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ARTICLE

Does a 3D immersive experience enhance Mandarin writing by CSL students?

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Abstract

This study aimed at enhancing the Mandarin essay writing by learners of Chinese as a second language (CSL) in Singapore by using authentic contexts in Second Life (SL). The participants were students in two classes of eighth graders from a junior high school in Singapore, and the study lasted for 5 weeks. A quasi-experimental design was adopted by randomly assigning the two classes to the experimental group (N=26) or the control group (N = 34). The two groups received identical writing instructions and were asked to write essays about identical topics within an identical time period. The only difference between the two groups was the activities performed at the prewriting stage: with or without immersive exploration in SL. Three kinds of qualitative data were collected and analyzed: students' writing plans, students' compositions, and in-class observation data. The analysis results show that the writing motivation and performance of the CSL students varied depending on whether or not they performed immersive exploration before writing. Those who explored the authentic contexts in SL before writing performed significantly better at constructing a prewriting plan and exhibited significantly higher writing quality compared to those without such an immersive experience. The former group also demonstrated higher motivation.

Keywords: *Chinese as a Second Language, Mandarin Writing, 3D Immersion, Second Life*

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

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Introduction

How to teach writing in a foreign language (FL) or second language (L2) is a key issue in education. Assessing language abilities requires consideration of the four skills of listening, speaking, reading, and writing. In particular, listening and reading can increase language stimulus and thereby expose learners to unfamiliar language, helping them to acquire linguistic knowledge (Krashen, 1987). In contrast, writing and speaking are forms of language output that can help (a) identify gaps between what a person wants to and is able to write or say, (b) recognize gaps between a learner's interlanguage and the target language, and (c) learners pay more attention to the form of a language (Swain, 1995). Writing can be considered a combined demonstration of overall language proficiency (Lou, Wu, Shih, & Tseng, 2010).

L2 and FL learners frequently experience difficulties in mastering writing skills (Lan, Sung, Cheng, & Chang, 2015). The relatively small amount of time allocated to writing itself and the instructional methods used to teach writing are two major factors that contribute to these difficulties (Applebee & Langer, 2011). The challenges faced by general FL or L2 learners are also faced by learners of Chinese as a second language (CSL) in Singapore. Technology-enhanced language learning is a possible method for addressing this problem in CSL classes, since the results of a survey conducted by the Mother Tongue Languages Review Committee (MTLRC) indicated that students showed considerable interest in using technology to

assist in the learning of mother-tongue languages (Ministry of Education, Singapore, 2011b). Among the advanced technologies, 3D virtual worlds have attracted considerable attention from researchers due to their unique features of imagination, immersion, and interaction (Lan, Kan, Sung, & Chang, 2016). However, despite many studies having identified the benefits of using 3D virtual worlds in FL and L2 learning, there is a sparsity of literature focused on CSL writing.

Literature Review

Writing Instruction

Writing is important for FL and L2 learners to understand their performance in using a target language. According to the perspective of the output hypothesis, L2 learners recognize the gap between what they want to express and what they are able to express during the writing process (Swain, 1995). Given the essential role of writing in L2 acquisition, writing instruction should be emphasized in practical L2 instruction. However, little attention is paid to the implementation of writing instruction due to the relatively small amount of time allocated to writing itself and the insufficiency of instructional methods for teaching writing (Al-Jarrah & Al-Ahmad, 2013). For example, Chang (2006) reported the inadequate teaching hours allocated to writing instruction for teaching English as a foreign language (EFL). After collecting the perspective of 20 American English language learners (ELLs) via questionnaires and interviews, Lin (2015) concluded that the 14 highest-ranked writing difficulties identified by the interviewed ELLs could be divided into 3 categories: linguistic or cognitive deficiencies (e.g., limited vocabulary, lack of writing fluency, and poor writing skills), psychological or emotional deficiencies (e.g., anxiety), and sociocultural aspects of writing (e.g., adjusting to American thought patterns).

Students in Mandarin CSL classes in Singapore also experience difficulties. The bilingual educational program makes Mandarin Chinese an obligatory course for around three quarters of Singaporean elementary-school students, but students in Singapore have little interest in Chinese writing (Sim, 2005). Sim (2005) criticized the traditional methods used to teach writing as being limited to forming sentences or paragraphs and writing weekly journals and suggested that more assistance and guidance should be provided to students.

In order to address the above-mentioned challenges faced by L2 learners in writing, numerous studies have focused on prewriting strategies such as the use of picture prompts (e.g., Lin, 2010) and brainstorming and listing during FL writing instruction (Kroll, 2001). Prewriting strategies are used by L2 writers before the actual writing stage to test ideas, list words, and explore a range of topics for inclusion in their writing, similarly to how an artist makes quick sketches before painting. Most of the existing literature supports the position that the writing outcomes of L2 learners can be improved by guiding them to construct writing plans at the prewriting stage (e.g., Mohseniasl, 2014). Furthermore, studies of prewriting strategies have often employed technology-enhanced learning tools, such as concept maps (e.g., Ciekanski & Chanier, 2008), to facilitate the writing process. Although most prewriting-related studies focus on using digital tools to help learners to write down and organize the words and ideas for use in subsequent writing tasks, this is often a de-contextual approach, such as sitting in the classroom and thinking of the words and ideas about the assigned writing topics. Such a de-contextual approach usually fails to help L2 writers connect what has been learned in the classroom with real-world experience (Henderson, Huang, & Grant, 2012). Furthermore, the sociocultural theory of second-language acquisition says that language learning should include intimate interactions within authentic and sociocultural contexts (Eun & Lim, 2009). Hence, language learning involves both social and mental factors that connect the person and the environment in an inseparably dialectic relationship (Lantolf, 2005).

