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The effects of participation, performance, and interest in a game-based writing environment

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Abstract

We have observed that many computer-supported writing environments based on pedagogical strategies have only been designed to incorporate the cognitive aspects, but motivational aspects should also be included. Hence, we theorize that integrating game-based learning into the writing environment may be a practical approach that can facilitate student participation, not only helping students learn how to write, but also sustaining their willingness to write. In this study, we investigate the effects of the game-based writing environment on improving students' participation, performance, and interest in writing. An experiment was conducted to compare the effectiveness of 2 approaches to writing in language arts at an elementary school. Two hundred forty-five third grade students participated in the experiment over a period of 1 year. One hundred thirty-nine students were assigned to an experimental group and learned with a game-based writing environment, and 106 students were in the contrast group and learned with an online writing environment. The empirical results show that the game-based writing environment can effectively promote students' writing participation, writing performance, interest in writing, as well as their perceptions of the use of educational self-management games. Some implications of the experimental results are also discussed.

KEYWORDS

game-based writing environment, writing engagement, writing habit

1 | INTRODUCTION

Elementary students have difficulty with writing. The results of a previous study investigating difficulties with Chinese writing for 3,051 sixth grade students in Taiwan by Yang, Yeh, and Wang (2009) indicated that 511 students feared to receive negative comments from their teachers; 819 students did not know how to start writing an article; 1,173 students did not have ideas related to the writing topic; 1,272 students did not know how to organize the content in their article; and 1,514 students worried that what they had written was too short or poorly written. In other words, Taiwan elementary school students often lack confidence in their writing ability, how to develop ideas about what to write, and writing skill.

These writing difficulties can be classified into two types. The first is *the lack of writing skills* that consists of the basic and advanced level. For a long time, the focus of past studies has been on how to improve students' basic writing skills. For example, research on how to assist with the writing process, help students develop skills, and improve knowledge has increased markedly in recent years (see, for example, Graham, McKeown, Kiuhara, & Harris, 2012). Graham et al. (2012) also attempted to identify effective writing instructional practices for elementary students and found four writing interventions that supported students' writing procedures and produced statistically significant effects: prewriting activities, peer assistance when writing, making goals, and assessing writing. Furthermore, the advanced writing skills involve experienced writers, such as forming strong arguments, use of sources and evidence, textual cohesion, audience awareness, and so on. Though it is still worth further examining, these advanced writing skills are not the threshold that younger writers first meet. The interventions as mentioned above could assist educational practitioners with instruction and enhance students' basic writing skills.

The second type of problem is that students often *lack the motivation to write*. In school, language arts teachers frequently asked researchers why students often lacked the motivation to write and how to increase this motivation (Boscolo & Hidi, 2007). There are

two sets of circumstances that may cause these problems: the complexity of the writing process (Harris & Graham, 1996) and the requirements of a conventional curriculum. In a traditional curriculum, students mostly write compositions on topics provided by the teacher. Some studies have focused on these situations. Bruning and Horn (2000) proposed four conditions aimed at the development of motivation: nurturing functional beliefs about writing, fostering engagement with authentic writing tasks, providing a supportive context for writing, and creating a positive emotional environment. According to previous studies (e.g., Troia, Shankland, & Wolbers, 2012), writing motivation is not a unitary construct. Troia and his colleagues summarized four theorized components of writing motivation—self-efficacy beliefs, goal orientations, personal and situational interest, and attributions for outcomes. Some studies indicated that not only self-efficacy plays a prominent role in writing motivation (e.g., Pajares, 2003) but also other studies (Albin, Benton, & Khramtsova, 1996; Hidi & McLaren, 1991) suggested that interest is necessary because it may lead to facilitate students' writing performance. The aforementioned strategies and components could be used as the reference for educational practitioners to improve students' writing motivation.

1.1 | Applying the game-based learning approach to facilitate the engagement of writing

With advancement in information and communication technology, researchers are finding new ways to facilitate the writing process or solve difficulties students may have in writing via the computer-supported writing environments, especially with regard to improving basic writing skills (e.g., Erkens, Jaspers, Prangsma, & Kanselaar, 2005). In particular, these computer-supported writing environments provided many novel tools and opportunities that encourage students to write through coordinated processes (Erkens et al., 2005) and provided students with a peer audience (Cho & Schunn, 2007). One of the benefits of these tools is that they make it easier for students to participate in the process of writing. Unfortunately, these studies have not emphasized the motivational aspects of writing. Until recently, only a few have explored the motivational aspects, such as in game-based practice for writing (Proske, Roscoe, & McNamara, 2014). Over the past decade, the acceptance of the potential benefits of game-based learning (GBL) has gradually increased among educators, researchers, and practitioners. It has been widely agreed that GBL can increase the attractiveness of learning (e.g., Gee, 2003; Girard, Ecalle, & Magnan, 2013; Hainey, Connolly, Boyle, Wilson, & Razak, 2016). Furthermore, many researchers believe that sustaining motivation is critical for transforming learning from the use of GBL to educational goals (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005; Gee, 2003; Girard et al., 2013; Hamari et al., 2016).

2 | LITERATURE REVIEW

This study considers that a useful way to organize the variety of writing studies is to divide them into two approaches based on the students' writing difficulties. First, the cognitive approach activates basic skills in the prewriting, writing, and rewriting phases (Rohman, 1965). Second, the affective approach arouses students' motivation to write about the difficulty of the task and the contextual resources.

2.1 | Cognitive approach: Computer-supported writing environment

Over the past two decades, many tools and diverse environments have been developed to facilitate the acquisition of writing skills and to assist teachers with instruction. In this study, three main directions of effort are classified according to the proposed tools and environments: prewriting, writing, and rewriting.

