



Differences in serious game-aided and traditional English vocabulary acquisition

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ARTICLE INFO

Keywords:

Pedagogical issues
Gender studies
Improving classroom teaching
Interactive learning environments
Teaching/learning strategies

ABSTRACT

A number of studies have been devoted to the effectiveness of serious gaming in English vocabulary learning, which has reported different results. Some studies support serious gaming in vocabulary learning, while others oppose. This study used a mixed-design research method through two experiments and two interviews to explore serious gaming in English (English as a foreign language) vocabulary learning. Data were collected from randomly selected participants, who were randomly assigned to three cohorts in both experiments: (1) Cohort A, where they learned English vocabulary through the more interactivity-prone serious games-Hujiang Fun Vocabulary in the first experiment and New Oriental Fun Vocabulary in the second experiment; (2) Cohort B, where they learned English vocabulary aided with the less interactivity-prone serious games-Baicizhan in the first experiment and Kingsoft Vocabulary in the second experiment; (3) Cohort C, where they learned English vocabulary through traditional approaches in both experiments. It is concluded that (1) the interactivity-prone serious gaming is significantly more effective than the less interactivity-prone serious gaming in English vocabulary learning at the significance level $p = .05$; (2) the less interactivity-prone serious gaming is significantly more effective than the traditional approach in English vocabulary learning at the significance level $p = .05$; (3) males significantly outperformed females in serious game-aided English vocabulary learning at the significance level $p = .05$. We also discussed the features that should be considered when a serious game is designed to assist English vocabulary learning. Future research directions were suggested that serious gaming in English vocabulary learning be integrated into interdisciplinary research such as cooperation between computer science, education, psychology, applied linguistics and statistics.

1. Introduction

In Chinese language, new characters tends to be created by combining used words, while English words tend to be formed by absorbing new words, which constitutes a major difference between the formation of English words and Chinese words in modern times (Li, 2017). The significant differences between Chinese and English vocabulary make it difficult for Chinese native speakers to acquire English vocabulary. As for morphologically similar Chinese characters, different Chinese intonations couple with different meanings. Intonations exert a great influence on meanings of Chinese vocabulary, while English vocabulary semantic inferences have less to do with intonations. Thus, it is reasonable to find that Chinese native speakers feel it hard to learn English vocabulary which relies heavily on morphology and alphabetic sequence rather than intonations. The distinctive comparisons of Chinese characters are affected by the number of these orthographic units and, for “different” judgments, by the proportion of mismatching units, but not by

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<https://doi.org/10.1016/j.compedu.2018.07.014>

Received 26 February 2018; Received in revised form 12 July 2018; Accepted 12 July 2018

Available online 07 September 2018

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the number of individual strokes (Chen, Allport, & Marshall, 1996). English, alphabetically spelled, is distinguished by different combination of morphemes.

Vocabulary acquisition plays an important role in language learning and teaching. Rapid development of science and technology has greatly changed the settings of English language learning and teaching in recent years. The popularity of mobile applications has exerted a far-reaching influence on traditional language learning and teaching approaches (Rezaei, Mai, & Pesaraghader, 2014).

English vocabulary, sourcing from various languages such as French, German, and Chinese, is large in its range, which increases difficulties in acquisition. Learning English is in need of proper learning strategies in order to increase English language competence of learners (Meschyan & Hernandez, 2002). English language learners have attempted to adopt a number of learning strategies, as well as cognitive approaches in the process of English acquisition (Magogwe & Oliver, 2007).

As an important complement to learning strategies and cognitive approaches, mobile technologies such as PDA, laptops and smart phones, have played an increasingly effective role in English language learning. Mobile applications made vocabulary learning less difficult while more convenient. Therefore, this study aims to identify the influence of mobile applications, i.e. serious games, on English vocabulary learning effectiveness.

The traditional pedagogical approach has been conducted in a classroom setting with a lecturer giving lectures and students sitting around to listen and take notes, where interaction between lecturers and students is deemed significant (O'Malley & McCraw, 1999). The traditional English vocabulary learning approach is operationally referred to as the English vocabulary learning method via traditional tools such as textbooks, vocabulary pronunciation and spelling drills, listening, speaking, reading and writing exercises, etc. Students are required to take notes and write down language points to enhance the memory.

The notion of “vocabularies” was used to mean “words” as opposed to a list of words with definitions or translations in a particular subject (see Oxford English Dictionary). Interactivity is operationally referred to as the learning process where learners share opinions with others, or learners gain knowledge via learning materials such as textbooks, mobile devices or notebooks. Effectiveness is operationally defined as the learning outcomes of English vocabulary. A serious game is defined as a computer application for which the original intention is to combine with consistency, serious aspects, in this case learning, with playful elements taken from the video game (Alvarez & Djaouti, 2011).

Similar to the traditional approach, in the serious game-enhanced approach, interaction between students, teachers, and learning materials is considered essential. We thus selected two serious games that are more interactivity-prone than the other pair in order to determine the role of interactivity in serious game-enhanced English vocabulary learning.

2. Literature review

This section will comprehensively review the recent studies related to serious game-aided vocabulary learning in order to pave a solid ground for further study.

2.1. Effectiveness of use of serious games in vocabulary learning

This part introduces several cases of serious game-aided vocabulary learning, describes the necessity to integrate serious games into vocabulary learning, reviews serious games for learners on different English levels, and discusses mechanisms of the effectiveness of serious games in vocabulary learning, coupled with anxiety and effort caused by serious games.

2.1.1. Several cases of serious game-aided vocabulary learning

There have been a number of studies on serious game-aided English vocabulary learning, demonstrating the positive impact of serious games on English vocabulary learning. The serious game “bingo” was reported effective in sight word training and reading by an earlier exploration (Kirby, Holborn, & Bushby, 1981). Aided with online resources and serious games, players increased their range of vocabulary significantly ($p < .0005$) more than those who acquired vocabulary through hardcopy texts, lists of words and multiple-choice questions (Smith et al., 2013). Students significantly enlarged the range of English vocabulary aided with the serious game “The SIMS” although the effect was decreased by the small number of participants (Miller & Hegelheimer, 2006). The shared book reading and vocabulary review game were also reported effective in improving students' English vocabulary acquisition compared with the vocabulary learning approach merely aided with shared book reading, after-reading vocabulary review, but without gaming (Hassinger-Das et al., 2016).

