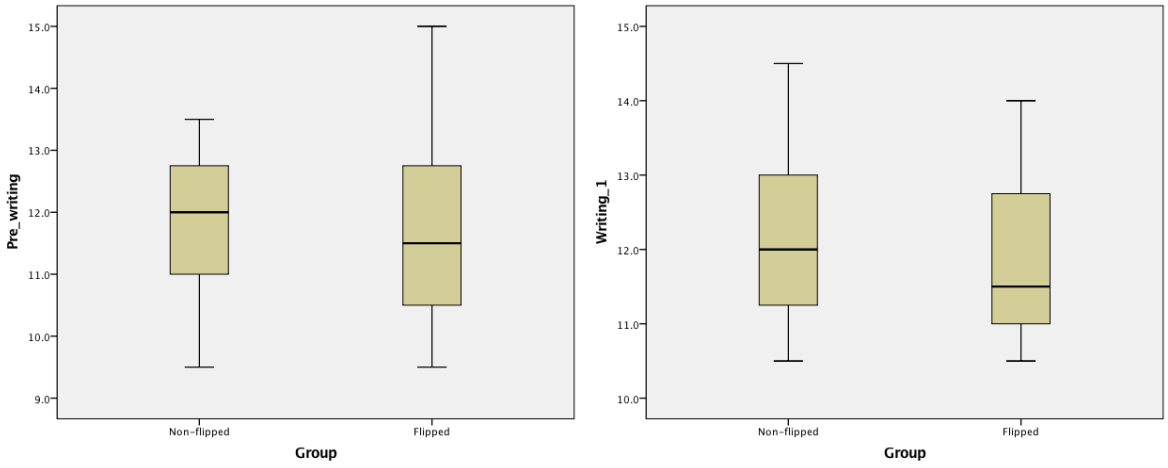
Appendix H. Summary of the Teacher's Reflection Findings

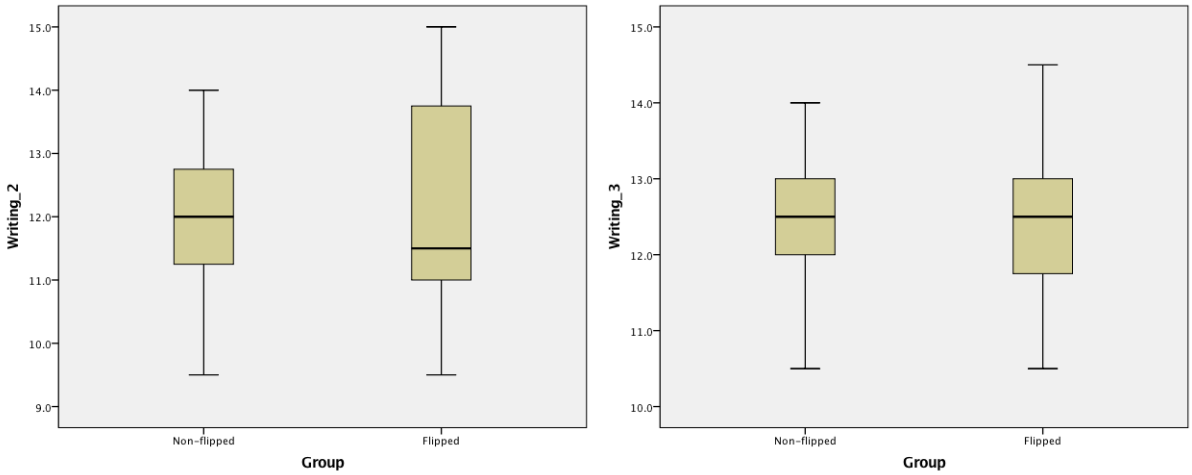
	Example quotes	
	Flipped	**Non-flipped**
Enhanced interest	"Compared with learning through YouTube, they are a lot more focused and engaged." (*n* = 1)	"Students were all on task and engaged." (*n* = 2)
Learning benefits	"When I discussed the topic in class, the students showed good understanding of the topic." (*n* = 2)	"Using the SPELIT power matrix, the students quickly came up with ideas for their writing tasks." (*n* = 3)
Technological advantages	"Students were quite pleased with the EdPuzzle app, which enabled them to work on the video tasks anywhere on their phone." (*n* = 4)	"I can display all students' answers by question on the classroom screen, which made discussing answers so much easier." (*n* = 3)