To inspire students to generate ideas and write more freely, they are provided with many materials (e.g., narrative texts or attractive cartoon characters) and taught how to utilize organizational tools to arrange their ideas in a prewriting phase. Madden, Chung, and Dawson (2008) reported that visualizing through cartoons provided elementary students with more opportunities for expressive visualization to foster imagination and creativity, where they can write their version of the story according to the created cartoons. Liao and Chan (2013) proposed an interactive approach that proceeds from reading, creating to sharing in which elementary students can recommend their favourite books through richly varied expressions. Others have proposed from a similar perspective, digital tools that build on the concept of the link between reading and writing that show promise for supporting the capacity for narrative construction in elementary students (Cordero et al., 2015). In a more general sense, in the prewriting phase, attractive materials and planning tools can serve as bridges between elementary students' idea generation and concept organization.

From another perspective, students' writing practice can be supported through adopting personal writing or collaborative writing in the writing phase. Studies exploring how to design computer-supported personal writing systems through adaptive prompts or various learning materials included that by Schwonke, Hauser, Nückles, and Renkl (2006) who utilized cognitive and metacognitive prompts to assist undergraduate students in the writing of learning protocols in their so-called eHELp computer-based environment. They found that adaptive prompts improved the quality of the learning protocols and fostered the acquisition of declarative knowledge and deep understanding. To sum up, personal writing in the online writing environment (OWE) can be made more effective by adaptive support based on the individual student's characteristics and needs. Besides, Erkens et al. (2005) developed a computer-supported collaborative writing environment that supports secondary students' efforts to write an argumentative essay. From their analysis of the discussion logs for task-related processes, they found that collaborative coordination could increase the quality of the students' argumentative texts. According to the above studies, we can see that an effective collaborative writing environment is inseparably connected which a scaffolded and interactively guided environment.

The third direction is to facilitate students' efforts for self-revision with a sophisticated automated writing evaluation (AWE) and peer review design in the rewriting phase. According to the critical review of Wilson, Olinghouse, and Andrada (2014), AWE is divided into two aspects: summative scores and formative feedback. The objective of the summative scores is used for assessment purposes, such as

Project Essay Grade™, e-rater®, Intelligent Essay Assessor™, and IntelliMetric™. The objective of the formative feedback is designed for the classroom, such as Criterion (based on e-rater; Educational Testing Service), MY Access! (based on IntelliMetric; Vantage Learning), Summary Street (Kintsch et al., 2000), and WritetoLearn (based on Summary Street and Intelligent Essay Assessor™; Landauer, Lochbaum, & Dooley, 2009), and Writing Roadmap (McGraw Hill). Briefly, AWE of computer-generated feedback provides the measures of written products such as scores, error frequencies, and specific comments or corrections.

Wichmann and Rummel (2013) found that collaboration in the writing of scripts can foster coordination and increase communication frequency among undergraduate students, as well as enhancing revision behaviour. Studies could use an e-portfolio as a reflective tool. In particular, their findings showed that students improved writing performance over time taking advantage of the e-portfolio that helped them document their progress, re-examine their work, and send feedback to peers. These features have the benefit of systematically and efficiently facilitating the rewriting phase. Although keeping the concept above of receiving feedback from peers, Schunn and his colleagues (Cho & Schunn, 2007) developed an educational scaffolding system for writing and rewriting, entitled SWoRD, designed to encourage undergraduate students to practice writing through web-based computer tools. They adopted a reciprocal peer review strategy to improve students' writing skills and to gain content knowledge. The above studies provide support for the use of AWE or peer review as a pivotal rewriting activity.

Besides, Writing Pal system that might be worth discussing by McNamara and colleagues (Allen, Crossley, Snow, & McNamara, 2014; Proske et al., 2014; Roscoe & McNamara, 2013) is an intelligent tutoring system for high school English classrooms. Writing Pal provided students with explicit writing strategy instruction, extended practice, and formative feedback for prewriting, drafting (writing), and revising (rewriting), and it is the overall cognitive approach (Roscoe & McNamara, 2013). The objective of the strategy instruction is used for prewriting, drafting, and revising phases via nine writing lesson videos. The objective of the extended practice is used for drafting phase via 15 game-based practice. The objective of the formative feedback is used for revising phase via automated essay-based feedback. The studies above could be used as the reference for practitioners to design and support overall writing cognitive approach.

2.2 | Affective approach: Integrating game-based learning into the writing environment

Recently, studies have shown GBL to be beneficial in learning mathematics, science, and the like (Barab et al., 2005). Similarly, GBL can be adapted to improve students' writing ability and skills, as well as enhance their affective performance. GBL studies are commonly used for three main reasons: to provide complementary information to stimulate the imagination, to improve learning engagement, and to facilitate sustained participation. Related studies can be divided into three research directions.

The first direction is by fostering imagination and stimulating interest through utilizing narrative cues or attractive phenomena. For example, Thomas and Brown (2007) developed a 3D game narrative environment that provides rich and elaborate spaces. Dickey (2011) examined the effectiveness of using an immersive 3D GBL environment, entitled Murder on Grimm Isle, to foster argumentation and persuasive writing, by transferring game narrative experiences into prewriting activities. In another study, Squire and Jan (2007) developed a location-based augmented reality game to engage students in meaningful scientific argumentation, called the Mad City Mystery. The game provides a series of narrative accounts of scientific phenomena, for which students are required to develop and argue scientific writing or explanations. Game-like virtual learning can enhance the self-efficacy of student writing. The technique of digital storytelling can be effectively used in the classroom setting to teach writing (Xu, Park, & Baek, 2011). In short, the game environment can provide a series of storylines and cues, and inspire positive perceptions.