2.1.2. Comparison between serious gaming and traditional approaches

The serious game-aided vocabulary learning, in need of less learning time, produced significantly higher effectiveness than the non-serious game-aided learning (Sandberg, Maris, & Hoogendoorn, 2014). Because students were satisfied with the serious game-aided English vocabulary learning, they conducted adaptive and independent vocabulary practices. Through gaming, students felt they could increase the range of vocabulary and improve their linguistic understanding (Schamroth & Sara, 2014). Able to cater for various requirements of different students, a patented board game could delight participants and facilitate their vocabulary learning effect (Burrowes, 2003). Additionally, off-campus serious games were positively correlated with on-campus English vocabulary ranges and learning outcomes. Serious gaming was also reported more effective to acquire English vocabulary compared with the traditional vocabulary learning approach via reading comprehension (Sundqvist & Wikström, 2015).

2.1.3. *Serious games for players on different English levels*

It has been demonstrated that serious games exert different influences on students who have different levels of English proficiency (Peterson, 2010), which should be considered important in the research into serious gaming in English vocabulary learning. Students on intermediate or advanced English levels held intense motivation in serious games, especially those characteristic of interactivity. Aided with the interactivity-prone serious gaming, students could have the opportunity of communicating with peers, teachers and learning materials, which would enhance player satisfaction.

2.1.4. *Mechanisms of the effectiveness of serious games in vocabulary learning*

Serious gaming could improve vocabulary recall practice, and facilitate vocabulary transferability in authentic contexts, which led to improvements on English vocabulary learning (Franciosi, 2017). Another important mechanism might be that serious gaming prolonged the retention of English vocabulary and thus improved the effectiveness of serious gaming in vocabulary learning and teaching (Alshaiji, 2015). After reviewing seventeen sound studies in ten years, serious gaming-aided English vocabulary learning improved the effectiveness significantly better than the non-serious gaming-aided approach. In serious gaming-aided vocabulary learning, students might use numerous learning strategies such as repetitions of vocabulary, contextual inferences, convenient communication with English native speakers and peers, animated visualization of vocabulary and flexible exercises of vocabulary in authentic situations (Ebrahimzadeh, 2017). These learning strategies, which were not used in the non-serious gaming-aided contexts, might enhance the acquisition and retention of English vocabulary.

2.1.5. *Anxiety and effort caused by serious games*

A proper amount of, rather than excessive, player anxiety and mental effort could strengthen the effectiveness of vocabulary learning. The restricted serious game “Augmented Reality” provided students with effective learning because the serious gaming led to slight player anxiety and mental effort, while the free serious game system could merely produce flow experience for students (Hsu, 2017). Children who suffered from autism spectrum disorder could improve their vocabulary learning and keep vocabulary in mind longer because of the slight player anxiety and mental effort (Khowaja & Salim, 2018).

2.2. *The role of interactivity in serious game-aided vocabulary learning*

The interactivity-prone serious game was deemed as an important innovative technology, which could improve language learning and achieve learning goals (Ebrahimzadeh & Alavi, 2016). Due to their ability to help students analyze language knowledge, to improve student linguistic competence and to promote students' interaction (Marsh & Tainio, 2009), highly interactivity-prone serious games could improve the effectiveness of language learning, attract students' attention (Townsend, 2009) and thus help students achieve success in language learning. Interactive computer simulation games could promote language learning by offering rich animations, sophisticated scenarios, and high interactivity. The plentiful contexts, cognitive engagements and virtual language learning situations in the serious games could also act as an stimulus to improve the effectiveness of language learning (Ranalli, 2008). Through peer interactivity and cohort activities, beginners of English language learning successfully acquired English vocabulary using the Scrabble Game embedded in their mobile applications (Lin, Young, Hung, & Lin, 2007). The Scrabble Game was applied at the elementary school level, without relating to the tertiary education level. It is not concluded whether the findings on interactivity could be applicable to tertiary education. One of the aims in this study is to determine the role of interactivity of serious gaming among tertiary students, which can complement for this regret.

2.3. *Gender differences in serious game-aided vocabulary learning*

There are gender differences in the effectiveness of English vocabulary learning aided with serious games. Male students held significantly more positive attitudes toward serious game-aided English vocabulary learning than female students, although this learning approach was beneficial to both genders (Sedigheh & Amin, 2013). In vocabulary tests and English proficiency examinations, males who used serious games more frequently in vocabulary learning, outperformed females who used serious games less frequently (Sundqvist & Wikström, 2015). Vocabulary scores via serious games were positively correlated with the frequency of serious gameplay, while vocabulary scores via the traditional learning approach were not directly correlated with the learning frequency. The frequency of males' serious gameplay was significantly and positively correlated with the range of vocabulary compared with females (Sundqvist & Wikström, 2015).

2.4. *Other factors in serious game-aided vocabulary learning*

Other factors that may influence serious game-aided English vocabulary learning effectiveness were also taken into account. Design features of serious game-aided vocabulary learning such as age and linguistic backgrounds were essential when the impact of serious game-aided vocabulary learning on the range of vocabulary was researched (Chen, Tseng, & Hsiao, 2018). Serious gaming plays an important role in English vocabulary learning. In a computer science class aided with English-medium music video games, serious game observers attained to a significantly larger range of vocabulary than those who played serious games (Dehaan, Reed, & Kuwada, 2010). Serious game players could recall significantly less English words than serious game observers possibly because the players' extraneous cognitive load was heavier than the observers. The serious game players thought that the vocabulary learning through playing games was much harder than through watching games (Dehaan et al., 2010). However, both serious game players

and observers outperformed vocabulary learners through traditional approaches (Ebrahimzadeh, 2017).

2.5. Disagreements among studies on serious game-aided vocabulary learning

Disagreements among studies on serious game-aided English vocabulary learning still exist despite that most researchers believe serious gaming is effective in English vocabulary learning. Students having an immediate access to serious games outperformed those who have no immediate access to serious games in vocabulary tests. Whether students have an intense interest in serious gaming has no significant impact on English vocabulary learning effectiveness. The extrinsic motivation plays an essential role in vocabulary learning, such as player desire to play serious games, initial range of vocabulary and difficulty of perceiving learning materials (Calvo-Ferrer, 2017).

An isolated learning environment seems more appropriate for word retention compared with an interactive environment. In the isolated setting, students kept newly acquired words longer than in the interactive setting (Herusatoto, 2012), due to which more interactivity-prone serious gaming could lead to higher vocabulary learning effectiveness than less interactivity-prone serious gaming. Excessive interactivity-prone gaming might be harmful to the effectiveness of vocabulary learning, as well as too much note taking and excessive communicative strategies (Yudintseva, 2015). Extraneous cognitive loads might be increased in the interactive process of serious gaming, which could weaken the effectiveness of vocabulary learning (Dehaan, 2009). As some students were not familiar with the interactivity-prone serious game-aided vocabulary learning, they might feel anxious about the learning effect under the interactive condition. This anxiety posed a threat to vocabulary learning effectiveness (Neville, Shelton, & McInnis, 2009). Consequently, it is necessary to explore the element of interactivity in serious gaming-aided English vocabulary learning.