To address the importance of authentic contexts, L2 researchers have begun integrating 3D virtual worlds, such as Second Life (SL) and World of Warcraft (WoW), into FL and L2 settings (Chun, Smith, & Kern, 2016). For example, Henderson et al. (2012) investigated how SL could enhance the learning motivation of CFL learners and other affective constructs such as self-efficacy beliefs. They found potential advantages

to using SL for enhancing the motivation of CFL learners in Australia. Most of the studies involving 3D virtual worlds are on oral or text-based conversations, virtual experiences, and cross-cultural issues in FL or L2 learning (Reisoğlu, Topu, Yılmaz, Yılmaz, & Göktaş, 2017), while few have been on FL or L2 writing. Although some studies on 3D virtual worlds have investigated L2 writing ability, the investigated writing abilities were actually interavatar conversations (either text-based or oral conversation), unrelated to essay writing (e.g., Berns, Gonzalez-Pardo, & Camacho, 2013). For example, Thorne (2012) examined real-time writing by ESL learners in WoW and found that various attendant discourses emerged and inspired both in-game and out-of-game discourse and enriched the written-language semiosphere of L2 learners. However, Thorne did not arrange in-class writing assignments for the L2 learners to complete within a fixed amount of time. Xu, Park, and Baek (2011) investigated how a 3D immersive experience can enhance writing self-efficacy among college students. The participants were grouped into teams of five or six and were asked to explore the SL environment and then compose an exploration story. Although that study focused on writing activities, only writing self-efficacy and flow were investigated. As such, whether 3D virtual experiences benefitted in-class writing among CSL students was unknown. Moreover, most of the existing literature related to the use of 3D virtual worlds is related to EFL or ESL, and not CSL. Thus, how a 3D virtual immersive experience affects the writing of CSL learners needs further exploration.

Mandarin Language Education for CSL Students in Singapore

In order to cultivate the competitiveness of students in Asia and their comprehensive views of the world, the Ministry of Education, Singapore has implemented a bilingual educational program in which all students learn both English and their native language from elementary school (Chin, 2011). A population report says that more than 74.3% of Singapore's residents are of Chinese ethnicity. Therefore, around three quarters of Singaporean students learn Mandarin Chinese from elementary school as part of the regular school syllabus. Although a large proportion of students' parents are of Chinese ethnicity, few of them speak Mandarin Chinese to their children in daily life. A report by the Department of Statistics, Singapore (2010) indicates that ethnic Chinese families have tended to use English rather than Chinese as the dominant language at home over the last 20 years. This means that the home environment is not favorable for their children to learn Chinese (Chin, 2011). The evolving language environment in Singapore—which is increasingly emphasizing English—presents challenges for providing Chinese education to students from predominantly English-speaking families, especially related to writing (Tan, Puah, Teoh, & Ting, 2014).

Gong, Chin, Tay, and Soh (2016) have identified three main difficulties faced by Singaporean students during the process of writing Chinese: content, structure, and language. The lack of rhetorical tactics eventually leads to poor language expressions and low motivation (Sim, 2005). Moreover, current writing instruction methods are not considered attractive by teachers in their daily teaching regimes (Sim, 2005). To address the need to improve writing instruction as well as enhance the writing performance of CSL students, information and communication technology (ICT) has been used in language classes in Singapore for many years. There is research evidence that using ICT to facilitate writing instruction improves students' writing in terms of both their motivation and their performance (Goldberg, Russell, & Cook, 2003).

The government of Singapore has endorsed the use of ICT in language teaching and learning. One of the key recommendations from the latest round of the MTLRC review was to increase the use of ICT in mother-tongue language teaching (Ministry of Education, Singapore, 2011b). For example, Puah, Tan, and Teoh (2015) developed a blog platform (the iWrite.sg platform) to teach creative Chinese writing in Singapore. They found that writing creativity was improved in the experimental group relative to the control group. They also discovered that the teachers and students who used the blog platform to teach and learn evaluated it highly due to it enhancing the writing interest and imagination of the students.

While all the studies mentioned above found that ICT affected the writing performance and motivation of CSL learners, none of them focused on cultivating individual writing abilities. However, most Chinese-writing classes ask students to finish a writing assignment individually within a specific time limit. Therefore, in addition to collaborative learning, it is also important to improve CSL students' ability to individually complete writing assignments. This challenge can be addressed by effectively scaffolding

students during the prewriting stage and helping them to construct an effective writing plan (Lan et al., 2015), while contextualized instruction is also helpful. Li (2008) proposed that situational writing could help students enrich their writing content, express ideas and feelings, and inspire their creativity, imagination, and logical thinking. However, it is always a challenge for L2 teachers to provide their students with authentic contexts daily in the teaching environment (Lan, 2015).

3D Virtual Worlds for Mandarin Teaching and Learning

The difficulties in creating authentic contexts experienced by FL and L2 teachers have prompted language instructors and researchers to investigate the use of 3D virtual worlds. A 3D virtual world is a computer simulation system in which almost anything (realistic or fanciful) can be created, allowing learners to immerse themselves and perform contextual social interactions via their avatars (Lan et al., 2016). 3D virtual worlds have already been applied to the teaching and learning of multiple languages. For example, Berns et al. (2013) used 3D virtual worlds in a German class to enhance the general conversation and reading skills of students. Additionally, Lan (2015) created a virtual English village to help students at an elementary school in Taiwan become involved in authentic role playing as soon as they enter an English class.

In addition to the applications in learning alphabetic languages, 3D virtual worlds have also been successfully applied to the teaching and learning of Mandarin Chinese (e.g., Tang, Sung, & Chang, 2016). Grant developed a Chinese island in SL aimed at providing CFL learners with task-based opportunities to use what they had learned in Chinese classes (Henderson et al., 2012). Lan (2014) analyzed the differences in student–teacher conversations between traditional and virtual Chinese classes. She found that the authentic immersion experience in SL inspired CSL students to improve their oral performance. Lan et al. (2016) also found that the oral performance of CSL students improved significantly after they carried out the assigned tasks. They found that those carrying out reasoning-gap tasks showed significantly greater improvement than those carrying out information-gap tasks. In contrast to using 3D virtual worlds as a platform for CSL learning, Cheng, Zhan, and Tsai (2010) used SL for Chinese language teacher training. They found that the feedback from participating Chinese language teachers was more positive if the teachers had more teaching experience in SL and that the teachers were more willing to adopt SL as their teaching platform when technical challenges were reduced.

Most studies of Mandarin teaching and learning in SL have focused on general text- or oral-based communication; few studies have focused on writing, let alone essay writing. Although some studies have investigated writing instructions in virtual worlds, most of them (e.g., Xu et al., 2011) only considered writing in the first tongue. Although some studies covered practices involved in Chinese writing, the writing contents were oriented toward conversations rather than essay writing. Therefore, investigating the effects of a virtual immersive experience on the essay-writing performance of CSL learners is an important issue.