The second direction is aimed at improving engagement through game-based practice environments. Writing Pal (Allen et al., 2014; Proske et al., 2014) provided students with explicit writing strategy instruction and practice. They adopted a game-based practice strategy to improve students' writing skills (e.g., freewriting, paraphrasing, revising, and so on). They found that students perceived this system to be more interesting and engaging than other forms of writing practice (Proske et al., 2014). Allen et al. (2014) also found that the minigames of Writing Pal could strengthen engagement with the writing task and provide students with opportunities to practice writing strategies. Additionally, Warren, Dondlinger, and Barab (2008) took advantage of the game elements and problem-based learning in a multiuser virtual environment (called Anytown) in order to improve elementary student writing. Their study indicated that game elements could increase voluntary writing and improve the writing achievement of the students. In short, the game elements facilitated the willingness of students to practice writing skills.

The third direction is aimed at facilitating student participation through designing text-based adventure games or accomplishing a series of game tasks by writing a script. Some studies have proposed using a narratological approach to teach writing, such as script development. For example, Quest, a text-based game development tool, allows students to create their text-based adventure games and interactive fictional story games (Ballentine, 2015). Ballentine (2015) also demonstrated how undergraduate students experience the entire software development lifecycle and its many writing challenges while developing their text-based adventure games. Additionally, some have found that computer games have the potential to help students to write (Johnson, 2008). For example, students who played World of Warcraft, a massively multiplayer online role-playing game, could complete writing assignments as a series of implicit and explicit task challenges (e.g., writing various self-determined documents related to the game or creating a learning feedback loop). As another example, children were allowed to play The Sims and then asked to produce different written texts both inside and outside the classroom (Lacasa, Méndez, & Martínez, 2008). In short, games can be designed to encourage students to write stories, strategies, and tips for gaming.

Overall, above most adopting cognitive or affective approach studies investigated the different aspects and obtained preliminary findings and evidence. The former focus on writing performance, such as writing

ideas (Cordero et al., 2015), writing skill (Roscoe & McNamara, 2013), writing quality (Erkens et al., 2005; Schwonke et al., 2006), human feedback quality (Cho & Schunn, 2007), and machine feedback quality (i.e., AWE). The latter emphasizes writing motivation, such as perception (Xu et al., 2011), participation (Ballentine, 2015; Johnson, 2008), engagement (Allen et al., 2014; Proske et al., 2014), and self-efficacy (Squire & Jan, 2007).

2.3 | The present study

We hypothesize that the game-based writing environment (GWE) may be an effective approach. Specifically, this study argues this GBL approach, which not only facilitates participation and helps students learn how to write but also sustains their willingness to write. It is known that the GBL approach has great potential for facilitating the engagement of students in learning activities (i.e., writing activities). However, there are challenges to attracting and sustaining such engagement (e.g., participate and interest) and practice (e.g., performance) in a GWE. The challenges are as follows: (a) to facilitate students' development by engaging in writing tasks that match their abilities and current motivational levels and (b) to help students develop the habits and strategies that will keep them moving ahead productively (e.g., Graham & Harris, 1997). In short, engagement is an important key that can benefit students; but currently, there have been few studies comparing the effectiveness of GWE with normal OWE or exploring the influence of the GBL approach on students' writing.

Hence, an experiment was conducted to evaluate the effectiveness of two situations in language arts courses at an elementary school over a period of 1 year. The specific research questions addressed are

1. To understand the degree that students participate voluntarily in a GWE.
2. To address the effects of different practice conditions on writing performance, at the word level, sentence and paragraph level, and text level.
3. To investigate the influence of the GWE on the writing interest of students, that is, personal and situational interest for the writing activity.

3 | METHOD

3.1 | Participants

Participants were 245 third grade students (42.86% girls; 57.14% boys) and nine teachers from nine classes of an elementary school in a rural area of Taiwan. All students and teachers participated in the study over the period of one school year in Chinese literacy course. One goal of the Chinese literacy course is expected to help students learn how to write. Mean age of students were 9.32 years (*SD* = 0.16). Each student had a computing device with wireless capabilities such as a "tablet PC" and access to a digital classroom environment through wireless access points and an interactive whiteboard. After 6 months of training during the first semester, each student had learned to manipulate the tablet PC and to type. Teachers were 77.78% female with a mean age of 43.48 years (*SD* = 2.39). All teachers' teaching experience ranged from 11 to 14 years and have similar teaching for these writing activities because they received a series of training classes in the previous semester.

3.2 | Research design and procedure

The goal was to understand the influence of GWE on students' *writing participation*, *writing performance* in regard to linguistic differences and their *writing interests*. Therefore, a 2 (Semester) × 2 (Group) quasi-experimental design was used in the experiment (see Table 1). There were no significant differences between the groups for gender, age, and basic writing skills. Participants were randomly assigned to one of two writing conditions with a between-subjects design: an OWE and a GWE. The experiment was conducted consisting of two phases: baseline phase in the first semester and investigative phase in the second semester.

In the baseline phase, all students participated in an OWE. During the first semester, all students familiarized themselves with the writing model. They participated in three 40-min training sessions for operating the system, understanding the writing model, and practicing the writing skills. This was aimed at minimizing the influence or effect of unfamiliarity with the system and the writing model. At the end of the first semester, pretests for Written Expression Task (WET) and Writing Interest Questionnaire (WIQ) were conducted in order to establish a baseline of writing performance and writing interest. After that, the main experiment was conducted during the second semester.