2.6. Research questions and hypotheses

Based on the reviewed literature, we designed the study aiming to identify the influence of both interactivity-prone and less interactivity-prone serious gaming on the effectiveness of English vocabulary learning, together with gender differences in serious game-aided English vocabulary learning. We raised four research questions: (1) Will the interactivity-prone serious gaming be more effective than the less interactivity-prone serious gaming in English vocabulary learning? (2) Will the less interactivity-prone serious gaming be more effective than the traditional approach in English vocabulary learning? (3) Are there any gender differences in serious game-aided English vocabulary learning? (4) What features should be considered when a proper serious game is designed to assist English vocabulary learning?

The neutral null hypotheses are: (1) The interactivity-prone serious gaming is not more effective than the less interactivity-prone serious gaming in English vocabulary learning; (2) The less interactivity-prone serious gaming is not more effective than the traditional approach in English vocabulary learning; (3) There are no gender differences in serious game-aided English vocabulary learning.

The alternative hypotheses are established that: (1) The interactivity-prone serious gaming is significantly more effective than the less interactivity-prone serious gaming in English vocabulary learning at the significance level $p = .05$; (2) The less interactivity-prone serious gaming is significantly more effective than the traditional approach in English vocabulary learning at the significance level $p = .05$; (3) Males significantly outperformed females in serious game-aided English vocabulary learning at the significance level $p = .05$.

3. Research methods

We conducted two experiments to test the hypotheses raised in this study. The purpose of this section is to introduce participants, research instruments and research procedure in two experiments, as well as two semi-structured interviews. Crosstabulation between gender, interviewee and cohort numbers is presented in the supposed demographic profiles of participants in Table 1.

3.1. Participants

In the first experiment, participants, 107 in total, were all non-English majors, recruited through systematic sampling from a public university (Student population: 51,419 at the end of September of 2017; Lecturer-student ratio: 1:14.94 at the end of September of 2017; 2018 US news Ranking: 885; Medium of instruction: both English and Chinese; Geographical location: Nanjing China; Duration: 103 years until 2018). All of them have similar educational backgrounds, and have learned English for

Table 1
Crosstabulation of both experiments.

Numbers	Cohort A	Cohort B	Cohort C	In Cohorts A & B		Interviewees	
				Males	Females	Males	Females
In the first experiment	31	32	32	41	22	21	22
In the second experiment	33	31	32	40	24		
Total	64	63	64	81	46	43	

approximately a decade. They, ranging from 18 to 21 years old, were self-reported normal in literacy and perception. However, the volunteers, as university students, may have developed their own learning styles. In order to compensate for this regret, we excluded 12 of them who reported that their learning styles were especially different from peers. Some of them said that they extremely disliked serious games, and others said that they strongly hated traditional English vocabulary learning approaches. The number of participants is thus finally 95. On the other hand, the participants are studying engineering and sciences, and other majors are not included in the first experiment.

They, voluntary to participate in the research, received proper rewards after the research. In order to avoid Hawthorne effects or other psychological effects, they had no idea of the exact reward, which were some pens, until the experiment was completed. They were randomly assigned to the interactivity-prone serious game, less interactivity-prone serious game and traditional treatments. Thirty-one participants were assigned to the interactivity-prone serious game-aided vocabulary learning approach (Cohort A); 32 participants were assigned to the less interactivity-prone serious game-aided vocabulary learning approach (Cohort B) and 32 were assigned to the traditional approach (Cohort C).

In the second experiment, 96 pupils who learned the same courses were randomly selected, which complemented for the limitation of majors in the first experiment. We conducted the second experiment by choosing English learners of early stage, e.g. the pupils in the third grade, who are beginners of English learning. They were all self reported normal in literacy and psychology, ranging from 9 to 12 years in age.

The quality of the game itself influences the learning procedure since the two games are developed by two different companies. Therefore, the second experiment involved two more serious games-New Oriental Fun Vocabulary and Kingsoft Vocabulary in order to eliminate the impact of irrelevant factors to verify the proposed hypotheses. They were also randomly assigned to three cohorts: (1) Cohort A (N = 33), where they learned English vocabulary through the more interactivity-prone serious game-New Oriental Fun Vocabulary; (2) Cohort B (N = 31), where they learned English vocabulary aided with the less interactivity-prone serious game-Kingsoft Vocabulary; (3) Cohort C (N = 32), where they learned English vocabulary through the traditional approach.

3.2. Research instruments

The research instruments include two word lists, four serious games, a vocabulary knowledge scale and a semi-structured interview.

3.2.1. A word list for the first experiment

We randomly selected 100 words from CET4 (College English Test Band 4) and CET6 (College English Test Band 6) examinations, combining with a vocabulary knowledge scale, to determine the ranges of vocabulary of participants. They were required to make choices for each word in the scale, which was scored based on the scoring rules. Their total scores were summarized and analyzed in corresponding programs.

The 100 words were randomly selected from the items, occurring with the highest frequency, in the recent five CET4 and five CET6 examinations. The recent ten examinations can be representative of English proficiency of learners at the intermediate English level (Jin & Yang, 2018). CET4 and CET6 are examinations designed by Shanghai Jiaotong University under the guidance of Ministry of Education of China, which have endured more than thirty years' practice since their birth in the 1980s. Both examinations were internally reliable and externally valid to determine test takers' English proficiency (Jin & Yang, 2018).

3.2.2. A word list for the second experiment

In the second experiment, 100 words were randomly selected from New Concept English IA for Teenagers, which aimed to identify the range of vocabulary of teenagers taught through both traditional and serious game-enhanced English vocabulary learning approaches. Among various kinds of English textbooks in China, New Concept English is of high quality and widely influential among English learners (Li, 2011). The selected 100 words were most frequently used in students' life, which could stand for the range of vocabulary of primary students. The primary students, ranging from 11 to 13 years in age and having normal literacy and psychological state, were also requested to identify the meaning of each word, which was scored according to the following vocabulary knowledge scale.

3.2.3. A vocabulary knowledge scale

A vocabulary knowledge scale (VKS) (see Table 2) was adapted on the basis of previous works (Paribakht & Wesche, 1993; Yu, 2014) in order to identify different levels of ranges of vocabulary, classified into total unfamiliarity, a little knowledge, and proficient

Table 2
The vocabulary knowledge scale.

Level	Description	Scoring
I	I have never seen this word before.	1
II	I have seen this word before, but I don't know what it means.	2
III	I have seen this word before, and I think it means_____. (synonym or translation)	3/2
IV	I know this words, it means_____. (synonym or translation)	4/2
V	I can use this word in a sentence: _____.	6/5

mastery (Paribakht & Wesche, 1993). The main rationale for selection of the VKS is that it has been demonstrated internally reliable and externally valid to determine the range of English vocabulary (Paribakht & Wesche, 1993).