To this end, the current study aimed to determine the effects of exploration experience in SL on the Chinese essay-writing performance of CSL learners. Three research questions were answered to address the research purpose:

1. What are the effects of the exploration experience in SL on the prewriting plans of CSL learners?
2. What are the effects of the exploration experience in SL on the essay-writing performance of CSL learners?
3. What are the effects of the exploration experience in SL on the in-class behaviors of CSL learners during the writing process?

Method

Participants

Two classes totaling 60 students from a secondary school in Singapore participated in this study. They were

in the second year of secondary school and followed the regular educational program in Singapore. Their abilities in writing Mandarin Chinese were at Level 4 on the syllabus standards announced by the Curriculum Planning and Development Division of the Ministry of Education, Singapore (2011a). Students at Level 4 on the syllabus standards can use basic writing skills to create their own essays in Chinese. In addition to mastering narrative writing skills, they are also expected to be able to use Chinese to create more-advanced essays, such as expository and argumentative essays. The students in the two classes were randomly assigned to two groups: the control group (n = 34, 12 males and 22 females, mean age = 13.56, SD = 0.70) and the experimental group (n = 26, 8 males and 18 females, mean age = 13.27, SD = 0.60).

Additionally, all of the participants had successfully passed an entrance examination, and therefore their Mandarin Chinese abilities were at the same level when they entered high school. However, since the study was conducted in the second year, their scores in the latest final examination—a regular assessment administered at the end of a semester and just before the current study—were collected as a covariant to ensure that their Mandarin writing abilities were at the same baseline. Additionally, the contents of the final examination regularly administered at the participating school covered all the CSL abilities being investigated in the present study, including vocabulary, grammar, and handwriting.

Research Design

A quasi-experimental design was adopted in this study by randomly assigning the included students into the experimental and the control groups. The students in the two groups received identical writing instructions from the same Chinese teacher and were asked to write essays about identical topics within an identical time period. Both groups underwent the same procedure, except that during the prewriting stage, when the experimental group performed an exploration in SL, the control group followed a traditional approach of collecting and writing down their writing ideas while watching a writing guide given by the teacher. The time used for collecting ideas (i.e., the prewriting stage) was identical in the two groups.

Three kinds of data were collected: students' writing plans, students' compositions, and in-class observations. The collected data were processed by two researchers by (a) scoring the students' compositions and (b) encoding both the writing plans and the in-class observation data. The scores and encoded data were then analyzed to confirm the effects of SL exploration at the prewriting stage on the writing plans, essay-writing performance, and in-class behaviors of CSL students.

Instruments

3D Virtual Platform

Three different virtual contexts in SL were developed by the authors for the writing activities: a hotel, two restaurants (a Chinese one and a Western one), and a zoo. To help the CSL students link what they saw in the virtual contexts to the Mandarin Chinese needed for their subsequent writing, keywords and sentences were embedded in the corresponding objects. Figure 1 shows two screenshots with the two restaurants used for teaching descriptive and comparative writing. These virtual contexts allowed the CSL students to explore the virtual restaurants and collect ideas to use in their essay writing by immersing themselves into the contexts.

Figure 1. A Chinese restaurant (left) and a Western restaurant (right) in the 3D virtual platform

Writing Guide

A writing guide was used as a scaffold for guiding CSL students in the control group to write a topic-focused essay composition. The guide contained three or four pictures taken from different angles in each virtual context. The form of each picture set was similar to that commonly used in writing classes in Singaporean schools, except that an additional scaffold was embedded in the pictures exclusively for the current study. In addition to the pictures of the scenes, the words and the sentence patterns needed for writing the composition corresponding to the scenes were included on the writing guide sheet. The guide was given to the control group at the prewriting stage. The pictures and the corresponding words and sentences helped the students in the control group collect ideas for their subsequent compositions. Figure 2 shows the writing guide sheet used for the topic of *describing a room in a house*. Note that the hints on the original guide sheet were only in Chinese; the translation shown in Figure 2 is added to facilitate understanding by the readers of this article.

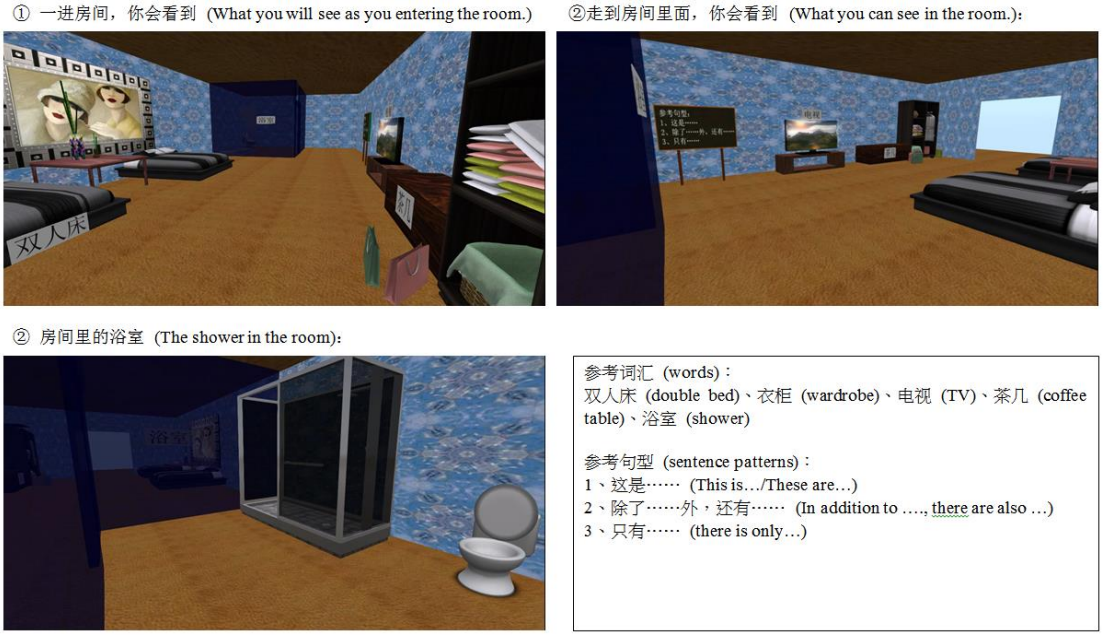

Figure 2. Writing guide sheet used as a scaffold for the CSL students to write a composition on an assigned topic.