In the investigative phase, the classes were randomly assigned to two conditions: a GWE and an OWE. The GWE was the experimental group (EG) and included 139 students from five classes whereas the OWE was the contrast group (CG) and contained 106 students from four classes (see Table 1). At the beginning of the second semester, the GWE was introduced to the EG. The CG continued to participate in the OWE. The two groups wrote three same thematic articles within their writing environment. When the students finished the experimental activity, WET and WIQ posttests were administered to collect students' perceptions related to system usage.

3.3 | Writing thematic materials

Five thematic materials were provided in Chinese. Each theme had four relevant texts, the aim of which was to stimulate students to

TABLE 1 Context of the study

Group	First semester (baseline phase)	Second semester (investigative phase)	*N* (boys:girls)
Experimental group	OWE	GWE	139 (78:61)
Contrast group	OWE	OWE	106 (62:44)
Total			245 (140:105)

OWE = online writing environment; GWE = game-based writing environment.

generate writing ideas. Both of these student groups wrote on the same themes. There were two themes in the first semester, that is, Theme 1: the imagination of nature and Theme 2: my father. There were three themes in the second semester, that is, Theme 3: cherish time, Theme 4: the surprise of growing up, and Theme 5: a field trip. Writing about these themes helps students integrate new knowledge with what students already know. All students were required to complete these thematic articles.

3.4 | Two conditions of the writing environment

Our research team developed two environments: an OWE (Liao, Chang, & Chan, 2014) and a GWE (Liao, Chang, & Chan, 2015).

3.4.1 | Online writing environment

The OWE supports students to compose their texts through two compositional strategies: (a) *reading for creating* in the writing phase and (b) *talking for revising* in the rewriting phase (Liao et al., 2014). In the writing phase, the OWE incorporates theme-based texts that are used to inspire ideas and also provides questions to guide the students to write their first draft. In other words, students could generate many ideas, practice their writing skills, and observe their writing process (see Figure 1). In the rewriting phase, the OWE considers scaffolding prompts to facilitate students to talk about what they have written. In other words, students could revise and improve their writing according to other students' comments, such as refining topic sentences or thesis statements, and reorganize content.

3.4.2 | Game-based writing environment

The GWE was also developed by the same research group (Liao et al., 2015) based on OWE with game elements in order to gain the students' writing interest and promote their motivation of a longer span of time. Specifically, the GWE provides an island-construction environment; different regions represent different writing themes (see Figure 2). The GWE incorporates many management game elements into the island, such as construction and maintaining, using a simplified, intuitive interface. As in real life, the "island constructors" need to pay for buildings and resources, and a successful island community should include roads, houses, and spaces for people to work, as well as essential services, such as police stations, fire departments, and hospitals.

Hence, we encourage students more often participate actively, because students need to develop and invest an island in GWE. Specifically, students can construct and maintain an island with residential, commercial, and industrial buildings in order to recruit long-stay residents; students also can invest their resources from other students' island in order to attract tourists' attention and interest. These mechanics of island-construction involve a series of writing and gaming activities.

The system provides limited resources according to students' writing practice. For example, according to the writing model process, students are asked to generate the ideas first and then write the draft. So these systems not only assess the amount of the number of writing ideas but also compare the consistency between the previous ideas and draft. Moreover, when the students generate ideas, these systems will give positive feedback or resources (e.g., virtual money). More specifically, most writing activities can earn resources, such as generating new ideas, organizing main ideas, offering helpful suggestions, and revising and completing a manuscript, except taking audience suggestions.

Another, when students use more previous ideas or write more words in their draft, students will get more resources. Likewise, the students' number of suggestions or the degree of revisions will be assessed; and then our systems give students appropriate feedback or resources based on their behaviors. But these number of resources are limited to avoid students to over-reliance on these feedbacks or resources. Through generating and organizing ideas, students can construct a building; through giving suggestions and revising articles, students can upgrade a building. Most gaming activities need students to spend resources, constructing new buildings, upgrading existing buildings, purchasing additional land, and decorating and advertising own island.

Through above first two activities, students can prosper island environment; through the last two activities, students can expand island influence. Students can manage (e.g., construction, upgrade, purchase, and decoration) their island in the island city hall (see Figure 2).

FIGURE 1 Online writing environment in the writing phase [Colour figure can be viewed at wileyonlinelibrary.com]

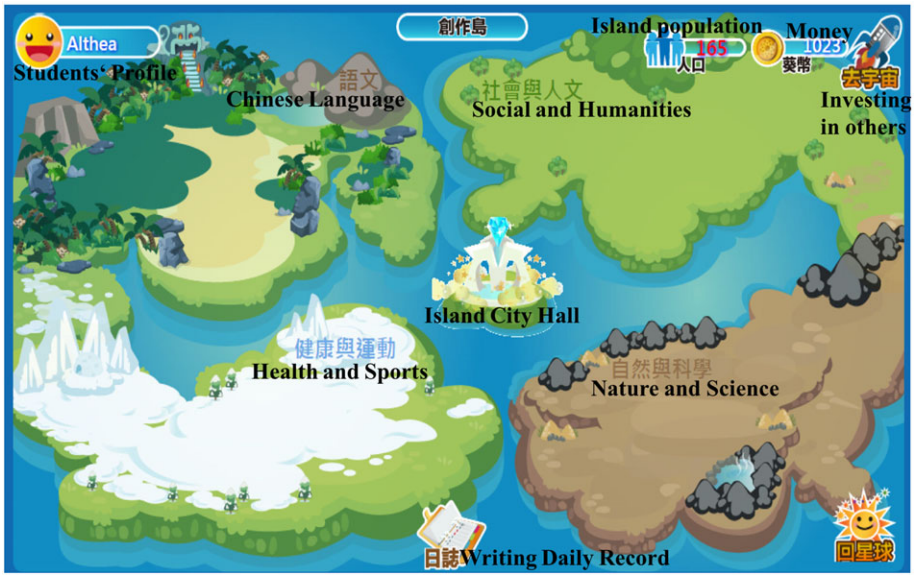

FIGURE 2 Game-based writing environment [Colour figure can be viewed at wileyonlinelibrary.com]

