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Investigating the Effect of Game-based Writing Environment on Students' Writing Participation, Performance, and Interest

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Abstract: In this study, we investigated the effect of game-based writing environment for improving students' participation, performance and interest of writing. An experiment was conducted to evaluate the effectiveness of two conditions in language art courses at an elementary school. Total of 245 third graders students participated in the experiment during a year. 139 students were assigned to the experimental group and learned with a game-based writing environment (GWE), and 106 students were in the control group and learned with an online writing environment (OWE). From the empirical results, it was found that GWE could effectively promote students' writing participation, writing performance, interest on writing, as well as their perceptions of the use of educational self-management games. Moreover, some implications about the experimental results were also discussed.

Keywords: game-based learning, online writing environment, writing performance, interest on writing

1. Introduction

Digital game-based learning has shown some benefits in learning mathematics, science, and so on (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005). One potential advantage is to foster student engagement in game-based learning environment. Unfortunately, few researches were adopted into the use of game-based learning elements as a support for learning to write, or allowing students to practice their writing skills. This study carefully reviewed some related studies.

On one hand, some researchers utilized some narrative cues or attractive phenomena in 3D game-based learning environment and some studies considered that game narrative design provides rich and elaborate spaces for fostering imagination and play (Thomas & Brown, 2007). For examples, Dickey (2011) investigated that an immersive 3D game-based learning environment, entitled Murder on Grimm Isle, used to foster argumentation and persuasion writing, because game narrative experiences were transferred into prewriting activities. Moreover, Squire, & Jan (2007) developed a location-based augmented reality game for engaging students in meaningful scientific argumentation, called Mad City Mystery. This game provides a series of narrative accounts of scientific phenomena, and requires students to develop and argue scientific writing or explanations. In short, the game environment could provide a series of storylines and cues, and inspire students' writing ideas.

On the other hand, some research groups attempted to support writing skill practice in game-based learning environment. McNamara and her colleagues (Roscoe, & McNamara, 2013; Proske, Roscoe, & McNamara, 2014; Allen, Crossley, Snow, & McNamara, 2014) developed an intelligent tutoring system, called Writing Pal, and provided students with explicit writing strategy instruction and practice. They adopted that game-based practice strategy to improve students' writing skills (e. g. freewriting, paraphrasing, revising, and so on), and revealed that students perceived more interesting and engaging than other forms of practice (Proske, Roscoe, & McNamara, 2014). Allen et al. (2014) also found that mine-games of Writing Pal could increase writing engagement and provide students

opportunities to practice writing strategies. In short, the game elements could facilitate the willing of students into practice writing skills.

Following the above studies, the game-based learning approach has been potential for facilitating the engagement of students in writing activities. However, it could be a challenge that to achieve and sustain students' engagement with practice in a game-based writing environment. In brief, engagement likes as an important key which possible brings some benefits for students; yet there is currently few researches comparing the effectiveness of game-based writing environment with conventional forms of online writing environment and then exploring the game influence for students' writing.

Hence, this study expected that game-based writing environment may be an effective approach which not only facilitates students' participation or helping students learn how to write, but also sustains students' the willing to write. The research goals in particularly were: 1) to understand the degree of students perceive more voluntary participation in game-based writing environment. 2) To examine the effects on writing performance, such as word level, sentence and paragraph level, and text level. 3) To investigate the extent to which students perceive game-based writing environment as more interesting.

2. Methods

2.1. Participants and Research Design

This study employed a between subject design with two groups. The participants were 245 nine-year-old third-grade students from nine classes of elementary school and 9 teachers in rural area in Taiwan. All students and teachers participated in this study during two semesters in order to understand the influence of students' *writing participation*, *writing performance* about linguistic differences and their *writing interesting*.

In the first semester, all students participated in an online writing environment (OWE). In the second semester, these students were assigned to two conditions: online writing platform with game-based writing environment (GWE) and pure online writing environment (OWE). GWE means experimental group (EG) and there are 139 students participated in. In contrast, OWE means control group and there are 106 students participated in. Both of these two group students should write the same writing topics: There are two themes in the first semester, Theme #1: the imagination of nature and Theme #2: my father. There are three themes in the second semester, Theme #3: cherish time, Theme #4: the surprise of growing up, and Theme #5: a field trip.