Teaching Materials

Three units designed by the authors were used in this study: (a) describing a room in a house, (b) comparing and contrasting a Chinese restaurant and a Western restaurant, and (c) narrating a field trip to a zoo. Each lesson followed a 4-step writing instruction aimed at helping the CSL students to successfully write a complete composition within 90 minutes: (1) the teacher introduced the topics, including an authentic occasion (5 minutes); (2) the teacher explained writing skills, such as writing tips and rubrics (25 minutes); (3) the students collected ideas and constructed writing plans (15 minutes); and (4) the students wrote their own essays (45 minutes). Once the process was completed, the students' compositions were collected, evaluated, and scored by two researchers, and feedback was then given to the students. A detailed teaching plan of Unit 2 can be found here.

Chinese-Writing Rubrics

The rubrics were developed by the authors by integrating two documents: the Chinese language syllabus implemented by the Ministry of Education, Singapore (2011a), and the writing rubrics proposed by Lan et al. (2015). Five dimensions were included in the Chinese-writing rubrics: (a) *content*, focusing on the

relevance between the topic and the article as well as the variety and diversity of the article; (b) *organization*, focusing on the completeness and context of the structure of the article; (c) *vocabulary*, focusing on the accuracy, variety, and creativity of word choices; (d) *grammar*, focusing on fluency and the variety of sentences used; and (e) *punctuation and handwriting*, focusing on the correctness of punctuation and the handwriting of Chinese characters. A detailed description of the rubrics can be found here.

In-Class Observation Table

The in-class observation table was designed by the authors and confirmed by two senior CSL researchers as being suitable for understanding how the participating CSL students in the experimental and the control groups behaved differently in the writing classes. The aim was to identify the writing behaviors of CSL students during four activities: (a) instruction, or the introduction of writing tasks and writing tips; (b) prewriting, the stage when ideas were collected; (c) writing; and (d) post-writing, or refining. Table 1 lists the target behaviors for the observations.

Table 1. *The Target Behaviors for the In-Class Observation*

Activities	**Target Behaviors**
Instruction	Excited about the class
	Curious about the class
	Able to complete pre-class tasks
Prewriting	Able to engage in collecting ideas and creating writing plans
	Positive
	Active
Writing	Focused
	Able to complete all tasks successfully
	Able to complete all tasks on time
Post-writing	Able to refine own writings

Procedure

Figure 3 shows the procedure of this study. The study started with both the participants and their parents completing the consent forms. Next, a training session on SL was provided to the experimental group using a virtual context that was not relevant to the learning topics. The training only focused on how to use SL, such as controlling the avatar and moving around in the virtual environment, with no reference to CSL writing or learning. Three cycles of CSL writing activities were then conducted. In each essay-writing cycle, all the students in both groups received 30 minutes of writing instruction from the same teacher, and they were then given 15 minutes to construct their writing plans, including writing down words and sentences as well as ideas for the subsequent writing task. Those in the control group made their plans by observing the set of scene pictures and a writing guide, while those in the experimental group did so by exploring the 3D virtual worlds using their avatars in SL. Finally, all the participants were asked to complete their essays within 45 minutes. Details of a writing cycle can be found here.

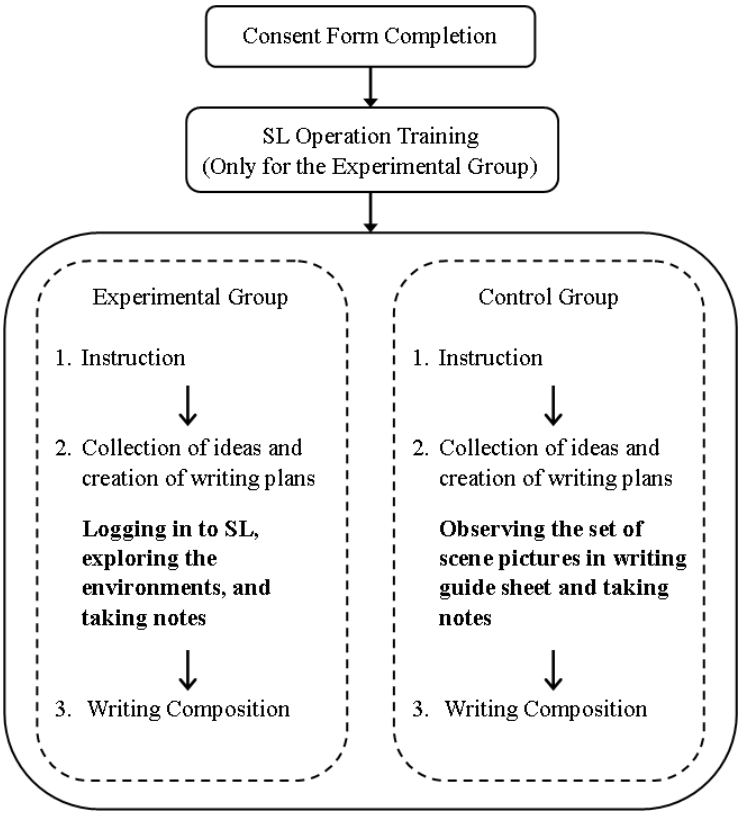

Figure 3. Procedure of this study

Results and Discussion

The Prewriting Plans

At the prewriting stage, the control group was given the writing guide and a set of pictures relevant to the topic of the assigned essay, whereas the experimental group logged in to the virtual contexts in SL. Within an identical time period, all of the students were encouraged to construct their writing plans and to write down their ideas on a piece of paper for use during their composition writing in the next activity. All the written ideas and the student compositions were compiled for further analysis by two researchers.

Table 2. *Coding Scheme for Student Writing Plans*

Themes	Categories	Descriptions
Styles	Picture-based	Drawing pictures in prewriting stage
	Outline-based	Outlining main points in prewriting stage
	Vocabulary-based	Writing down key words in prewriting stage
	Sentence-based	Writing down sentence structures in prewriting stage
Contents	Detail-oriented	Noticing the details in prewriting stage
	Overall-theme-oriented	Focusing on the overall descriptions in prewriting stage
	Modifier-oriented	Using adjectives to modify objects in prewriting stage

A coding scheme for analyzing the students' writing plans was developed based on careful checks of the writing plans and discussions with two senior CSL researchers. The coding scheme consisted of two main

dimensions, listed in Table 2. Two coders analyzed the collected writing plans while following the coding scheme. Pearson's correlation coefficient for the coding results obtained from the two coders was .987 ($p < .001$).