3.5 | Data collection and analysis

3.5.1 | Writing participation

Writing ideas

Weston, Crossley, McCarthy, and McNamara (2011) claimed that the number of writing ideas is a significant predictor of free-writing quality. Also, writing ideas could be an indicator of students' participation, because high participation produces a lot of different ideas about a theme, much more than with low participation. For this reason, this study examines writing ideas generated by EG and CG guided by the association-stimulation free-writing activities to understand how the two environments influence students' participation and diversity of idea generation. Writing idea means the point relevant to writing topics, such as students' experience or new thought. Writing ideas were generated and decided how long of an idea by students. If an idea could not express meaning, it was deleted while scoring. Take Theme 2 as an example. Writing ideas could be scored, such as "My father is tall but fat" and "I love my father play with me." The analysis was conducted by two Chinese language experts, and the Spearman correlation, which was conducted to validate consistency, was very high (r = .920, p < .01).

Length of composition

Longer compositions are often associated with a greater number of ideas. Also, the length of a composition could be an indicator of students' participation because highly engaged students compose a lot more text than those with low participation. For this reason, this study examined the length of compositions for both EG and CG during the two semesters, with the goal of understanding how the two environments influenced student participation and length of compositions produced during a year.

3.5.2 | Written expression and linguistic analysis

The WET is an experimental task designed by the authors to gauge the students' ability to express themselves in writing. The written expression tasks were entitled "My favorite food" given at the end of the first semester (pre-WET) and "Afterschool" given at the end of the second semester (post-WET). Two Chinese language teachers validated the WET according to the written expression using a table of specifications. The internal reliability of the test was .82 and .79 (Cronbach's alpha). The Chinese Readability Index Explorer (CRIE) developed to understand the readability of Chinese texts includes several indicators for the evaluation of textual factors (Sung et al., 2013, 2015). The CRIE relies on machine learning techniques that compute text scores using a set of text variables. This study took advantage of CRIE websites to parse students' articles pre/post-WET, for factors such as *word level* (number of total words, number of different words, and number of difficult words), *sentence and paragraph level* (number of total sentences and number of total paragraphs), and *text level* (the length of the composition).

3.5.3 | Writing interest questionnaire

Interest in writing was measured by the WIQ, designed and developed by the authors. The content of the WIQ was developed based on the four-phase model of interest development (Hidi & Renninger, 2006; Schraw & Lehman, 2001). Twelve items were included in the WIQ, six items for the two components of writing interest: individual interest (II), and situational interest (SI). Individual interest is defined as an individual's tendency towards a topic, activity, or knowledge domain (Cronbach's α = .91), and situational interest is defined as a series of stimuli and conditions that determine an immediately affective response (Cronbach's α = .83). Both of the two types of interest certainly improve students' learning. Students rated their writing interest on a 5-point Likert-type scale (e.g., 1 = *strongly disagree* and 5 = *strongly agree*). Take as an example, the following interest concept: "*I think that writing is interesting*." (II) and "*I like to share my article with others in the online writing environment*." (SI).

All data were analysed with a two-way multivariate analysis of variance (MANOVA) for writing participation, writing performance, and writing interest, where the level of significance was set at p < .05 for all comparisons.

4 | FINDINGS

4.1 | Writing participation

This study collected 490 theme-based articles in the first semester and 723 theme-based articles in the second semester (see Table 2). A two-way mixed design MANOVA revealed both the main effects (Theme: Wilk's Λ = 0.507, $F(8, 230)$ = 24.63, p < .001, partial η^2 = 0.490 and Group: Wilk's Λ = 0.928, $F(2, 236)$ = 8.14, p < .01, partial η^2 = 0.072) and the interaction (Theme × Group: Wilk's Λ = 0.806, $F(8, 230)$ = 6.09, p < .001, partial η^2 = 0.194) are significant. Therefore, the follow-up analysis of the significant interaction was conducted.

In Table 3, this analysis revealed a significant univariate main effect for theme on EG students' writing ideas and both groups' compositional length, but no significant on the writing ideas of CG. This implied that both groups produced better from first semester (i.e., T1 and T2) to second semester (i.e., T3, T4, and T5), except the CG students' writing ideas. Besides, the results indicated that students in EG demonstrated significantly greater writing ideas (i.e., T3, T4, and T5) and compositional length (i.e., T4) than those in CG in the second semester, although the compositional length of CG (i.e., T1) demonstrated significantly greater than EG in the first semester. Consequently, these findings implied that students using the GWE seemed to be more capable of generating writing ideas and longer articles than in the OWE.

Moreover, we consider the possibility that results of EG due to the novelty effect of game-based writing practice. In Table 3, post hoc comparisons (i.e., theme at EG) indicated that the compositional length of T5 was significantly higher than T4 and T3. This means that game-based writing practice effects continued to facilitate students' participation, then the effects are not just novelty. More specifically, it shows an overall upward trajectory from T1 to T5. Figure 3 also showed that the compositions gradually increased in length.