As shown in Table 2, in case the participant responds, “I have never seen this word before”, he or she will gain one point and the range of vocabulary will be classified into Level 1; in case the participant says he or she has seen this word before, but he or she does not know what it means, he or she will get two points and the range of vocabulary will be classified into Level 2. If the participant says he or she has seen this word before, and he or she thinks it means ..., he or she will get three points if correct and two points if wrong and the range of vocabulary will be classified into Level 3. The correct meaning indicates that he or she assumes the meaning correctly although it is not clear in their memory. Even though the assumption is wrong, there must be some lexical residues in their mind. Thus, he or she will obtain three points for the right assumption while two for the wrong assumption. In case he or she says he or she knows this word, it means ..., he or she will get four points if the meaning is correct and two points if wrong and the range of vocabulary will be classified into Level 4. At this level, the participant believes he or she knows the meaning, indicating that he or she must have learned the word and also believes he or she knows the meaning. Therefore, he or she obtains four points for the right belief. Although the answer is incorrect, the word still impresses him or her. Therefore, he or she obtains two points even for the wrong answer. In case he or she says he or she can use this word in a sentence ..., he or she will get six points for correct use and five points for wrong and the range of vocabulary will be classified into Level 5. At this level, he or she can use the word and connect it to a given context. The ability to make sentences using the word is at a higher level than the previous. Even the use of word is incorrect, they must have understood the word and can outperform those who only know the meaning. Therefore, they obtain six points for the right use while five for the wrong use. The obtained points will be summarized and analyzed in the computer.

3.2.4. Four serious games

The four serious games are popular among English learners in China because they can cater for players' different requirements. There is no potential conflict of interest in the study of the four games. They were both free of charge and free for testing. The feature of interactivity clearly divides the four game into two types: interactivity-prone versus less interactivity-prone. The interactivity-prone serious games enable players to interact with each other in cohorts, while the less interactivity-prone serious games have no this function. This is the main rationale of game selection.

Two interactivity-prone serious games and two less interactivity-prone serious games were provided for participants to choose, i.e. Hujiang Fun Vocabulary, Baicizhan, New Oriental Fun Vocabulary and Kingsoft Vocabulary. The reason why four games were provided for participants to choose, instead of being assigned to participants is that self-choice could encourage their participation while assignment might stimulate their resistance.

Hujiang Fun Vocabulary (see Fig. 1), a serious game developed by Hujiang Group, helps players learn English vocabulary via quizzes, reviews, games, exercises and contests. Players can interact with peers by joining vocabulary contests when playing the



Fig. 1. Hujiang fun vocabulary.



Fig. 2. Baicizhan.

serious game. All the players' rankings are accessible to all of them, which can be a motivator of participation.

There are five main characteristics of Hujiang Fun Vocabulary. (1) Players can learn new words via passing fun barriers. Hujiang Fun Vocabulary establishes several barriers for players to pass through, reducing the dullness of word repetition. Through barrier passing gameplay, colorful backgrounds, various settings and interesting interactions, the game enables players to learn vocabulary happily and efficiently. The game also provides players with opportunities of going over learned contents and overcoming barriers to encourage players to continue. (2) Ten languages are embedded. In the gaming process, ten languages are provided, i.e. English, Japanese, Korean, French, Italian, German, Spanish, Chinese, Thai and Russian. (3) There are a sea of classic textbooks in the game, such as New Concept English, New Standard Japanese, IELTS, TOEFL, Business English, Primary School English, Secondary School English, High School English and more than 1000 English vocabulary books. (4) There are various motivators in the serious game. Each time when players pass a barrier, they will get an e-reward. The e-rewards accumulate with an increasing number of barriers passed, which can encourage players to play the serious game. Rankings of gaming scores are also provided as a facilitator of gameplay. (5) Game-based word learning is provided on the platform. Game players can simultaneously invite peers to compete in word gameplay and they may also play games with friends they occasionally meet.

Baicizhan (see Fig. 2), developed by Chengdu Super-love Science and Technology Company, provides game players with word-enhanced pictures and illustrations to entertain players and meanwhile enlarge their range of vocabulary. The main characteristics of this serious game are that: (1) each lexical item is connected to a picture, producing a visual impression; (2) peer gaming scores are openly accessible, facilitating gaming progress; (3) players' vocabulary range is stored for reference; (4) each word is accompanied by audios and videos, together with professional lecturing; (5) the scope of vocabulary is widely dispersed, ranging from words for middle schools, high schools, CET4, CET6, TOEFL, IELTS, SAT, GRE, GMAT, TEM4 to TEM8.

It is clearly found that major differences in Hujiang Fun Vocabulary and Baicizhan are that the former forms cohorts for players to interact with each other, while the latter provides audios, videos and lecturing, rather than an interactive platform.

New Oriental Fun Vocabulary (see Fig. 3), a mobile platform as well as a serious game, assisting players to memorize English words, was designed by New Oriental School, including word banks of middle school, high school, New Concept English, CET4, CET6, Entrance Examination for Postgraduates, IELTS, TOEFL, SAT, GRE, and GMAT, etc. This application explains each word in details, presents daily expressions, and provides standard pronunciation, rich pictures and plentiful examples. It also provides many online courses and videos taught and designed by reputable lecturers of New Oriental School. Students are also able to create cohorts to learn English vocabularies, stipulate learning rules, cooperate with each other, cultivate sound learning habits and achieve success in English words acquisition. Kingsoft Vocabulary does not possess this grouping feature, by which students cannot organize in cohorts for interactive learning activities.

Kingsoft Vocabulary (see Fig. 4), designed by Kingsoft Corporation Limited, enables students to learn English words. It includes many word banks such as New Concept English, College English Test Band Four (CET4), College English Test Band Six (CET6), TOEFL, GRE, IELTS, Oxford English, Middle School English and Primary School English. Through this platform, students can consult Kingsoft Dictionary, also designed by Kingsoft Corporation Limited, for further detailed explanation of specific words. It provides task-based assignment for students to acquire new words and expressions. Students can bookmark the learned contents for review. It can also customize special word lists to cater for students' different requirements. Students can choose the proper time or venue to



Fig. 3. New oriental fun vocabulary.

learn words at their will. However, this platform cannot form cohorts, where students can interact with each other. The major difference between New Oriental Fun Vocabulary and Kingsoft Vocabulary is whether cohorts can be created for interactive communication. The former can form the cohort and is thus referred to as “interactive”, while the latter is less interactive since it cannot form cohorts for interactive communication on the platform.