Table 3 lists the number of writing plans constructed by the two groups. Most of the students in the experimental group constructed writing plans at the prewriting stage, whereas only a very small percentage of students in the control group did, excepting Unit 2. The small number of writing plans constructed in the control group for Units 1 and 3 meant that only the plans constructed for Unit 2 could be analyzed further. Those writing plans were first analyzed by their styles; the results are listed in Table 4.

Table 3. *Students Making Writing Plans*

	Experimental Group Students Making a Plan		**Control Group Students Making a Plan**	
Unit	***N***	**%**	***N***	**%**
Unit 1	23	92.00	1	2.94
Unit 2	25	96.15	25	75.76
Unit 3	25	96.15	3	9.09

Table 4. *Styles of the Writing Plans*

Styles	**Experimental Group**	**Control Group**
Picture-based	14.29%	0.00%
Outline-based	28.57%	38.46%
Vocabulary-based	53.57%	61.54%
Sentence-based	3.57%	0.00%

The writing plans were more diverse in the experimental group than in the control group (four types vs. two types). A chi-squared analysis also revealed a significant intergroup difference in the style of writing plans ($\chi^2_{(1,3)} = 13.96$, $p = .003$). Figures 4–7 show some examples of the students' writing plans in both groups.

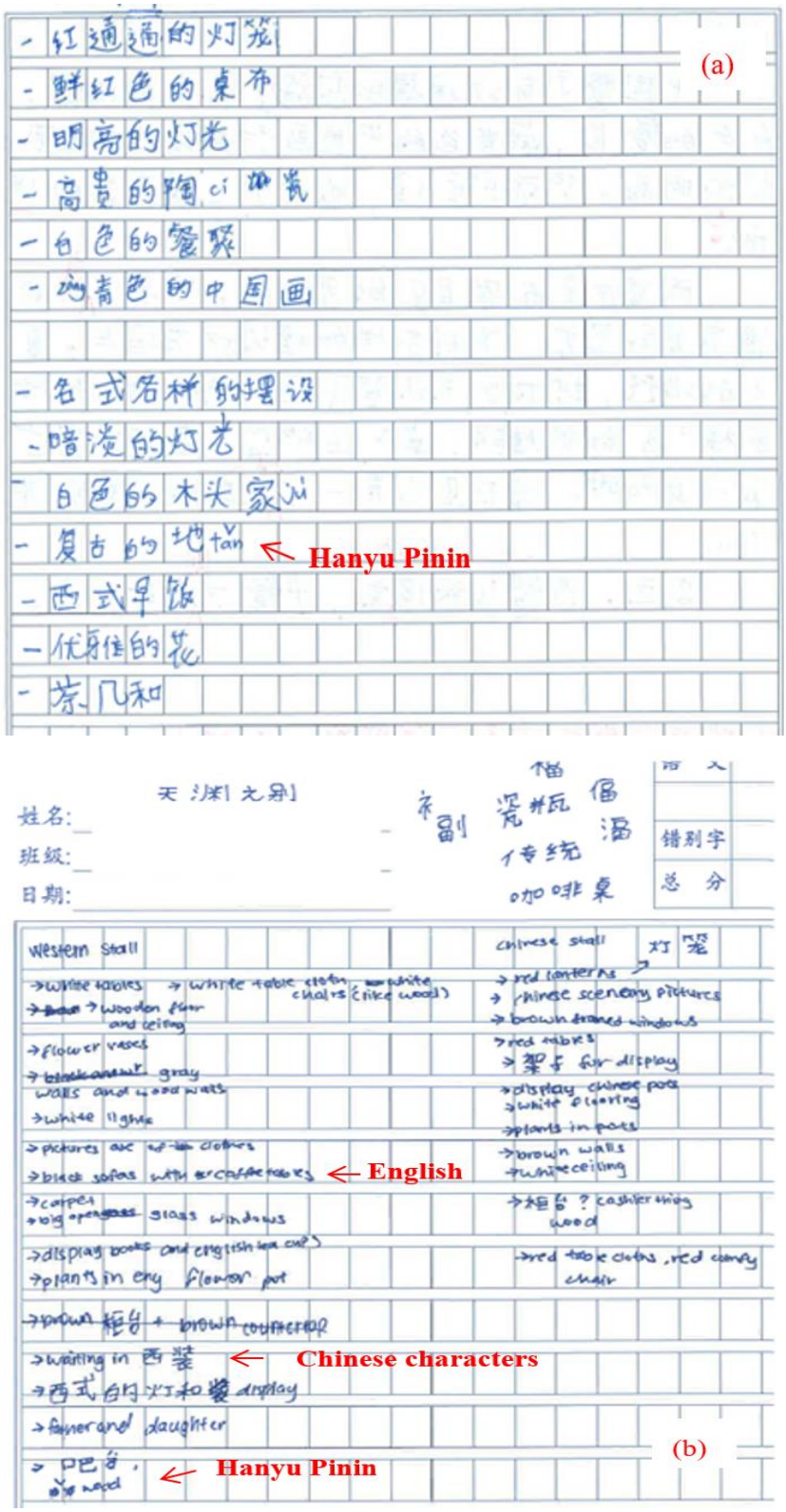

Figure 4. Examples of vocabulary-based writing plans: (a) control group; (b) experimental group