2.2 Two Writing Environment Treatments

2.2.1. Online Writing Environment (OWE)

Online writing environment (OWE) developed by the research group (Liao, Chang, & Chan, 2014) for helping students to writing and rewriting, see figure 1. First, the writing process includes 3 steps: *theme-based reading*, *association-stimulation freewriting*, and *organizing into a draft*. Specifically, students could gain domain knowledge about writing topics through theme-based reading in step 1. The theme-based essay had to be convincing and based on authentic information sources. Students could generate ideas with guidance extensively through association-stimulation freewriting in step 2. Finally, students could compose an essay based on written ideas through composition in step 3.

Second, the rewriting process includes 3 steps: *examining peer articles*, *peer talking*, and *self-revising*. Specifically, students could access and aware other students' content of articles through examining other articles in step 1. Students could read classmates' articles and give suggestions for helpfulness and specificity. Moreover, students in the step of peer talking also could provide textual and oral responses with scaffolding prompts in step 2, such as, supporting classmates by cueing them about their articles or about aspects of revision; students could revise an essay based on other students' suggestions through self-revising in step 3. The OWE enables students' meaningful revision activity, not just editorial actions.

2.2.2. Game-based Writing Environment (GWE)

Game-based writing environment (GWE) also developed by the research group (Liao, Chang, & Chan, 2015) integrated the management game into writing and rewriting activity for arousing interest of students, see figure 2. The GWE provides an engaging island-construction environment in which students could build and maintain an island with residential, commercial, and industrial buildings (i.e. writing process), and invest their selves money in other students' island in order to attract tourists' attention and interest (i.e. rewriting process). In particular, the GWE incorporates many elements of an island, using a simplified interface designed to be intuitive for young students. As in real life, "island constructors" in the game need to pay for buildings and resources, and a successful island should include roads, houses, and spaces for people to work, and essential services such as police and fire departments and hospitals.

Furthermore, among game categories, the category of management games has one characteristic: the student plays the role of "island constructor" to administer his/her island for long period of time. This characteristic is helpful to sustain the motivation to learn. Besides, based on idea of management game, while students develop their own island or invest others' island, they are actually taking good care of their own learning status in the form of game playing. In short, the GWE incorporates the island' map and provides feedbacks designed to arouse the students' caring nature. The idea is to enhance and transform the learning process by skillfully interweaving writing and managing to create a new environment.

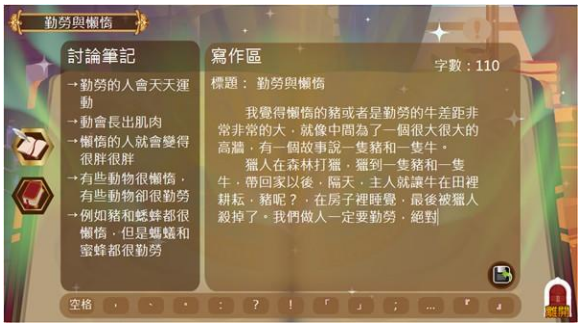

Figure 1. Online Writing Environment

Figure 2. Game-based Writing Environment

2.3. Data Collection and Analysis

2.3.1. Writing Participation Records

The collected data included the timestamps of specific relevant writing data in OWE and GWE, such as writing ideas and articles performance. Each student should write 2 and 3 articles in the first and second semester.

Writing idea: Weston, Crossley, McCarthy, & McNamara (2011) claimed that the number of writing ideas would be the significant predictor of free-writing quality. For this reason, this study examines the writing ideas of EG and CG guided by the association-stimulation free-writing activities, in order to understand whether different environment with/without game how influence student' participation in diversity of idea generation. The analysis conducted by two Chinese language experts. The Spearman correlation was conducted to validate consistency, which was very high (r = .920, p < .01).

Length of composition: Longer length of composition is often associated with a greater number of ideas. For this reason, this study examined the length of composition of EG and CG during two semesters, in order to understand whether different environment with/without game how influence student' participation in length of composition production during one year.

2.3.2. Written Expression Task and Linguistic Analysis

The written expression task (WET), an experimental task designed by the authors, was conducted in order to understand the students' written expression ability. The written expression tasks were entitled

"My favorite food" in first semester and "After school" in second semester. Besides, the Chinese Readability Index Explorer (CRIE) has been developed by Sung and their colleagues (Sung, Chen, Lee, Cha, Tseng, Lin, Chang, & Chang, 2013) to understand Chinese text readability which includes several indicators based on the textual factors. CRIE generally relies on machine learning techniques that compute essay scores using a set of text variables. This study also adopted CRIE website to parse out the students' articles on pre/post written expression task, 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, average sentence length, and number of total paragraphs), and *text level* (the length of composition).