3.2.5. Two semi-structured interviews

We designed a semi-structured interview aiming to collect qualitative research data mainly through open-ended questions. Generally, four sections are involved. The first section aims to let participants know the research objective of both interviews. They are assured that their personal information will remain confidential and will be merely used in this research. The second section intends to collect participants' demographic information such as gender, age, name, birthplace, nationality, contacts, literacy and psychological status. The third section is the body part of the interview, which is composed of open-ended research questions: (1) Will the interactivity-prone serious gaming be more effective than the less interactivity-prone serious gaming in English vocabulary learning? (2) Will the less interactivity-prone serious gaming be more effective than the traditional approach in English vocabulary learning? (3) Are there any gender differences in serious game-aided English vocabulary learning? (4) What should be taken into account when we design a serious game to facilitate English vocabulary acquisition? The last section is the acknowledgement part, which extends gratitude to the participants.

3.3. Research procedure

The research follows the procedure from the pretest study, the treatments, the posttest study, to the interviews.

3.3.1. The pretest study

In order to identify the initial range of vocabulary of participants in both experiments, all the participants experienced pretests for future comparative analysis between different cohorts in both experiments. All the participants in both experiments received vocabulary testing of evenly numbered words (see Appendix I and II) through VKS, whose results were studied combined with those of the posttests.



Fig. 4. Kingsoft vocabulary.

3.3.2. The treatments

The treatments include two experiments. All the participants were required to register in the serious games so that their play frequency and duration in the games were all tracked. They could also consult dictionaries and lecturers when encountering difficulties. In the first experiment, the minimal acceptable days in the whole semester are 70. The minimal acceptable days are 8 in the second experiment. Both experiments involve three cohorts, i.e. Cohorts A, B and C. Ninety-six primary students in the third grade, divided into three cohorts, participated in the second experiment, while ninety-five joined the first experiment.

Specifically, in the first experiment, Cohort A learned English vocabulary aided with the serious game-Hujiang Fun Vocabulary, which was installed on their mobile phones. Participants were required to play the serious game at least 2 h a day. They were required to learn English vocabulary by playing the serious game throughout a semester.

Participants in Cohort B learned English vocabulary by playing the serious game-Baicizhan after they were trained to be familiar with the game that was installed on their smart phones. They were required to play the serious game-Baicizhan for at least 2 h a day during the whole semester.

Different from Cohorts A and B, participants in Cohort C learn English vocabulary via the traditional approach for the whole semester. They were not aided with any serious game in English vocabulary learning. They, required to learn CET4 and CET6 vocabulary for at least 2 h a day, had an easy access to textbooks, dictionaries, notebooks, and other learning materials.

In the second experiment, we randomly divided participants into three cohorts: Cohorts A, B and C. In Cohort A, primary students (N = 33) were requested to learn English vocabulary through using the serious game-New Oriental Fun Vocabulary, which was installed in their parents' mobile devices. After negotiating with parents, they all agreed to provide mobile devices for the children to learn English vocabulary in New Concept English IA For Teenagers. The children were requested to learn English vocabulary for 2 h a day in cohorts via the platform, continuously lasting for 10 days.

While in Cohort B (N = 31), primary students were requested to learn English vocabulary in New Concept English IA For Teenagers for 2 h a day using Kingsoft Vocabulary, also continuously 10 days. The difference from Cohort A was that they were not provided with the cohort interactivity via the platform. Instead, they learned English words through the less interactivity-prone serious game, where they acquired words using the plentiful mobile resources individually.

Students (N = 32) in Cohort C learned English words through traditional learning methods such as textbook-based learning, vocabulary pronunciation, spelling drills, listening, speaking, reading and writing exercises, etc. They were also required to learn English words for 2 h a day for 10 days continuously. Three cohorts learned English words under the instruction of the same

experienced lecturer, who is familiar with both traditional and serious game-enhanced vocabulary pedagogical approaches.

3.3.3. The posttest study

After the treatments, participants received posttests, i.e. the vocabulary range testing. As for the first experiment, participants received three treatments for one semester. Cohorts A, B and C received the interactivity-prone serious game, the less interactivity-prone serious game and traditional English vocabulary learning approach respectively. Their ranges of vocabulary were determined by using oddly numbered 50 words in the word list (see [Appendix I](#)), which was scored by VKS. The reason why we selected the 100 words is that they are highly and frequently used, able to represent the range of English vocabulary at the intermediate stage.

As for the second experiment, ranges of vocabulary of both cohorts were determined based on VKS using the oddly numbered words in the word list (see [Appendix II](#)). The randomly selected 100 words are also highly and frequently used by English beginners, which can stand for the range of English vocabulary at the primary stage. Considering the English proficiency of participants, the testing words were easier than those in the first experiment. Gender differences in ranges of vocabulary via both pedagogical approaches were also identified through corresponding programs.

Ranges of vocabulary of participants after the treatments were calculated through posttests, after which differences of pre and posttest results were also calculated and analyzed, together with gender differences in both serious games-aided approaches.

3.3.4. The interviews

The method of qualitative study is comparative analysis in this study. We collected qualitative data through the method of interviewing. After the posttest, randomly selected 43 participants from both experiments (21 males and 22 females) experienced both interviews. The interviews were carried out in a testing room equipped with recorders. The interviewees were told that their answers would remain confidential and will be merely used in this study. Sometimes interviewees expanded their answers beyond the asked questions. For example, the interviewees said learning vocabulary through gaming was interesting and motivating. We also recorded and analyzed this kind of beyond-topic answer for complementary analysis.

The interviewers were researchers in this study, who was richly experienced in interviewing and unbiased toward the results. Two richly experienced interviewers should consider the interviewees' professional experience, emotional state, and cultural background. Interviewers should also make interviewees comfortable, relaxed and concentrated. Interviewers should keep in mind that they are not superior in any way to the interviewees and they should keep polite and respectful to the candidate who is joining the research. They should get the interviewees' permission and inform the interviewees of the research purpose before the interviews start. The interviewers should not ask the question which is not familiar to the interviewee. An example is that interviewees from Cohort B and Cohort C should not be supposed to answer Question One since they have not played the interactivity-prone serious game.

All the interviewees were selected from Cohort A, Cohort B and Cohort C, in which they were interviewed one by one. Different answers between males and females were analyzed to perceive gender differences in the effectiveness of serious games.

4. Research results

Two experiments and two semi-structured interviews are designed to test the alternative hypotheses raised in the study.

4.1. Results of the first experiment

The test items were identical in both pretest and posttest. The full score of both tests is 16 points for each participant. The mode, median and mean band or grade are shown in [Table 3](#).

4.1.1. Hypotheses 1 and 2

Data comparing differences of post- and pre-tests between three cohorts of participants were collected to test Hypotheses 1 and 2 through a Shapiro-Wilk test, whose results are presented in [Table 4](#).