4.2 | Writing performance

Table 4 showed the descriptive statistics for the WET assessing students' writing performance. A two-way mixed design MANOVA revealed the main effects of Semester (Wilk's Λ = 0.219, $F(6, 231)$ = 127.36, p < .001, partial η^2 = 0.781) and the interaction on Semester × Group (Wilk's Λ = 0.869, $F(6, 231)$ = 5.40, p < .001, partial η^2 = 0.131) are significant, but the analysis also showed no significant differences on Group (Wilk's Λ = 0.972, $F(6, 231)$ = 1.04, p > .05, partial η^2 = 0.028). Therefore, the follow-up analysis of the significant interaction was conducted.

In Table 5, this analysis revealed a significant univariate main effect for the semester on EG students' five textual indicators and CG students' three textual indicators. This implied that both groups performed better from the first semester to the second semester. Moreover, the results indicated that univariate main effects were no significant on the first semester for most of the textual indicators,

TABLE 2 Means and standard deviations for writing participations

		First semester		Second semester		
		Theme 1 *M* (*SD*)	Theme 2 *M* (*SD*)	Theme 3 *M* (*SD*)	Theme 4 *M* (*SD*)	Theme 5 *M* (*SD*)
EG	Ideas	2.29 (3.10)	1.65 (2.50)	3.44 (3.18)	4.02 (5.80)	3.72 (2.46)
	Length	138.91 (91.60)	209.68 (96.64)	229.39 (113.97)	260.30 (157.88)	284.06 (189.33)
CG	Ideas	2.17 (2.59)	1.67 (2.21)	1.83 (1.37)	2.16 (2.79)	2.25 (2.03)
	Length	186.27 (139.60)	231.09 (134.88)	215.07 (97.67)	207.96 (112.86)	261.13 (196.30)

Note. EG = experimental group; CG = contrast group.

TABLE 3 Univariate main effects for writing participations

		df	*F*	MSE	Partial η^2	*p*	Comparison
Theme							
EG	Ideas	(4, 132)	12.93	147.57	0.098	<.001***	T5 > T2, T1; T4 > T2, T1; T3 > T2, T1
	Length	(4, 132)	72.10	762759.74	0.377	<.001***	T5 > T4 > T3 > T2 > T1
CG	Ideas	(4, 105)	1.07	3.54	0.012	.374	T5 > T3
	Length	(4, 105)	15.05	245136.45	0.142	<.001***	T5 > T4, T3, T2, T1; T4, T3, T2 > T1
Group							
T1	Ideas	(1, 244)	0.20	1.61	0.001	.658	
	Length	(1, 244)	9.98	131303.50	0.040	.002**	CG > EG
T2	Ideas	(1, 244)	0.01	0.04	0.000	.931	
	Length	(1, 244)	3.73	47872.89	0.015	.055	
T3	Ideas	(1, 244)	22.63	148.85	0.087	<.001***	EG > CG
	Length	(1, 244)	0.38	3326.52	0.002	.539	
T4	Ideas	(1, 244)	8.69	195.20	0.037	.004**	EG > CG
	Length	(1, 244)	13.38	227163.45	0.053	<.001***	EG > CG
T5	Ideas	(1, 244)	14.98	133.35	0.059	<.001***	EG > CG
	Length	(1, 244)	0.96	34830.77	0.004	.328	

Note. EG = experimental group; CG = contrast group; MSE = mean squared error; T1 = Theme 1; T2 = Theme 2; T3 = Theme 3; T4 = Theme 4; T5 = Theme 5.
*p < .05. **p < .01. ***p < .001.

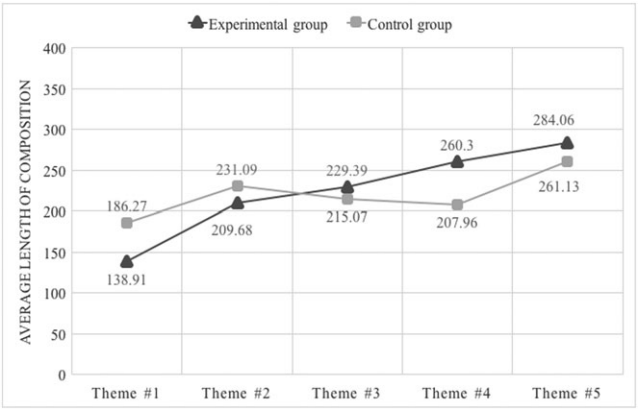

FIGURE 3 Gradual increase in the length of compositions for the two groups during the first and second semesters

but the results also showed that main effects were significant on the second semester for the *word level* (number of total words, number of different words, and number of difficult words), *sentence and paragraph level* (number of total sentences), and *text level* (the length of the composition).

Based on the above, the EG students produced more sophisticated words and more sentences than the CG students. Consequently, these findings suggest that students in the GWE seemed to be more capable of producing words and combining sentences into longer compositions than those students in the OWE.

4.3 | Writing interest

Writing interest included the concepts of individual interest and situational interest (see Table 6). A two-way mixed MANOVA revealed the main effects of Group (Wilk's $\Lambda = 0.972$, $F(2, 236) = 3.15$, $p < .05$, partial $\eta^2 = 0.028$) and the interaction on Semester × Group (Wilk's $\Lambda = 0.949$, $F(2, 236) = 5.99$, $p < .05$, partial $\eta^2 = 0.051$) are significant, but the analysis also showed no significant differences on Semester (Wilk's $\Lambda = 0.995$, $F(2, 236) = 0.53$, $p > .05$, partial $\eta^2 = 0.005$).

Therefore, the follow-up analysis of the significant interaction was conducted. In Table 7, this analysis revealed a significant on situational interest increased for EG students and decreased for CG students from the first semester to the second semester. Besides, the results also revealed that students in EG demonstrated significantly greater interest than those in CG in the second semester, but the two groups presented similarly in the first semester.