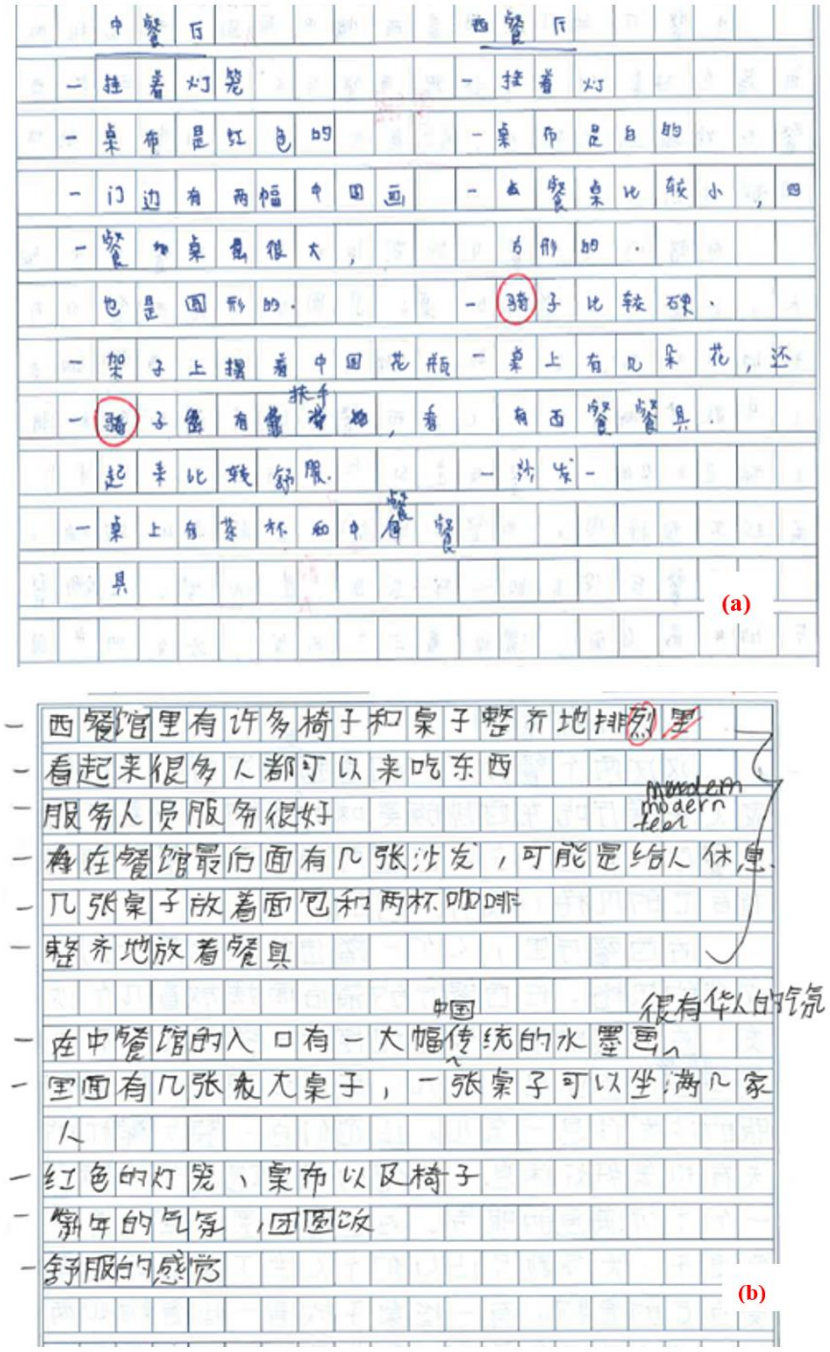

Figure 5. Examples of outline-based writing plans: (a) control group; (b) experimental group

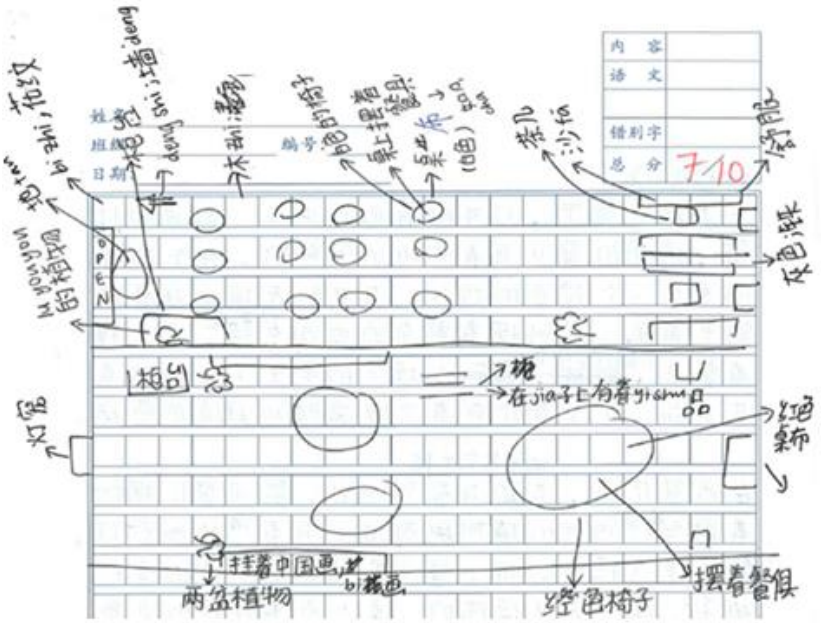

Figure 6. An example of a picture-based writing plan: experimental group

Figure 7. An example of a sentence-based writing plan: experimental group

An interesting finding was that the writing plans differed between the two groups as per the language used in constructing the writing plan. As shown in Figure 4, only one language (Chinese) was used by the control group: either Chinese characters or Hanyu Pinyin (the official romanization system for standard Chinese). The experimental group used Arabic numerals and two languages: Chinese (either Chinese characters or Hanyu Pinyin) and English. Additionally, the average number of words or numbers used by the students to construct writing plans was greater in the experimental group than in the control group (see Table 5).

Table 5. *Average Numbers of Words and Numerals Used by Students While Making Plans for Unit 2*

Group	Chinese Characters	Hanyu Pinyin	English	Arabic Numerals	Summary
Experimental	21.96	1.36	11.68	0.56	35.56
Control	28.32	0.44	0.00	0.00	28.76

Finally, analysis of the contents of the writing plans revealed that they could be categorized into three types:

(a) detail-oriented (e.g., *灯光是从灯笼发出来的* [*the light is shining from the lantern*] or *木造的收银台* [*a wooden cashier*]), (b) overall-theme-oriented (e.g., *装饰比较现代* [*the decoration is much more modern*] or *红色当主题* [*red is the theme*]), and (c) modifier-oriented (e.g., *精 zhi 餐具* [*exquisite tableware*] or *简单的餐具* [*simple tableware*]). Table 6 lists the proportion for each writing-plan category in the two groups. A further chi-squared analysis showed that the contents of the writing plans did not differ significantly between the two groups ($\chi^2_{(1,3)} = 1.90$, $p = .387$). These findings indicated that the largest proportion of students in both groups paid attention to the details of the objects while constructing writing plans. The next most common category was adding modifiers to objects, and the smallest proportion of students focused their writing plans on the overall theme of the essay.