Table 3
Frequency data for the first experiment.

		pretest	posttest	difference
N	Valid	95	95	95
	Missing	23	23	23
Mean		209.76	223.83	14.07
Std. Error of Mean		.283	.917	.938
Median		210.00	223.00	13.00
Mode		208	217	12
Std. Deviation		2.763	8.940	9.145
Variance		7.632	79.929	83.622
Range		11	47	50
Minimum		203	201	−8
Maximum		214	248	42
Sum		19927	21264	1337

Table 4

Comparison of difference of post- and pre-tests between three cohorts.

Dependent Variable: Difference of post- and pre-tests							
	(I) cohort	(J) cohort	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	1	2	8.585*	1.800	.000	4.30	12.87
		3	14.085*	1.800	.000	9.80	18.37
	2	1	-8.585*	1.800	.000	-12.87	-4.30
		3	5.500*	1.786	.008	1.25	9.75
	3	1	-14.085*	1.800	.000	-18.37	-9.80
		2	-5.500*	1.786	.008	-9.75	-1.25

*. The mean difference is significant at the .05 level.

In this study, the sample in each cohort was drawn from a normally distributed population; all populations had a common variance; all samples were drawn independently of each other; within each sample, the observations were randomly sampled and independently of each other.

The Shapiro-Wilk test was used to test for normality on the main dependent variable-difference of posttest and pretest. The percentage of difference of posttest and pretest for Cohort A, $D(31) = .948$, $p = .141$, the percentage of difference of posttest and pretest for Cohort B, $D(32) = .940$, $p = .077$, and the percentage of difference of posttest and pretest for Cohort C, $D(32) = .935$, $p = .054$ were all normal, indicating that the data was normally distributed in the three cohorts. Levene's Test for Equality of Variances was also assumed ($F = .065$, $p = .937$) at the significance level .05.

A one-way between subjects ANOVA was thus conducted to compare the effect of serious games on English vocabulary learning in Hujiang Fun Vocabulary-aided, Baicizhan-aided and traditional conditions (see Table 4). There was a significant effect of range of vocabulary learned at the $p < .05$ level for the three conditions ($F = 31.04$, $p < .001$). Post hoc comparisons using the Tukey HSD test indicated that the mean difference of posttest and pretest for the Hujiang Fun Vocabulary-aided condition was significantly higher than the Baicizhan-aided condition ($MD = 8.59$, $SE = 1.80$). The latter was significantly higher than the traditional condition ($MD = 5.50$, $SE = 1.79$). Taken together, these results suggest that serious games really do have an effect on English vocabulary learning. Specifically, our results suggest that when students learn English vocabulary through Hujiang Fun Vocabulary, they remember more words than they do through Baicizhan. They remember the fewest English words when they learn English vocabulary through the traditional approach.

Consequently, the null hypotheses were rejected that (1) the interactivity-prone serious gaming is not more effective than the less interactivity-prone serious gaming in English vocabulary learning; and (2) the less interactivity-prone serious gaming is not more effective than the traditional approach in English vocabulary learning. The alternative hypothesis that the interactivity-prone serious gaming is significantly more effective than the less interactivity-prone serious gaming in English vocabulary learning at the significance level $p = .05$ is accepted, so is the alternative hypothesis that the less interactivity-prone serious gaming is significantly more effective than the traditional approach in English vocabulary learning at the significance level $p = .05$.

4.1.2. Hypothesis 3

In order to determine gender differences in serious game-aided English vocabulary learning, data of ranges of vocabulary learning aided with both serious games were entered into SPSS16.0 for an Independent Samples Test analysis. The results are shown in Table 5.

A Kolmogorov-Smirnov test was used to test for normality on the main dependent variable difference of posttest and pretest. The percentage of difference of posttest and pretest for males, $D(55) = .091$, $p > .05$, and the percentage of difference of posttest and pretest for females, $D(40) = .086$, $p > .05$, were both normal, indicating that the data was normally distributed in both genders. Levene's Test for Equality of Variances were also assumed ($F = .00$, $p = .99$) at the significance level .05.

An independent-samples t -test was conducted to compare gender differences for learned words in Hujiang Fun vocabulary-aided and Baicizhan-aided conditions (see Table 5). There was a significant difference in the range of vocabulary (MD for male = 19.24; MD for female = 14.77; $MD = 4.47$, $SD = 2.20$) at the significance level .05. The result suggests that gender does have an significant effect on English vocabulary learning at the significance level .05. Specifically, our results suggest that males learn significantly more

Table 5

An Independent Samples Test for gender differences in the first experiment.

		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	MD	SE	95% Confidence
									Lower Upper
Difference	Equal variances assumed	.000	.99	2.04	61	.046	4.47	2.20	.080 8.86

Table 6

Frequency data for the second experiment.

		pretest	posttest	difference
N	Valid	96	96	96
	Missing	22	22	22
Mean		206.46	219.89	13.43
Std. Error of Mean		.255	.491	.591
Median		207.00	220.00	14.00
Mode		207	221	15
Std. Deviation		2.500	4.808	5.791
Variance		6.251	23.113	33.531
Range		12	21	24
Minimum		200	208	1
Maximum		212	229	25
Sum		19820	21109	1289

English words at the significance level .05. Therefore, we rejected the third null hypothesis and accepted the third alternative research hypothesis “Males significantly outperformed females in serious game-aided English vocabulary learning at the significance level $p = .05$ ”.

4.2. Results of the second experiment

The test items were identical in both pretest and posttest. The full score of both tests is 16 points for each participant. The mode, median and mean band or grade are shown in Table 6.

4.2.1. Hypotheses 1 and 2

In order to enhance the reliability of the study, the second experiment also attempts to test the three hypotheses. The first two hypotheses are tested through a one-way ANCOVA, whose results are shown in Table 7.

The one-way ANCOVA (see Table 7) was conducted to compare the effectiveness of three cohorts whilst controlling for the pretest. Levene's test and normality checks were carried out and the assumptions met ($F = 1.763$, $p = .128$). There was a significant difference in mean gain of vocabulary range ($F = 74.247$, $p < .001$) between the cohorts. Post hoc tests showed there was a significant difference between Cohorts 1 and 3 ($p < .001$) and Cohorts 2 and 3 ($p < .001$). Comparing the estimated marginal means showed that the most vocabulary range was gained on Cohort 1 (mean = 225.30) compared to Cohorts 2 and 3 (mean = 221.30 and 215.00 respectively). Therefore, we rejected the first two null hypotheses and accepted the first two alternative research hypotheses: (1) The interactivity-prone serious gaming is significantly more effective than the less interactivity-prone serious gaming in English vocabulary learning at the significance level $p = .05$; (2) The less interactivity-prone serious gaming is significantly more effective than the traditional approach in English vocabulary learning at the significance level $p = .05$.