2.3.3. Writing Interest Questionnaire

The interest on writing was measured by the Writing Interest Questionnaire (WIQ), designed and developed by the authors. The content of the questionnaire was developed based on the four-phase model of interest development (Hidi, & Renninger, 2006; Schraw, & Lehman, 2001) and RCTR model (Liao, Chang, &Chan, 2014). The WIQ had 12 items, each six items for two components of writing interest: individual interest (II), and situational interest (SI). Individual interest has been defined as an individual's tendency towards a topic, activity, or knowledge domain, and situational interest has been defined as a series of stimuli and conditions that determine an immediate affective response. Past research also proposed that the both of the two kinds of interest certainly improve students' learning (Hidi, & Renninger, 2006). Students were asked to rate their writing interest on a Likert-type item with five anchors (1 = strongly disagree, 2 = disagree, 3 = not sure, 4 = agree, 5 = strongly agree). Take sample items as an example for each interest concept: '*I think that writing is interesting.*' (II), and '*I like to share my article with others in online writing environment.*' (SI).

2.4. Procedure

The experiments were divided into two phases: the first and second semester. During the first semester, to familiarize all students with the use of the online writing environment. All students should learn how to write and write two articles. In the end of the first semester, a pretest of written expression task and writing interest questionnaire were conducted in order to establish a baseline of writing performance and writing interest. After that, the main experiment was conducted in the second semester. In the beginning the GWE was introduced for the EG. The CG continued to participate in the OWE. When the students finished the experimental activity, which was followed by the posttest of written expression task and writing interest questionnaire.

3. Findings

3.1. Writing Participation

3.1.1 The Number of Writing Ideas

Writing ideas could be the indicator of students' participation, because the high participation of students possibly produces lot of different ideas about the theme more than low participation. The independent samples *t*-test was used to examine differences between the EG and CG, in terms of students' writing ideas. The two group students were received the same experimental treatment in the first semester and different treatment condition in the second semester. Hence, students' performance in the first semester showed the baseline and that in the second semester showed to compare the effect of the game-based environment.

First semester: Because the character and genre of writing themes were different, each theme was compared separately by two groups. Regarding the average number of ideas about Theme #1, no significant difference ($t_{(238)} = 0.34$, $p = .731 > .05$) existed between the EG ($M = 2.29$, $SD = 3.10$) and the CG ($M = 2.17$, $SD = 2.59$). Regarding the average number of ideas about Theme #2, no significant difference ($t_{(238)} = 0.04$, $p = .966 > .05$) existed between the EG ($M = 1.65$, $SD = 2.50$) and the CG ($M = 1.67$, $SD = 2.21$). This implied that both groups had a similar performance on Theme #1 and #2.

Second semester: Regarding the average number of ideas about Theme #3, the EG (M =3.44, SD = 3.18) significantly ($t_{(238)}$ = 4.90, p = .000 < .05) outperformed than the CG (M =1.83, SD = 1.37). Regarding the average number of ideas about Theme #4, the EG (M =4.02, SD = 5.80) significantly ($t_{(238)}$ = 2.94, p = .004 < .05) outperformed than the CG (M =2.16, SD = 2.79). Regarding the average number of ideas about Theme #5, the EG (M =3.72, SD = 2.46) significantly ($t_{(238)}$ = 2.11, p = .042 < .05) also outperformed than the CG (M =2.25, SD = 2.03). The *t*-test procedure revealed that students in EG showed a greater number of writing ideas than those in CG on Theme #3, #4 and #5. Consequently, these findings implied students with the GWE seemed more capable in generate their writing ideas than those pure OWE.

3.1.2 The Length of Composition

The length of composition could be the indicator of students' participation because the high participation of students possibly writes a lot of texts more than low participation. The results showed that length of composition increased gradually from theme-based article #1 to article #5. In order to understand the progress of increasing length of composition of students between EG and CG, it needed further to examined with paired *t*-test to uncover the development about students' length of composition.

First semester: Regarding the average length of composition on Theme #1, the CG (M =186.27, SD = 139.60) significantly ($t_{(238)}$ = 2.89, p = .004 < .05) outperformed the EG (M =138.91, SD = 91.60). Regarding the average length of composition on Theme #2, no significant difference ($t_{(238)}$ = 1.72, p = 0.086 > .05) existed between the EG (M = 209.68, SD = 96.64) and the CG (M = 231.09, SD = 134.88). This implied that OWE reduce in extent of length of composition gradually between the two groups from Theme #1 to Theme #2.