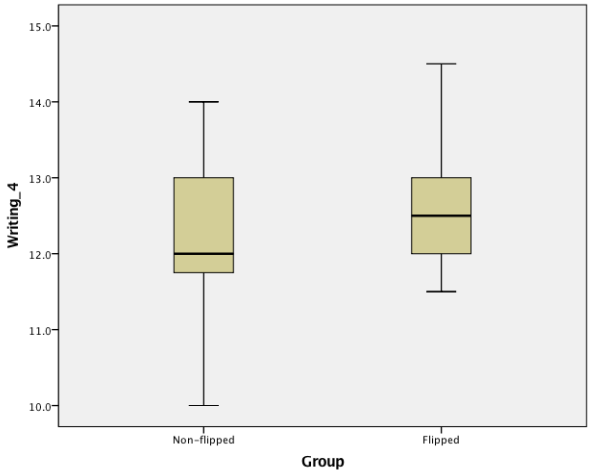
Note. *n* = number of the teacher's comments in the category.

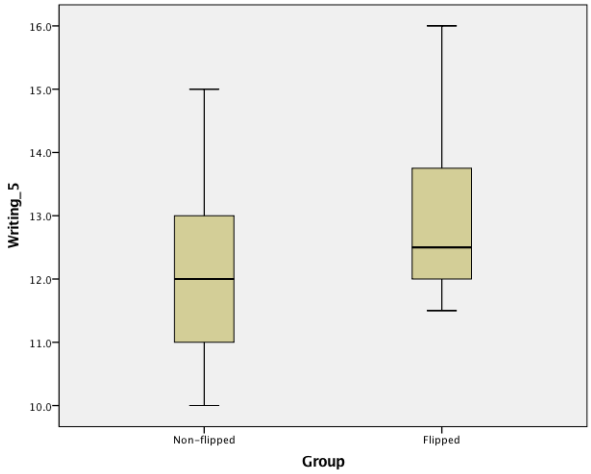
Appendix Ia. Test of Outliers

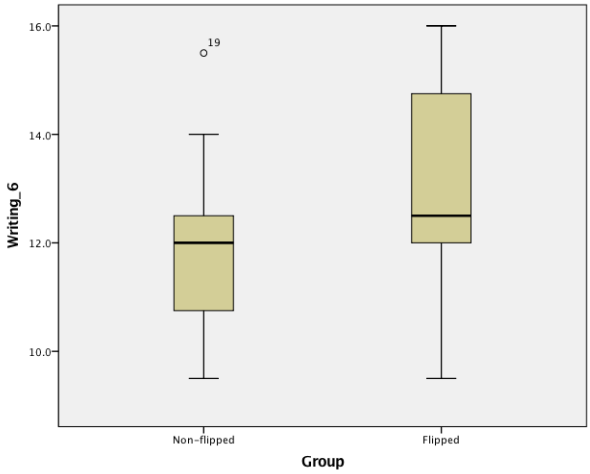
The following boxplots are given for the eight writing tests for both flipped and non-flipped groups. The studentized residuals for all the data were smaller than absolute 3, except for the one score in Writing 8 non-flipped group that had residual of 3.23 (i.e., case ID #23). An observation with a studentized residual that is larger than ±3 is often deemed an outlier (Gray & Woodall, 1994; Silvestrini & Burke, 2018). Therefore, we may consider case ID #23 a significant outlier in this case.