Table 6. *Percentage of Each Category of Writing Plans*

Writing Plan Category	Experimental Group (%)	Control Group (%)
Detail-oriented	47.92	41.86
Overall-theme-oriented	22.92	23.26
Modifier-oriented	29.17	34.88

The results described above echo Lan's (2014) arguments that an immersive context serves as an efficient platform for L2 learning. Moreover, they are also consistent with the perspective of sociocultural theory, stating that interactions between learners (including perception, action, and body) and the environment are essential components of L2 learning (Barsalou, 2008).

The present findings provide further evidence that 3D immersive experiences benefit the writing process of CSL students, especially in the prewriting stage. It was found that the virtual exploration experiences of CSL students inspired them to construct writing plans with more flexibility pertaining to the styles of the plans themselves and how language and symbols were used. Additionally, the quantity of the prewriting plans constructed by the students in the experimental group indicated that they were able to use the time more wisely in collecting ideas for composition writing at the prewriting stage if they participated in immersive and authentic exploration in SL. In contrast, their peers in traditional writing classes ended up constructing fewer such plans.

It is also interesting that while the students in the experimental group used multiple symbols (pictures, Chinese characters, Hanyu Pinyin, and English and Arabic numerals) to plan their composition writing, only Chinese characters were found in their essays. It appears that immersing themselves in such an environment allowed students to write down their ideas without being restricted by their CSL abilities, and consequently better express whatever came to their minds while constructing their plans. Additionally, a 3D virtual world overcomes the spatial limitations encountered in a traditional class, freeing students' imaginations and encouraging them to explore and learn (also see Chun et al., 2016). This aspect is emphasized by the process-oriented approach (Kroll, 2001), which concerns the process of how ideas are collected, developed, and formulated in writing and which has been found to be beneficial when learning to write (Patera, Draper, & Naef, 2008).

The Performance of Chinese Writing

In order to confirm that the two groups were homogeneous before the treatment, the scores of the two groups obtained from the participants' regular Mandarin Chinese final examination administered before the experiment were analyzed. The result of the test of homogeneity showed that the Mandarin Chinese abilities did not differ significantly between the two groups ($F_{(1,25)} = 0.72$, $p = .205$).

The scores determined by two researchers based on Chinese-writing rubrics for the three written compositions were also analyzed. Before a further statistical analysis was conducted, the Spearman coefficient of concordance was computed from the scoring results obtained from the two researchers. The Pearson correlation coefficient was .981 ($p < .001$). Table 7 lists the average scores obtained by the two

researchers including those for the three individual units and the average of the three units.

Table 7. *Scoring Results of the Three Compositions*

Rubric Dimension		Unit 1		Unit 2		Unit 3		Average	
		Ex	Con	Ex	Con	Ex	Con	Ex	Con
Total	*M*	20.24	17.12	20.52	18.29	20.75	19.13	20.51	18.17
	SD	2.34	2.92	2.25	3.13	1.81	2.42	2.13	2.93
Content	*M*	4.12	3.13	4.02	3.52	3.56	3.49	3.90	3.38
	SD	0.60	0.77	0.66	0.68	0.54	0.67	0.64	0.72
Organization	*M*	3.82	2.99	3.85	3.00	3.77	3.57	3.81	3.19
	SD	0.72	0.85	0.77	1.02	0.57	0.83	0.68	0.94
Vocabulary	*M*	3.78	3.26	3.94	3.72	4.15	3.56	3.96	3.51
	SD	0.72	0.76	0.73	0.69	0.61	0.70	0.70	0.74
Grammar	*M*	3.94	3.46	4.21	3.68	4.42	3.91	4.19	3.68
	SD	0.53	0.71	0.45	0.75	0.48	0.71	0.52	0.74
Punctuation and Handwriting	*M*	4.58	4.28	4.50	4.36	4.85	4.59	4.64	4.40
	SD	0.55	0.81	0.81	0.78	0.46	0.61	0.64	0.74

Notes. Ex = experimental group, Con = control group

Table 7 indicates that students in the experimental group outperformed their peers in the control group, achieving higher scores in all dimensions on the rubrics, including content, organization, vocabulary, grammar, and punctuation and handwriting. Additionally, with the exception of the vocabulary dimension for Unit 2, all of the standard deviations were smaller in the experimental group than in the control group. This indicates that students who explore in authentic and immersive contexts at the prewriting stage show reduced differences in their writing performance when compared to those without do not have virtual exploration experiences. The differences in writing performance between the two groups were statistically significant for all the dimensions except punctuation and handwriting, as indicated by the results of a one-way ANCOVA analysis presented in Table 8. The covariate was the participants' CSL scores obtained from their regular CSL final examination before the experiment, with the cutoff for statistical significance set at α=.05. The largest significant difference between the two groups was in grammar, followed by content, organization, and vocabulary.

Table 8. *One-Way ANCOVA for CSL Essay Rubric Scores*

	SS	***df***	***MS***	***F***	***p***
Total	62.69	1	62.69	25.80	.000***
Content	3.09	1	3.09	19.32	.000***
Organization	4.72	1	4.72	15.49	.000***
Vocabulary	2.15	1	2.15	11.64	.001**
Grammar	2.96	1	2.96	24.06	.000***
Punctuation and Handwriting	0.67	1	0.67	2.66	.109

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

A Cohen's *d* effect-size analysis was conducted to confirm the results obtained in the current study due to the smallness of the sample. The results presented in Table 9 are consistent with those mentioned above

and confirm the effects of authentic and immersive context exploration on the writing performance of CSL students.

Table 9. *Effect Sizes for CSL Essay Rubric Scores*

	Effect Size	***p***
Total	1.149	.000***
Content	1.062	.000***
Organization	1.022	.000***
Vocabulary	0.857	.002**
Grammar	1.093	.000***
Punctuation and Handwriting	0.475	.072

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

This study found that the experience of SL exploration helped improve the writing performance of CSL students. As argued by Jonassen, Peck, and Wilson (1999), meaningful technological integration can encourage learners to construct their own meaning from their experiences. The experiences of exploring SL in the present study seemed to help the students link their real-life understanding with what they had explored in the virtual worlds. For example, one student in the experimental group wrote the following in his composition for Unit 1 about describing a room in a house:

> 桌子上放着一个古典的花瓶，里面插满了许多娇艳欲满 (this is a typographical error; the term should have been 娇艳欲滴) 的鲜花，靠近一闻便芳香四溢，令人陶醉。
>
> [*On the table is a classical vase with bunches of beautiful flowers. When I come close, it smells so good that I have become intoxicated.*]

While the student was unable to actually smell the fragrance of the flowers in SL, the authentic and immersive experience seemed to remind the student about the fragrance of a flower in the real world and allowed him to express this in his composition writing.