4.2.2. Hypothesis 3

The second experiment was also designed to test the third hypothesis through a Kolmogorov-Smirnov analysis. The results are shown in Table 8.

The Kolmogorov-Smirnov test (see Table 8) was used to test for normality on the main dependent variable difference of posttest and pretest. The percentage of difference of posttest and pretest for males, $D(55) = .091$, $p > .05$, and the percentage of difference of posttest and pretest for females, $D(40) = .086$, $p > .05$, were both normal, indicating that the data was normally distributed in both genders. Levene's Test for Equality of Variances were also assumed ($F = .773$, $p = .383$) at the significance level .05.

Table 7

Tests of between-subjects effects.

Dependent Variable:posttest						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1489.981a	6	248.330	31.316	.000	.679
Intercept	428.545	1	428.545	54.042	.000	.378
pretest	1.849	1	1.849	.233	.630	.003
gender	84.354	1	84.354	10.637	.002	.107
cohort	1177.531	2	588.766	74.247	.000	.625
gender* cohort	45.457	2	22.728	2.866	.062	.061
Error	705.759	89	7.930			
Total	4643757.000	96				
Corrected Total	2195.740	95				

a. R Squared = .679 (Adjusted R Squared = .657).

Table 8
Gender differences in the second experiment.

		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	MD	SE	95% Confidence
									Lower Upper
Difference	Equal variances assumed	.773	.383	2.73	62	.008	2.63	.96	.707 4.560

An independent-samples *t*-test was conducted to compare gender differences for learned words in New Oriental Fun Vocabulary-aided and Kingsoft Vocabulary-aided conditions (see Table 8). There was a significant difference in the range of vocabulary (MD for male = 17.42; MD for female = 14.79; MD = 2.63, SD = .96). The result suggests that gender does have an effect on English vocabulary learning at the significance level .05. Specifically, our results suggest that males learn significantly more English words. Therefore, we rejected the third null hypotheses and accepted the third alternative research hypothesis “Males significantly outperformed females in serious game-aided English vocabulary learning at the significance level $p = .05$ ”.

4.3. The interviews

Findings of both interviews are generally in line with those in both experiments. Both interviews were recorded and transcribed into readable words. It was found that some (N = 23, Percentage = 53.49%) of them (17 males, 6 females) thought learning vocabulary through gaming was interesting and motivating. They believed that serious gaming-aided English vocabulary should be more effective than the traditional approach. Serious gaming might reduce the boredom in English vocabulary acquisition. Most of interviewees (N = 27, Percentage = 62.79%) considered interactivity-prone serious gaming more attractive than the less interactivity-prone ones and they also thought learning English vocabulary without assistance of serious gaming was less effective than with assistance of serious gaming. The majority of interviewees (N = 35, Percentage = 81.40%) thought that it was important to carefully consider the features when designing English vocabulary learning serious games.

4.4. Research question: what should be taken into account when we design a serious game to facilitate English vocabulary acquisition?

Based on the findings of this study, the element of interactivity needs to be seriously considered when a serious game is designed to help students learn English vocabulary. We should also pay special attention to females since for them serious gaming is less effective in English vocabulary learning compared with for males. Previous works indicate that an effective serious game in English vocabulary learning is in need of consideration of numerous factors.

Interviewees think that in a serious gaming, fun is an important element to attract learners. With fun, students may develop intense interest in the game and may therefore be absorbed in the serious gaming. Barriers in Hujiang Fun Vocabulary and New Oriental Fun Vocabulary may create fun and stimulate students' interest in gameplay. Routine lexical explanation and detailed description may disperse students' interest quickly, which may lead to ineffectiveness in English vocabulary learning.

Interviewees also consider interactivity an important factor of serious gaming in English vocabulary learning. In an interactive setting, players could connect the meanings of words to related context and establish semantic associations. Serious gaming-aided vocabulary learning could also enhance lexical recall and word recognition by optimizing the attention of target referents (Verga & Kotz, 2017).

Various influencing elements should be important factors when we develop a serious game. With the development of serious gaming, the influential elements in serious gaming include repeating/reviewing, multiple modalities, means and control over learning, challenging, fantasies, self-control, instant feedback, and applause (Butler, 2015). Interviewees also believe “interesting” is a key factor in serious gaming. As an interviewee said, “if the game is interesting, I would like to play it; if it is not, I would not”. They do not care whether gaming can accumulate the number of words. Game developers should assume the responsibility to consider the function of vocabulary retention during the gameplay process.

5. Discussion

Findings in this study are generally in line with those in previous works (e.g., Ebrahimzadeh & Alavi, 2016; Franciosi, 2017; Hassinger-Das et al., 2016; Sandberg et al., 2014; Schamroth & Sara, 2014; Smith et al., 2013; Uzun, 2009), where interactivity and genders are considered influential factors of serious gaming in English vocabulary learning.

Interactivity plays an important role in serious gaming-aided English vocabulary learning. It can make vocabulary learning more effective than the traditional approach (Ebrahimzadeh & Alavi, 2016). Both Hujiang Fun Vocabulary and New Oriental Fun Vocabulary provides opportunities for players to compete and interact with each other. It is natural to conclude that the interactivity-prone gaming is significantly more effective in facilitating English vocabulary learning than the less interactivity-prone gaming. Serious games can provide rich animations, pictures, virtual settings, audios, videos and examples for students, which improves learning effectiveness. However, the traditional approach only provides pencils, textbooks, notebooks and other related learning materials, which is uninteresting and even boring. Thus, it is understandable to find that serious games, even the less interactivity-

prone can be more effective than the traditional approach.

Short of interactive function, the traditional approach merely provides students with stark books and pencils, thick notebooks and dictionaries, and other traditional aids. Students can merely acquire English words through routine reviewing, practicing, reciting, and lecture attending, which might have little fun and attraction and led to poor performance. Serious gaming may, however, provide interactive communication, barrier breakthrough, exciting play, and attractive rewarding for students' vocabulary acquisition. It is thus reasonable to conclude that serious gaming is significantly more effective than the traditional approach.

In the serious gaming-aided English vocabulary learning, male players outperform females in learning outcomes (Sundqvist & Wikström, 2015), which is demonstrated true by this study. Due to intense interest in gameplay, males might have spent significantly more energy and time playing serious games, which enabled them to learn English vocabulary for longer than females. On the contrary, females tend to be less interested in gameplay and thus spend less time and energy learning vocabulary through gameplay than males. Gameplay can also distract females from concentrating on English vocabulary acquisition. Females might prefer the traditional approach when learning English vocabulary. They prefer attending the traditional lecture, reading paper English texts and consulting printed dictionaries when meeting difficulties. They might resort to traditional learning tools such as books, notes, audios and videos rather than serious games.