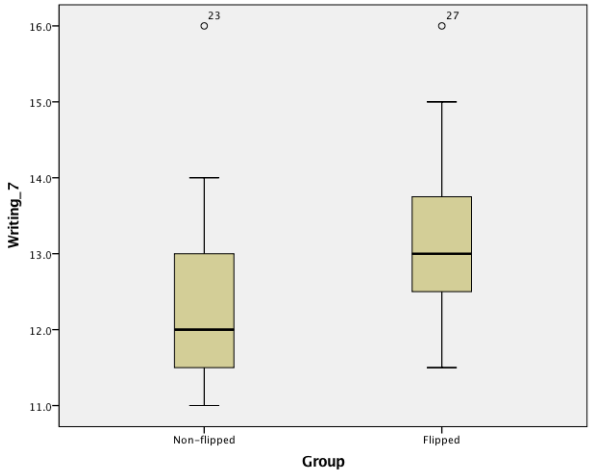






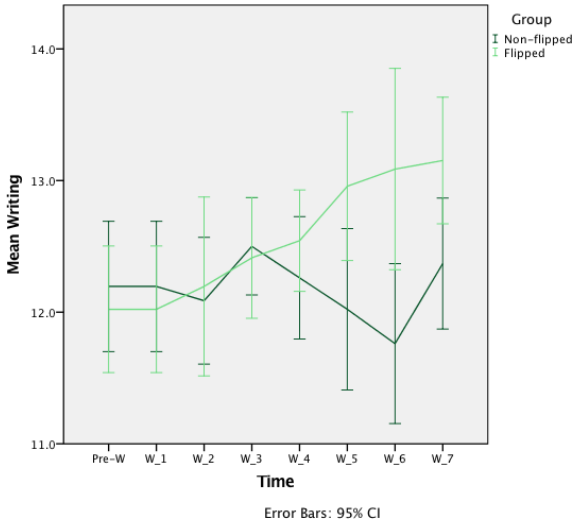




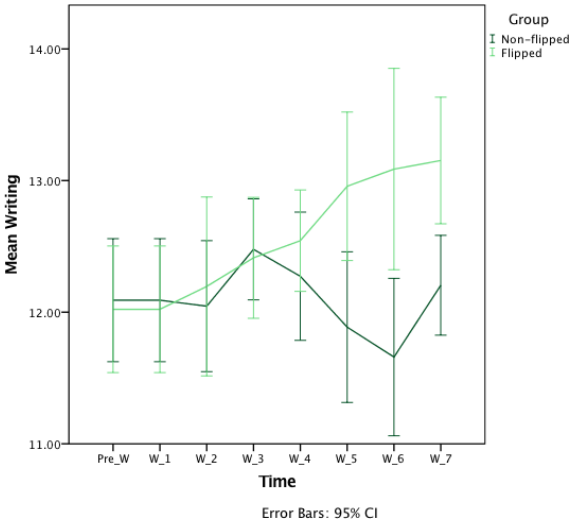


A sensitivity analysis was conducted to see whether the ANOVA results were the same when the case ID #23 was removed. Similar to the original results with full data ($F(7, 308) = 5.09$, $p < 0.001$, partial $\eta^2 = 0.104$), the results of the analysis without outliers also show that the writing scores differed significantly among the writing assessments administered at different times ($F(7, 301) = 5.85$, $p < 0.001$, partial $\eta^2 =$

0.120). The line graphs of mean writing scores with and without outliers are given below. Both graphs look similar to each other. Since the conclusions for the datasets with and without the outlier are essentially the same (e.g., both result in a statistically significant result, both line graphs have confidence intervals that are not appreciably different), we decided to keep the outlier in the analysis.