Second semester: Regarding the average length of composition on Theme #3, no significant difference ($t_{(238)}$ = 0.64, p = .64 > .05) existed between the EG (M =229.39, SD = 113.97) and the CG (M =215.07, SD = 97.67). Regarding the average length of composition on Theme #4, the EG (M =260.30, SD = 157.88) significantly outperformed ($t_{(238)}$ = 4.06, p = .000 < .05) than the CG (M =207.96, SD = 112.86). Regarding the average length of composition on Theme #5, no significant difference ($t_{(238)}$ = 1.02, p = .309 > .05) existed between the EG (M =284.06, SD = 189.33) and the CG (M =261.13, SD = 196.30). A series of paired t-test procedure revealed that students in EG showed a greater length of composition than those in CG gradually at Theme #4 and post-test. This means that students participating in GWE had improved the length of their written article more than OWE.

3.2. Writing Performance

Students' writing performance were evaluated according to three level: word level, sentence and paragraph level and text level.

Word Level: The indictor of writing performance in word level contains the number of total words, the number of difference word and the number of difficult words. First, to compare the number of total words of the two groups, one-way ANCOVA was conducted and the total words of pre-WET as covariate. The results revealed the main effect on treatments, $F_{(1, 229)}$ = 20.74, MSE = 103612.85, p = *.000* < *.05*, partial η^2= 0.080. The pairwise comparison revealed that students in EG (M = 189.89, SD = 89.74) with a significant greater number of total words than those in CG (M = 152.24, SD = 66.53). Second, to compare the number of different words of the two groups, one-way ANCOVA was conducted and the different words of pre-WET as covariate. The results revealed the main effect on treatments, $F_{(1, 229)}$ = 23.79, MSE = 20986.93, p = *.000* < *.05*, partial η^2= 0.094. The pairwise comparison revealed that students in EG (M = 101.01, SD = 39.44) with a significant greater number of different words than those in CG (M = 86.35, SD = 33.26). Next, to compare the number of difficult words of the two group, one-way ANCOVA was conducted and the difficult words of pre-WET as covariate. The results revealed the main effect on treatments, $F_{(1, 229)}$ = 16.19, MSE = 9323.96, p = *.000* < *.05*, partial η^2= 0.066. The pairwise comparison revealed that students in EG (M = 60.29, SD = 29.06) with a significant greater number of difficult words than those in CG (M = 49.38, SD = 23.55).

Sentence and Paragraph Level: The indictor of writing performance in sentence and paragraph level contains the number of total sentences, and the number of total paragraphs. First, to compare the

number of total sentences of the two groups, a one-way ANCOVA was conducted and the total sentences of pre-WET as covariate. The results revealed a main effect on treatments, $F_{(1, 229)} = 17.16$, $MSE = 998.37$, $p = .000 < .05$, partial $\eta^2 = 0.070$. The pairwise comparison revealed that students in EG ($M = 18.54$, $SD = 10.10$) with a significant greater number of total sentences than those in CG ($M = 14.75$, $SD = 7.60$). Second, to compare the number of total paragraphs of the two groups, a one-way ANCOVA was conducted and the total paragraphs of pre-WET as covariate. The results revealed no significant difference between the two groups, $F_{(1, 229)} = 0.06$, $MSE = 0.09$, $p = .807 > .05$, partial $\eta^2 = 0.000$.

Text Level: The indictor of writing performance in text level is the length of composition. In order to understand the statistical significance of the increasing in the length of composition, we further compared EG with CG. The correlation coefficient of the length of composition between the pre-WET and post-WET was significantly high. A one-way ANCOVA was conducted and the composition' length of pre-WET was the covariate. The results revealed a significant man effect on the treatments, $F_{(1, 229)} = 21.43$, $MSE = 315828.79$, $p = .000 < .05$, partial $\eta^2 = 0.086$. The pairwise comparison procedure revealed that students in EG ($M = 345.39$, $SD = 156.07$) with a significant greater length of composition than those in CG ($M = 282.88$, $SD = 121.32$).

Above the results, it means that the EG students produced more sophisticated words and more complex sentence than the CG students. Consequently, these findings implied students with the GWE seemed to be more capable in producing their words and originating sentences into articles than that pure OWE.

3.3. Interest for Writing

In order to understand how the effect of improving students' interest of writing, we further examined the pre- and post-WIQ to uncover the students' interest on writing between EG and CG. Further, writing interest consisted the concepts of individual interest and situational interest, so the two kinds of writing interest were compared isolated. Regarding as individual interest, the one-way ANCOVA was conducted and the pre-WIQ as covariate. The results showed no significant difference between the treatments, $F_{(1, 229)} = 0.72$, $MSE = 221.169$, $p = .396 > .05$, partial $\eta^2 = 0.003$. In contrast, regarding as situational interest, a one-way ANCOVA was conducted and the pre-WIQ as covariate. The results revealed a significant main effect on the treatments, $F_{(1, 229)} = 13.56$, $MSE = 221.169$, $p = .000 < .05$, partial $\eta^2 = 0.056$. The pairwise comparison revealed that students in EG ($M = 24.01$, $SD = 3.84$) with a significant greater situational interest than CG ($M = 22.08$, $SD = 4.70$).