In the traditional English vocabulary learning, students do not play games but learn English words through repeated spelling, practices, and routine memorizing. This traditional approach does not provide peer interaction, peer collaboration, and interesting barrier overcoming. In serious gaming-aided English vocabulary learning, students may learn English words by playing interesting games. They may also discuss difficulties in groups organized by the interactivity-prone serious games. In this way, students' cognitive loads may be decreased and working memory may be enlarged, which may improve learning outcomes.

Female students tend to choose the traditional approach because they prefer traditional textbooks and practices, while they dislike playing games. They might feel awkward to play games because they are not skilful in the gameplay. They are afraid that they cannot learn English vocabulary better than males through playing games. They may thus feel anxious and upset (Neville et al., 2009). Therefore, it is reasonable to conclude that there are significant gender differences in serious gaming-aided English vocabulary learning and males tend to outperform females in serious gaming-aided vocabulary acquisition.

Although interactivity was reported beneficial to English vocabulary acquisition, it is argued that too much interactivity in serious gaming may decrease the effectiveness of vocabulary learning (Yudintseva, 2015) because the extraneous cognitive load is increased by the interactivity, so is negative impact on language acquisition (Dehaan, 2009). Interactivity, gender differences and cognitive loads may be important elements that may be taken in serious consideration when we develop serious games to assist English vocabulary learning.

6. Conclusion

Serious gaming in English vocabulary learning presents a true potential because the game-based nature is reflected in some particularities that the traditional learning approach does not have, like fun or interaction.

6.1. Major findings

We designed a mixed research method to test three hypotheses through two experiments and two interviews. We conclude that the interactivity-prone serious gaming is significantly more effective than the less interactivity-prone serious gaming in English vocabulary learning at the significance level $p = .05$; the less interactivity-prone serious gaming is significantly more effective than the traditional approach in English vocabulary learning at the significance level $p = .05$; and males significantly outperformed females in serious game-aided English vocabulary learning at the significance level $p = .05$. We also discussed the features that should be considered when a serious game is designed to assist English vocabulary learning.

6.2. Advantages and disadvantages

The integration of qualitative research methods into the quantitative enhanced the reliability and validity, together with proper sampling and analytical methods. Participants, divided into three groups, were randomly selected, whose number is large enough to represent the population. The regret may be that the selected serious games chosen in the study were off-the-shelf commercial games, as opposed to bespoke educational games designed and developed specifically to test the hypotheses.

6.3. Future research directions

Future research directions were suggested that serious gaming in English vocabulary learning be integrated into interdisciplinary research such as cooperation between computer science, education, psychology, applied linguistics and statistics.

Funding

This study was funded by Jiangsu Provincial Social Science Fund in 2016 “Effect of College English flipped classroom in Jiangsu” (16YYB004); Chinese national fund for the humanities and social sciences (Chinese Academic translation) (17WSS005).

Conflicts of interest

The authors declare that they have no conflict of interest.

Appendix I. A word list for the first experiment

1. alter
2. burst
3. dispose
4. blast
5. consume
6. split
7. spit
8. spill
9. slip
10. slide
11. bacteria
12. breed
13. budget
14. candidate
15. campus
16. liberal
17. transform
18. transmit
19. transplant
20. transport
21. shift
22. vary
23. vanish
24. swallow
25. suspicion
26. suspicious
27. mild
28. tender
29. nuisance
30. insignificant
31. accelerate
32. absolute
33. boundary
34. brake
35. catalog
36. vague
37. vain
38. extinct
39. extraordinary
40. extreme
41. agent
42. alcohol
43. appeal
44. appreciate
45. approve
46. stimulate
47. acquire
48. accomplish
49. network
50. tide
51. tidy
52. trace
53. torture
54. wander
55. wax

56. weave
57. preserve
58. highlight
59. hence
60. herd
61. abuse
62. academic
63. academy
64. battery
65. barrier
66. cargo
67. career
68. vessel
69. vertical
70. oblige
71. obscure
72. extent
73. exterior
74. external
75. petrol
76. petroleum
77. delay
78. decay
79. decent
80. route
81. ruin
82. sake
83. satellite
84. scale
85. temple
86. tedious
87. tend
88. tendency
89. ultimate
90. undergo
91. abundant
92. adopt
93. adapt
94. bachelor
95. casual
96. trap
97. vacant
98. vacuum
99. oral
100. optics

Appendix II. A word list for the second experiment

1. eet
2. the
3. family
4. hello
5. my
6. name
7. is
8. this
9. wife
10. daughter
11. son
12. hi
13. and

14. nephew
15. friend
16. teacher
17. what
18. hey
19. good
20. look
21. wheel
22. green
23. OK
24. now
25. flower
26. red
27. umbrella
28. that
29. grey
30. bird
31. key
32. right
33. silver
34. chair
35. table
36. who
37. boy
38. which
39. on
40. man
41. with
42. Mr.
43. he
44. father
45. woman
46. she
47. mother
48. girl
49. New York
50. country
51. live
52. language
53. rank
54. October
55. before
56. about
57. dangerous
58. snow
59. winter
60. rain
61. sometimes
62. especially
63. mean
64. weather
65. warm
66. sick
67. Monday
68. Tuesday
69. jeans
70. newspaper
71. already
72. large
73. soap
74. ice cream

75. worry
76. healthy
77. handbag
78. true
79. always
80. morning
81. start
82. next
83. then
84. wash
85. when
86. bye
87. salad
88. finish
89. sea
90. computer
91. must
92. dinner
93. cook
94. difficult
95. balance
96. its
97. really
98. other
99. beside
100. can

Appendix III. A semi-structured interview

Section 1: The aim of this interview

This interview aims to determine the effectiveness of interactivity-prone serious game-aided English vocabulary learning, the less interactivity-prone serious game-aided English vocabulary learning and traditional English vocabulary learning. The interview data would merely be used in this study and their personal information would remain confidential.

Section 2: Demographic information

Your age_____Your name_____Your birthplace_____
Your nationality_____Your educational level_____

Section 3 Components of this interview

Please orally answer these questions:

- (1) Will the interactivity-prone serious game more effective than the less interactivity-prone serious game in English vocabulary learning?
- (2) Are there any gender differences in serious game-aided English vocabulary learning?
- (3) Is the serious game-aided English vocabulary learning significantly more effective than the traditional English vocabulary learning?
- (4) What features should be considered when a proper serious game is designed to assist English vocabulary learning?
- (5) Do you have other suggestions about English vocabulary learning?

Section 4 Acknowledgments

Thank you very much for your participation in the interview.

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