With outliers



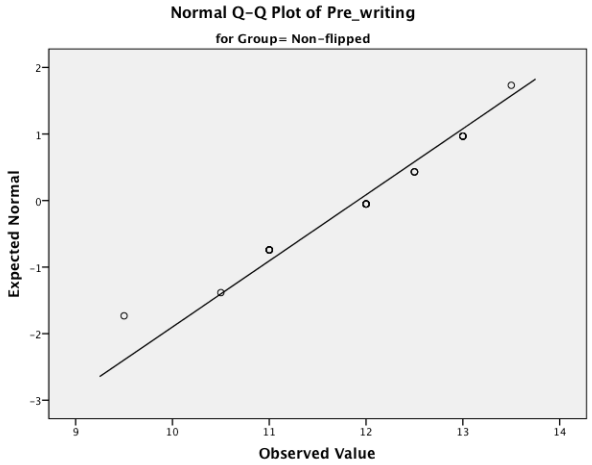
Without outliers

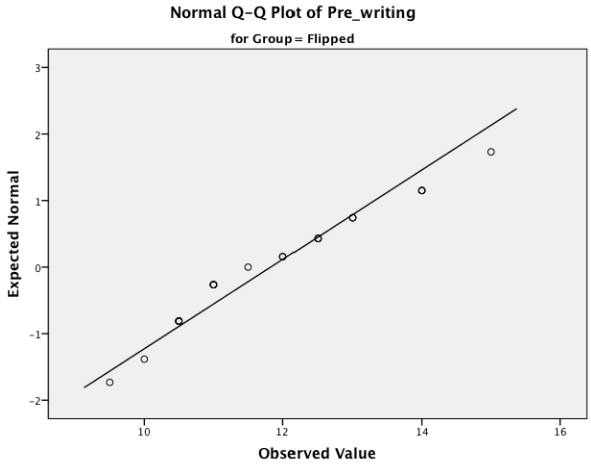
Appendix Ib. Test of Normality

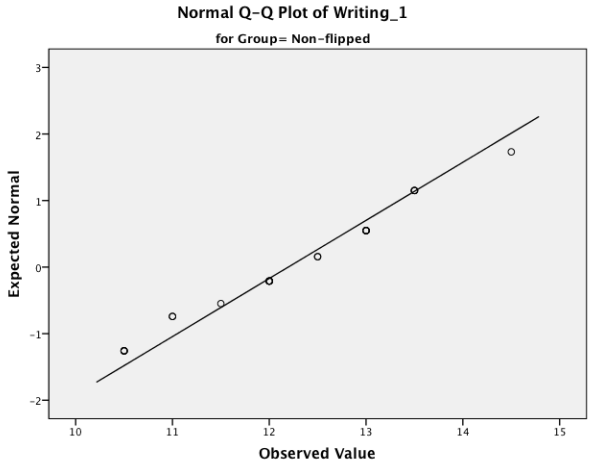
The Shapiro-Wilk test of normality is provided below. The *p*-values for a majority of the groups are larger than 0.05 whereas only a few are smaller than 0.05, which indicates that the distributions of dependent variable in most of the groups are normal. According to Blanca et al. (2017), ANOVA is robust with non-normal data. Blanca et al. (2017) found that ANOVA tests were robust in 100% of 1,308 different data conditions, regardless of the degrees of deviation from a normal distribution of the sample sizes, balanced or unbalanced cells, or of equal or unequal distributions in the groups. ANOVA, therefore, remains a valid statistical test, even under conditions of non-normality (Blanca et al., 2017; Ferreira et al., 2012; Schmider et al., 2010) even with very small sample sizes (Khan & Payner, 2003), and it is preferred to non-parametric analysis or to data transformation procedures (Blanca et al., 2017).