Students participating in GWE increased the situational interest more than in OWE; on the contrary, the two groups presented similar on the concept of individual interest. According to above findings, this study confirmed that online writing environment with game-based learning approach possible supported the development of situational interest.

4. Conclusions and Discussions

The aim of the present study was to examine the effect of writing performance in a game-based learning approach and take into consideration not only in the aspect of cognitive, but also in the aspects of affective and motivational experience. This study compered two writing environment with GWE and OWE that might lead students to have a different experience.

The results showed that a specific GWE practicing produced positive outcomes in three aspects: students' participation in the number of ideas and the length of composition changed incrementally; students' writing performance of improved significantly; and game-based learning approach increased students' situational interest in the writing process.

4.1. Facilitating Students' Voluntary Participation from Compulsory to Spontaneous Writing

Generally speaking, it is meaningless for students to write in the classroom, because in the general situation, it is usually only one teacher to be the reader or evaluator. For students, they lack the opportunity to share their products with others and lack the motivation to write. In addition, the writing topic for students is usually unfamiliar or purely academic, because writing is for the requirements of

school course rather than for the learning need of students. Moreover, students' writing is usually an individual activity where the student has to produce a text, but do not share with each other. Thus, it is often a compulsory for students to write articles, which leads to students lack of motivation and voluntary participation.

This study explored that the influence of game-based learning approach for students' participation on writing activity. The findings indicated that the number of writing ideas and the length of composition in GWE increasing significantly more than in OWE. This finding is consistent with previous research. For examples, Allen et al. (2014) found that utilized game with learning activity could increase writing engagement and provide opportunities to practice writing strategies. Our results proved that voluntary participation is a motivational factor, which is more complex than we expected. The findings have emphasized we should consider different tendency and interest of students and provide various writing topic and genre. It is a challenge for teachers to collect and edit approach writing materials. Thus, it is still a huge challenge for researchers to think about how to design and facilitate students' voluntary participation from compulsory to spontaneous.

4.2. Improving Students' Writing Performance from Reading to Creating, from Talking to Revising

The study compared two kinds of writing environment, GWE and OWE, in order to understand the influence of game-based approach on writing performance. Students in GWE could build their own island while at the same time practicing K-12 writing skills and concepts. The RCTR (Reading, Creating, Talking, and Revising) model contributed students' writing performance form reading to creating by implementing the creativity and productive activities about primary students' reading, creating, talking, and revising experiences. We looked specifically at three level improvements of students during two semesters via linguistic analysis. When students were allowed to explore and create a digital product on their own versus peer interaction. A joyful writing environment of reading, creating, talking, and revising may enable students to compile these skills into practice form learn-to-write to write-to-learn phase. In particularly, students could learn to apply practical knowledge representation and to construct a unique text; students also more sophisticated utilize literacy knowledge, such as naming a title, arranging the ideas, and presenting the statements into their products gradually. This phenomenon proved that GWE may promote these students' reading, creating, talking, and revising experiences form emergent to conventional phase.

4.3. Increasing Students' Situational Interest of Writing by Game-based Learning Approach

The interest is often a prerequisite for success (Hidi, & Renninger, 2006). There is a high probability that learning will not be successful if it lacks sustainable motivation, or called interest. Moreover, in the present, the results showed GWE could increase students' situation interest, but it is hard to change students' individual interest. We speculated that to develop one's individual interest should take more time rather than provide a different environment. Therefore, we suggested that researchers need to consider diverse strategies which increasing the students' interest of writing by game-based learning approach. First, the design of self-management learning game should help to keep the students long-term engaging and interacting. For examples, more and more game-like multi-user virtual environment (MUVE) have been developed for educational purpose, such as *Quest Atlantis* (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005). Second, the writing topics of interactive games should be consideration. For examples, researchers and teachers could involve in the co-design of new courses and applications of educational games. Final, what kind of situations the sustainable games and stimulative games should be considered. Interesting games could motivate sustainable long-term writing activity and sustain the deep levels of motivation, such as adopted writing course in a semester; stimulative games could motivate short-term learning activity, such as applied a unit of writing course.

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