Based on the above, the writing interest of students participating in GWE increased more than those participating in OWE. The findings above confirm that a GBL approach to an OWE supports the development of situational interest and even the facilitation of individual interest.

5 | DISCUSSION

5.1 | Facilitating voluntary participation from compulsory to spontaneous writing

The results showed that both groups gradually produced better from the first semester to the second semester, but not including the CG students' writing ideas. CG students in OWE may lack the willingness to generate more ideas for writing; in contrast, EG students in GWE have some game mechanisms (e.g., island construction and game-based feedback) and then developed their willingness for writing. The findings indicated that the GWE led to a significant increase in the number of writing ideas and the length of the composition in GWE over OWE. This finding is consistent with previous research. For example, Allen et al. (2014) found that utilizing games with learning activities could increase writing engagement and provide opportunities to practice writing strategies.

In brief, our results described that voluntary participation is an engagement process, which is more complex than expected. Previous studies (Fredricks, Blumenfeld, & Paris, 2004) defined engagement as three types: behavioural, cognitive, and emotional engagement. In this study, we explored the influence of a GBL approach to encourage students' voluntary participation, which is similar to behavioural engagement in writing activities, and to connect voluntary participation with writing performance. Noticeably, Sabourin and Lester (2014) also showed that a GBL environment was able to both support learning and promote engagement. Furthermore, Huizenga, Admiraal,

TABLE 4 Means, standard deviations for pre- and post-WET

	First semester		Second semester	
	EG *M* (*SD*)	CG *M* (*SD*)	EG *M* (*SD*)	CG *M* (*SD*)
Word level				
Total number of words	133.07 (76.53)	143.49 (91.94)	189.89 (89.74)	152.24 (66.53)
Number of different words	70.82 (29.75)	78.14 (36.94)	101.01 (39.44)	86.35 (33.26)
Number of difficult words	50.27 (26.37)	54.73 (28.92)	60.29 (29.06)	49.38 (23.55)
Sentence and paragraph level				
Total number of sentences	13.44 (8.02)	14.16 (9.26)	18.54 (10.10)	14.75 (7.60)
Total number of paragraphs	3.32 (1.83)	2.85 (1.58)	3.38 (1.41)	3.19 (1.28)
Text level				
Length of composition	219.14 (110.86)	238.43 (129.86)	345.39 (156.07)	282.88 (121.32)

Note. EG = experimental group; CG = contrast group.

*$p < .05$. **$p < .01$. ***$p < .001$.

TABLE 5 Univariate main effects for WET

		df	*F*	MSE	Partial η^2	*p*	Comparison
Semester							
EG	T#W	(1, 132)	46.86	163205.82	0.276	<.001***	S2 > S1
	#DW	(1, 132)	120.01	59985.68	0.494	<.001***	S2 > S1
	#DFW	(1, 132)	17.51	7348.79	0.125	<.001***	S2 > S1
	T#S	(1, 132)	44.36	1724.66	0.265	<.001***	S2 > S1
	T#P	(1, 132)	3.73	9.29	0.029	.056	
	LC	(1, 132)	112.27	163205.82	0.477	<.001***	S2 > S1
CG	T#W	(1, 105)	0.05	164.65	0.001	.825	
	#DW	(1, 105)	5.49	2904.44	0.056	.021*	S2 > S1
	#DFW	(1, 105)	3.75	1567.74	0.039	.056	
	T#S	(1, 105)	0.27	9.48	0.003	.602	
	T#P	(1, 105)	5.34	6.82	0.054	.023**	S2 > S1
	LC	(1, 105)	11.22	89409.05	0.109	.001**	S2 > S1
Group							
S1	T#W	(1, 229)	2.06	12549.86	0.009	.153	
	#DW	(1, 229)	3.36	3683.05	0.014	.068	
	#DFW	(1, 229)	2.12	1613.43	0.009	.146	
	T#S	(1, 229)	0.59	41.00	0.002	.460	
	T#P	(1, 229)	4.28	12.77	0.018	.040*	EG > CG
	LC	(1, 229)	2.05	29580.81	0.009	.153	
S2	T#W	(1, 229)	12.23	78629.89	0.049	<.001***	EG > CG
	#DW	(1, 229)	8.82	11640.07	0.036	.003**	EG > CG
	#DFW	(1, 229)	9.63	6779.43	0.039	.002**	EG > CG
	T#S	(1, 229)	8.87	727.09	0.036	.003**	EG > CG
	T#P	(1, 229)	1.05	1.96	0.004	.306	
	LC	(1, 229)	10.96	215075.57	0.044	<.001***	EG > CG

Note. EG = experimental group; CG = contrast group; WET = Written Expression Task; S1 = first semester; S2 = second semester; T#W = total number of words; #DW = number of different words; #DFW = number of difficult words; T#S = total number of sentences; T#P = total number of paragraphs; LC = length of composition.

*p < .05. **p < .01. ***p < .001.

TABLE 6 Means and standard deviations for pre- and post-WIQ

	First semester		Second semester	
	EG *M* (*SD*)	CG *M* (*SD*)	EG *M* (*SD*)	CG *M* (*SD*)
Individual interest	22.86 (4.29)	22.50 (4.11)	23.63 (3.96)	21.77 (5.01)
Situational interest	23.03 (4.54)	23.68 (4.04)	24.01 (3.84)	22.08 (4.70)

Note. WIQ = Writing Interest Questionnaire. Possible range for overall individual interest (6 ~ 30). Possible range for overall situational interest (6 ~ 30).