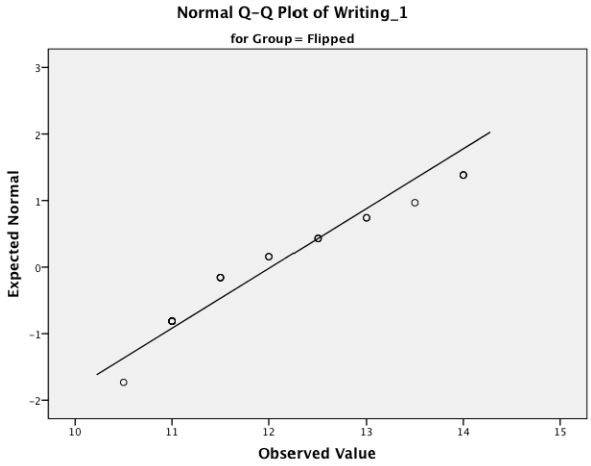
	Group	**Shapiro-Wilk**		
		Statistic	**df**	**Sig.**
Pre_writing	Non-flipped	.926	23	.090
	Flipped	.937	23	.158
Writing_1	Non-flipped	.935	23	.140
	Flipped	.885	23	.012
Writing_2	Non-flipped	.968	23	.649
	Flipped	.906	23	.033
Writing_3	Non-flipped	.932	23	.120
	Flipped	.960	23	.464
Writing_4	Non-flipped	.915	23	.051
	Flipped	.912	23	.044
Writing_5	Non-flipped	.954	23	.361
	Flipped	.908	23	.037
Writing_6	Non-flipped	.954	23	.360
	Flipped	.950	23	.295
Writing_7	Non-flipped	.857	23	.004
	Flipped	.921	23	.069

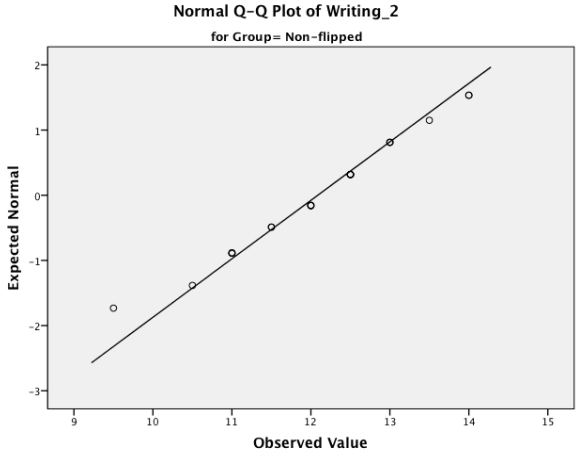
The QQ plots are given below for further reference.

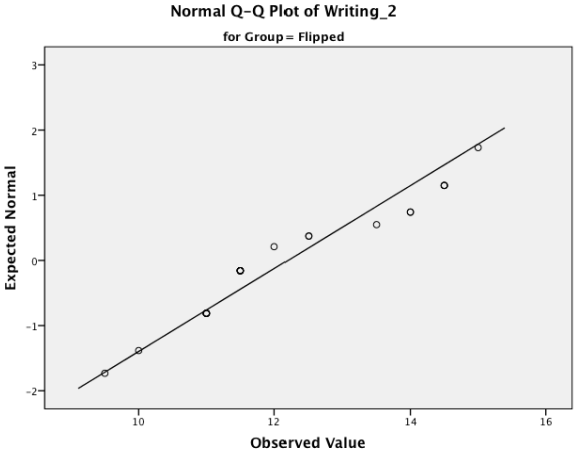

Normal Q-Q Plot of Pre_writing
for Group= Non-flipped
Expected Normal
Observed Value