Furthermore, the improvements in the writing performance of the CSL students were consistent with the findings of Patera et al. (2008), who confirmed the effects of exploring in 3D virtual worlds on the writing performance of elementary-school students. They found that students who explored the virtual worlds performed significantly better in writing performance and writing motivation than did those receiving a traditional approach to teaching writing. However, the study of Patera et al. was about writing activities in the native language (i.e., English), rather than a L2. Additionally, the application of 3D virtual worlds to FL learning by Suh, Kim, and Kim (2010) confirmed the effects of exploration in 3D virtual worlds on the FL learning of students (including listening, speaking, and writing). However, the target language in their study was English rather than Mandarin Chinese. Furthermore, the above-mentioned literature only focused on overall writing performance, and it did not provide details about the effects of 3D virtual exploration on specific writing abilities (e.g., content, organization, and grammar).

Although there were positive effects of 3D virtual exploration on CSL students' writing performance, the positive effects were not observed in their punctuation and handwriting abilities. Two possible reasons for this are (a) the lack of a scheme for reminding students to pay attention to the usage of punctuation and (b) the lack of text-based interaction during the exploration process in SL. Since the ability to use punctuation correctly and to write or choose Chinese characters are as important as the other abilities when performing CSL writing, this topic should be addressed in future research.

Target Behaviors of CSL Students in Writing Classes

In addition to attempting to understand how exploration in SL influences the writing performance of CSL

students, this study also investigated differences in student behaviors in CSL writing classes. Strict privacy rules about making in-class observations meant that the teaching process could not be videoed. The in-class observations therefore aimed at supplementing the quantitative evidence, by sketching what happened, and providing information about the writing behaviors of CSL students during the four activities listed in Table 1. The in-class observation records qualitatively focused on briefly describing events that occurred during the writing process, rather than precisely quantifying the frequencies of particular events. All the in-class observations were confirmed by the participating teacher after each class in order to ensure that the teaching process was faithfully reported. Table 10 summarizes the in-class behaviors of students in the two groups.

Table 10. *Target Behaviors in CSL Essay-Writing Classes*

Activities	**Experimental Group**	**Control Group**
Instruction	Students were very excited about what would happen in class and wondered whether there would be such writing activities in following classes.	Students behaved boringly. They even cried out 啊~ [*Naah*], showing an unwillingness to do CSL writing when they learned that they had to do it.
Prewriting	Some students were too excited in the virtual environment to focus on making writing plans in Unit 1. But from Unit 2 on, they explored the contexts and jotted down their ideas. They often raised critical questions to correctly express what they wanted to say in their compositions.	Students argued that it was difficult to think of what to write based on the pictures, even if the teacher had just provided the needed writing instruction before this activity. Few of them wrote down their ideas. Actually, most of the time was used for arguing or doing nothing, rather than thinking about the plans.
Writing	Students were proactive in writing. All the students concentrated on the task.	Students needed the teacher's frequent reminders and urges to focus on writing. The situation was worse for Unit 3. Six students did not write a word for a long period time even after the teacher's request.
Post-writing	Overall, there was little time for refining their writing. All the students used up the time to write about their exploration experience in SL. Some of them failed to complete their compositions for Unit 3, because there was too much they wanted to express to be completed within the time limit.	None of the students made any modifications although there was much time left. Some of them even laid their heads on their desks to take a nap.

The students in the experimental group were expected to perform CSL writing with SL exploration. Those students used their learning time more wisely in writing activities when compared with their peers in the control group. They also tended not to complain or show signs of boredom. These findings were consistent with those reported in Patera et al. (2008), both confirming that active immersion in a 3D virtual environment increased students' active engagement in writing activities. Furthermore, they also identified that a 3D virtual immersive experience was more beneficial to boys than girls, although all of the children in the 3D group in their study behaved more actively than their peers in the control group. Gender differences were not investigated in the current study. Because the boys in the study by Patera et al. (2008) reported feeling bored in writing classes, gender differences in the effects of using 3D virtual worlds for CSL writing merit further research. Moreover, the boredom displayed by the students in the control group is reportedly common in CSL classes in Singapore (Puah et al., 2015), mostly due to the inadequate CSL

abilities of the students (Puah, Liao, Yan, Lee, & Zheng, 2017). However, the results obtained from the current study reflected the study of Puah et al. (2015): boredom among students could be improved by cleverly integrating technology into traditional CSL writing classes.

It is interesting that the teacher played different roles when teaching the two groups in the current study. In the experimental group, she acted as a learning facilitator, answering critical questions from the students actively engaged in their writing activities. In the control group, she was a supervisor, constantly reminding the students to focus on writing. This difference in the role of the teacher is consistent with Collentine's (2011) finding that a 3D virtual world enhanced task involvement among Spanish learners.

In summary, the unique features of immersion, interaction, and imagination of 3D virtual worlds have the potential to improve the learning motivation of FL and L2 students and improve their learning behaviors. These positive effects can occur regardless of the target language, and have already been demonstrated for Chinese, English, German, or Spanish. Due to the associated promotion of writing motivation, CSL students who experienced SL exploration made more writing plans and made better use of their learning time for completing the assigned writing tasks. They consequently outperformed their peers who had no such experiences. However, while this study obtained positive findings, its limitations of having only one researcher enter the classroom and only rough sketches of the writing processes restrict its ability to generalize these findings.

Conclusions

This study aimed at determining how authentic and immersive exploration in SL influenced CSL students' prewriting planning, writing performance, and behavior during the writing process. The results obtained in the study indicated that such an immersive experience improved the ability of Singaporean CSL students learning to write while preparing themselves for writing, constructing writing plans, and completing essays. Traditional CSL writing classes are usually constrained by restricted authentic contexts, and they therefore fail to motivate students to write or improve their writing performance. Integrating 3D virtual worlds in CSL classes is a potential approach to freeing the minds and imaginations of students and consequently improving their writing abilities and learning motivation. Future studies should investigate the possibility of gender differences in technology-integration CSL classes as well as the design of an effective approach for enhancing the usage of punctuation and handwriting among CSL students.

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