Akkerman, and Ten Dam (2009) indicated a positive relationship between engagement and learning. However, it is still a huge challenge for researchers to think about how to support and facilitate students' voluntary participation to change writing from a compulsory to a spontaneous activity.

5.2 | Improving students' writing performance from reading to creating, from talking to revising

We looked specifically at improvements at three level for students over two semesters via linguistic analysis. Students allowed to explore and create a digital product on their own enjoyed writing environment for reading, creating, talking, and revising that enabled students to put these skills into practice from the learn-to-write to write-to-learn phase. The results proved that EG students in the GWE seemed to be more capable of producing diversified words and combining

TABLE 7 Univariate main effects for WIQ

		df	*F*	MSE	Partial η^2	*p*	Comparison
Semester							
EG	Individual interest	(1, 132)	2.39	41.26	0.017	.124	
	Situational interest	(1, 132)	4.53	68.51	0.031	.035*	S2 > S1
CG	Individual interest	(1, 105)	1.54	22.15	0.018	.218	
	Situational interest	(1, 105)	7.81	106.88	0.086	.006**	S2 < S1
Group							
S1	Individual interest	(1, 229)	0.39	7.02	0.011	.531	
	Situational interest	(1, 229)	1.17	22.25	0.012	.280	
S2	Individual interest	(1, 229)	9.45	181.60		.002**	EG > CG
	Situational interest	(1, 229)	11.24	196.25	0.091	.001**	EG > CG

Note. WIQ = Writing Interest Questionnaire; S1 = first semester; S2 = second semester.

*p < .05. **p < .01. ***p < .001.

sentences into longer compositions than CG students in the OWE. In other words, the findings specifically showed that game mechanisms in the GWE had a positive effect on writing performance.

Therefore, we speculate that game mechanisms make the significant impact on students' writing performance. For example, students in GWE could build and manage their island while at the same time practicing basic writing skills and concepts. Moreover, Brom et al. (2014) also found those game mechanisms are related to positive affect and both further to learning gains. Our arguments appear to be consistent with Shernoff's (2013) notions, which would have a positive effect on learning through positive engagement. Besides, this phenomenon proved that GWE more promoted these students' ability regarding reading, creating, talking, and revising experiences from the emergent to conventional phase. Thus, these statements also corroborated and built on previous studies of cognitive engagement in GBL (Fredricks et al., 2004).

5.3 | Increasing students' interest in writing by using a GBL approach

The results showed that GWE could increase students' interest whatever individual or situational interest in the writing activity. This implied that GBL approach could play a role, which posits that interest is a critical aspect of learning. Noticeably, previous research suggested that individual interest is related to intrinsic motivation (Hidi & Renninger, 2006). This means that it was hard to change the students' individual interests. According to the recent study, we speculate that it takes more time to develop one's individual interest rather than provide a different environment. For example, Bergin (2016) argued that the impact of social influences on interest may occur through experiences with friends, competition, public performance, and culture.

Therefore, we suggest that researchers need to consider diverse strategies to increase the students' interest in writing with a GBL approach. First, a self-management learning game should be designed to keep students engaged and interacting on the long-term. Indeed, more and more game-like multi-user virtual environments are being developed for educational purposes, such as *Quest Atlantis* (Barab et al., 2005). Second, the writing topics of interactive games should be given consideration. For example, researchers and teachers could codesign new courses and applications of educational games. Finally, the kinds of situations in sustainable games and simulation games should be considered. Interesting games could motivate long-term writing activity and sustain deep levels of motivation. Stimulating games could motivate short-term learning activity, such as for one unit of a writing course.

6 | CONCLUSIONS

This study aimed to compare the effect of writing performance in two writing environments, an online writing approach and a GBL approach, taking into consideration not only the cognitive aspects but also the aspects of behavioural participation and the motivational experience. This study compared two writing environments, GWE and OWE, which might lead students to have different experiences. The findings showed that GWE practice produced positive outcomes regarding an increase in the number of ideas and the length of the composition; significant improvement in students' writing performance; and the GBL approach increased students' interest in the writing process. We expect GWE interaction trends over time to be crucial to improving performance and motivation and to provide students with incentives over the environment. Overall, these findings afford researchers the opportunity to understand the effects of GWE and their impact on students' writing.

6.1 | Limitations of the study and future directions

This study has demonstrated that GBL approach is needed and should be stressed in students' writing environment. Due to the limitations of this study, further investigation is required about three aspects: behavioural, cognitive, and motivational. Regarding writing/gaming behaviours, the students' interactive behaviours in GWE and OWE were not analysed and compared. Some important or interesting interactive and writing patterns might have been ignored. Regarding cognitive and motivational aspects, particularly challenging is individual differences. First, we should understand the impact of students' differences, such as gender, prior knowledge, writing habits, and cognitive processes. Second, it is highly likely that individual teachers interpreted/implemented the curriculum differently, but that may or may not have affected the experimental results. But simply assuming that there were no students' difference or teacher effects are not justifiable. Besides, creation-island is used as an example, but this cannot reflect all GWE although it does offer a starting point to investigate the influences on students' participation, performance, and interest. Other GWE and the consistency of results should be examined in the future.

Although this study has limitations, it can serve as the basis for further study. Therefore, we will understand and specify the nature of these factors and how to provide optimum support in GWE. In other words, how to consider these factors by developing more linguist features with related machine learning techniques and deep learning approach and support students' writing assessment, which still needs to be studied. To obtain more reliable and objective data and determine whether students' writing participation, performance, and motivation have increased, we intend to continue pursuing this line of investigation on the relationships between prewriting, writing, and rewriting and examines the long-term influence of GWE. We hope that future research will provide more detailed results.

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