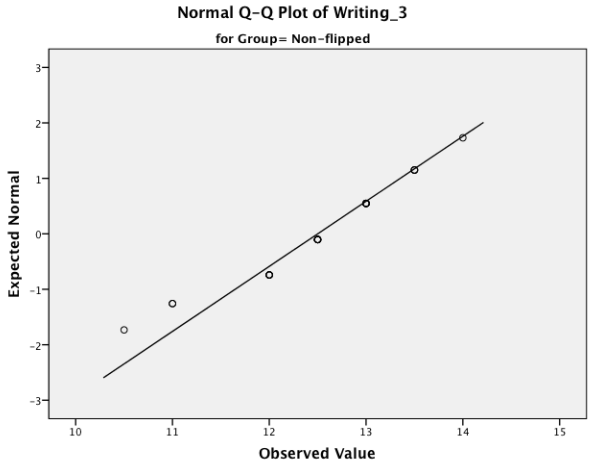

Normal Q-Q Plot of Pre_writing
for Group= Flipped
Expected Normal
Observed Value

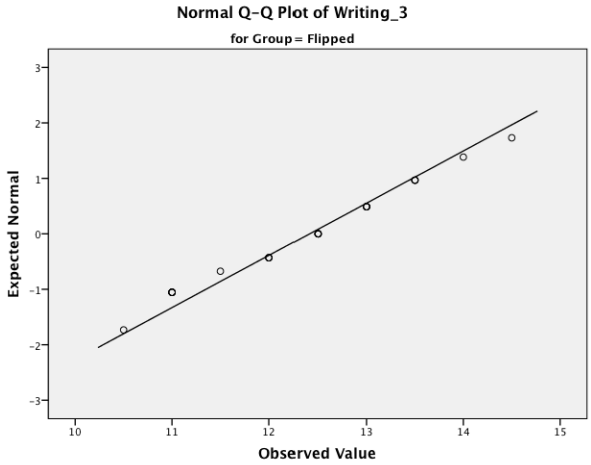

Normal Q-Q Plot of Writing_1
for Group= Non-flipped
Expected Normal
Observed Value

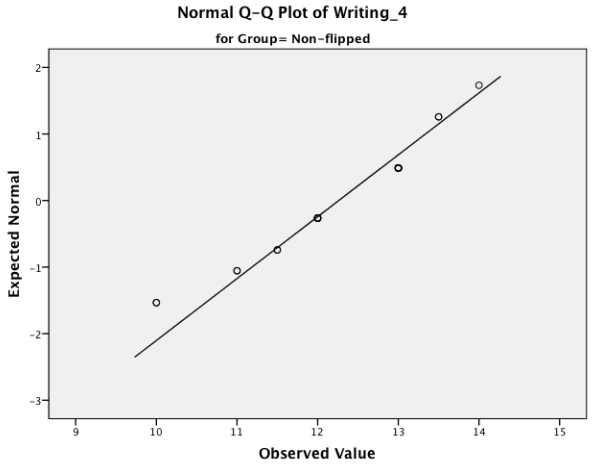

Normal Q-Q Plot of Writing_1
for Group= Flipped
Expected Normal
Observed Value

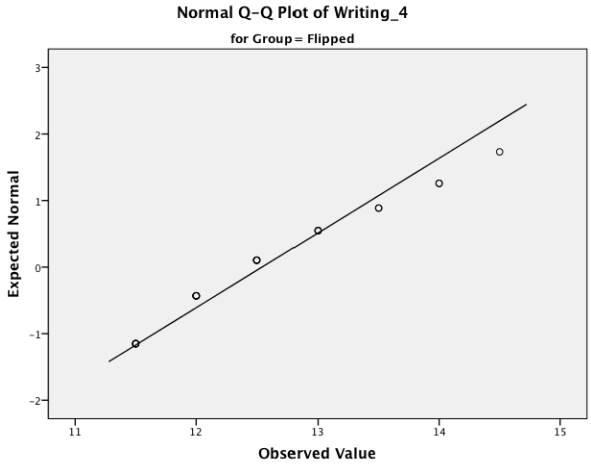

Normal Q-Q Plot of Writing_2
for Group= Non-flipped
Expected Normal
Observed Value

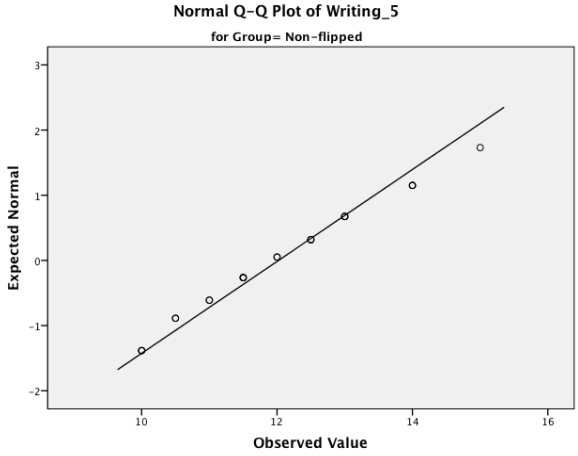

Normal Q-Q Plot of Writing_2
for Group= Flipped
Expected Normal
Observed Value

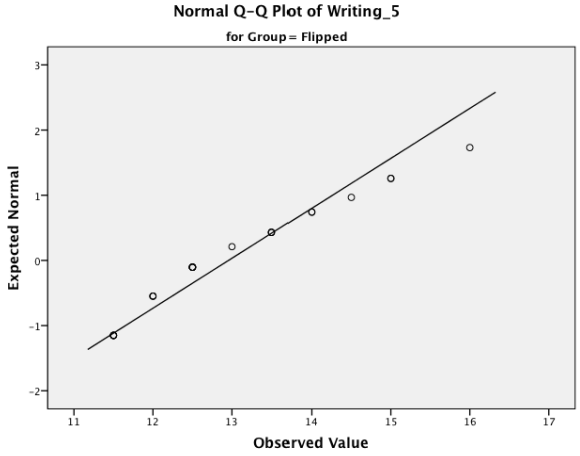

Normal Q-Q Plot of Writing_3
for Group= Non-flipped
Expected Normal
Observed Value

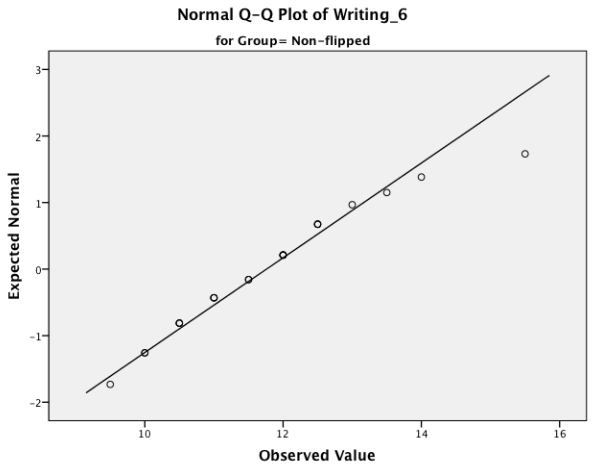

Normal Q-Q Plot of Writing_3
for Group= Flipped
Expected Normal
Observed Value

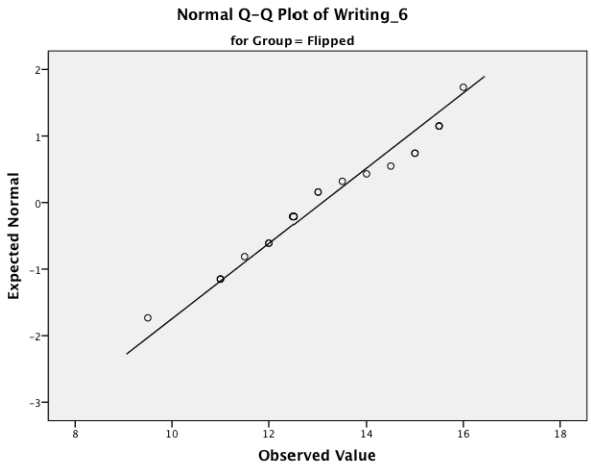

Normal Q-Q Plot of Writing_4
for Group= Non-flipped
Expected Normal
Observed Value

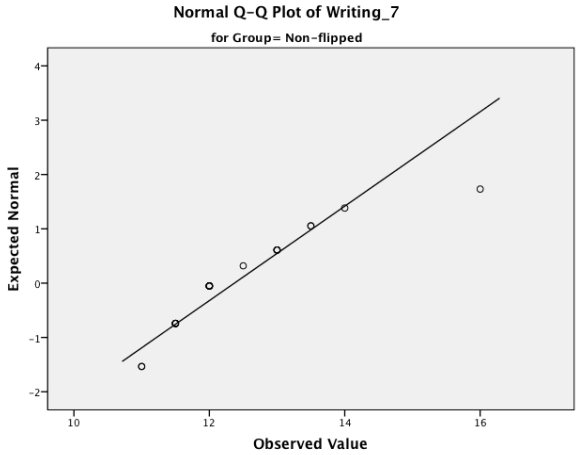

Normal Q-Q Plot of Writing_4
for Group= Flipped
Expected Normal
Observed Value

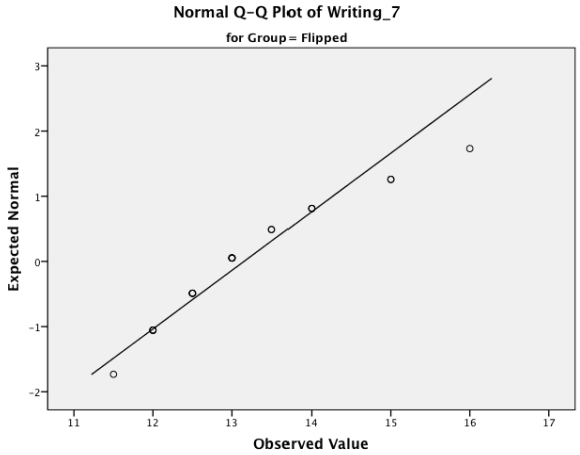

Normal Q-Q Plot of Writing_5
for Group= Non-flipped
Expected Normal
Observed Value


Normal Q-Q Plot of Writing_5
for Group= Flipped
Expected Normal
Observed Value


Normal Q-Q Plot of Writing_6
for Group= Non-flipped
Expected Normal
Observed Value


Normal Q-Q Plot of Writing_6
for Group= Flipped
Expected Normal
Observed Value


Normal Q-Q Plot of Writing_7
for Group= Non-flipped
Expected Normal
Observed Value


Normal Q-Q Plot of Writing_7
for Group= Flipped
Expected Normal
Observed Value

Appendix Ic. Test of Homogeneity of Variances

In a majority of cases, the variances were equal for flipped and non-flipped groups. The variances were unequal only in two cases: the pre_writing scores ($F(1,44) = 5.006$, $p = 0.030$) and the writing_2 scores ($F(1,44) = 4.346$, $p = 0.043$). Regarding the violation of the assumption of homogeneity of variance, ANOVA is robust when sample sizes are equal (Field, 2005), regardless of the total sample size and variance ratio (Blanca et al., 2018). Since the sample size of flipped and non-flipped groups in our study are equal (both are 23 students), we consider the ANOVA test to be robust in our analysis.

	Levene Statistic	**df1**	**df2**	**Sig.**
Pre_writing	5.006	1	44	0.030
Writing_1	0.000	1	44	0.983
Writing_2	4.346	1	44	0.043
Writing_3	1.779	1	44	0.189
Writing_4	1.110	1	44	0.298
Writing_5	0.114	1	44	0.737
Writing_6	1.952	1	44	0.169
Writing_7	0.027	1	44	0.870

Appendix Id. Test of Sphericity

The result of Mauchly's test of Sphericity indicated that the assumption of sphericity had not been violated, $\chi^2(27) = 27.561$, $p = 0.436$.

Mauchly's Test of Sphericity[a]

Measure: Writing

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Epsilon[b] Huynh-Feldt	Epsilon[b] Lower-bound
time	.514	27.561	27	.436	.840	1.000	.143

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Group
Within Subjects Design: time

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

About the Authors

Yau Wai Lam holds a Doctorate in Education from the University of Hong Kong. Her main research interests are instructional design and e-learning.

E-mail: vywlam@connect.hku.hk

Khe Foon Hew is an Associate Professor in the Faculty of Education at the University of Hong Kong. His research interests focus on understanding what engages people to learn in blended- and online-learning environments.

E-mail: kfhew@hku.hk

Chengyuan Jia is a full-time PhD student at the Faculty of Education, the University of Hong Kong. Her research interests lie in blended and online learning, technology-assisted language learning, and EFL listening.

E-mail: jiacy@connect.hku.hk