Effectiveness of Digital Game-Based Learning on Academic Achievement in an English Grammar Lesson Among Chinese Secondary School Students

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Abstract
Previous studies have proven that the widespread implementation of digital game-based learning (DGBL) in educational practice can be potentially beneficial. To date, however, far too scant attention has been paid to its efficacy in English grammar learning in China. Therefore, the principal objective of this study was to examine the effectiveness of DGBL on Chinese secondary school students' academic performance in English Grammar study. This research adopted a quasi-experimental design, and the samples consisted of 98 students from two first-grade classes at a public high school in Guangzhou. They were divided into an experimental group (n=49) and a control group (n=49), which received the DGBL and non-DGBL methods, respectively. As a formative assessment approach in the lecture, this research utilized Wordwall.net, a unique digital game-based online assessment instrument. The quantitative data was collected and compared in both groups. The results revealed significant statistical differences between the two groups, suggesting that DGBL was an efficacious tool for enhancing Chinese high school students' academic performance in grammar learning. The presented findings can contribute to the further development of DGBL and provide instructional implications for grammar learning.

Keywords: Digital Game-Based Learning, Academic Achievement, Grammar, Secondary School Students

Introduction

As the pace of globalization has accelerated and English become an increasingly essential lingua franca these days, English competence has evolved as a pivot for learners worldwide. Many non-English-speaking nations emphasize English as the most essential foreign language, as it facilitates people to interact with one another across national boundaries (Schumitt, 2014), further foregrounding the importance of research pertaining to second and foreign language teaching (Hinkel, 2016). During these processes, grammar instruction is the most controversial part of the history of foreign language teaching, which mainly focuses on whether it should be taught and how to impart it (Liu et al., 2018). Nonetheless, English grammar remains one of the rudimentary skills in the curriculum (Liu et al., 2018; Lin et al., 2019), playing a crucial role in the development of language and social contextual skills (Halliday, 1975), and showcasing a major guideline for effective English learning (Cam & Tran, 2017).

There is a consensus that studying grammar is one of the demanding tasks for learners, and many students have shown negative attitudes towards it, such as demotivation, disinterest, and lack of enthusiasm (Eltahir et al., 2021; Lin et al., 2019), which further hinders the learning process and outcomes. Similar situations are shared by Chinese students above (Liu et al., 2018), which can be attributed to unsatisfactory learning needs of students, such as conventional learning and teaching methods and lack of modern technology usage in language learning (Eltahir et al., 2021; Moylan et al., 2015). Students usually learn English grammar through the grammar-translation approach or through textbooks by filling out sentences with grammatical forms correctly according to the teacher-centered method (Liu et al., 2018; Lin et al., 2019). In China, the promulgation of the standards of the General High School English Curriculum (Chinese Ministry of Education, 2017) emphasized the importance of grammar learning and teaching, urging teachers to guide students to adopt and design different creative types of grammar education activities, integrating diverse teaching activities to develop students' awareness and ability of English grammar through exercises and activities in and out of the classroom under the information technology environment. For this reason, it is practical and pivotal for most English teachers and researchers to explore technology-assisted language learning tools and methods to inspire students to learn grammar.

The emergence of new technologies has resulted in the development of a variety of educational frameworks and instruments that enhance the efficiency pertaining to the process of language study. Digital games, for example, have been adopted and recognized with regard to learning practice and language instruction, which might have remarkable effects on students' learning performance when applied in classrooms since such games can enhance students' interests and motivation for learning (Dickey, 2005; Eltahir et al., 2021; Hwang et al., 2013). Despite that the advantages were found in most language learning domains, there is a paucity of research conducted at the secondary level, especially in estimating students' grammatical and academic achievement in China. Therefore, this study aimed to examine the influence of DGBL on students' academic achievement in English grammar classrooms in the secondary education.

Literature Review

Digital games are employed in educational contexts and have been employed as a form of new media for learning in various subject areas, including history, mathematics, engineering,

and English (Eltahir et al., 2020). Among such areas, studies have found that digital games are increasingly being used to support language learning, disclosing its great potential for providing students with various benefits compared with conventional means. Yen, Hou, & Chang (2015) stated that DGBL provides students with various practicing opportunities and reduces their affective barriers, such as anxiety, which is a conducive approach to increasing students' participation and learning motivation. For example, Campillo-Ferrer et al. (2020) adopted a quasi-experimental study on 101 undergraduate students to investigate the efficacy of Kahoot! as DGBL to improve students' active participation and motivation, showing positive outcomes and also stimulating the learning environment. Eltahir et al. (2021) conducted a quasi-experimental study to evaluate the impact of DGBL at an Arabic grammar lesson in a local university, which affirmed its effect highly improves students' engagement and motivation. Alawadhi and Abu-Ayyash (2021) employed a mixed-method study in Emirati to assess the effect of DGBL from 112 undergraduate students' perspectives in English classes, disclosing students' high participation and enhancing the enjoyable learning experience. These studies show that educators adopted DGBL to facilitate students studying via generating an enjoyful and entertaining study atmosphere, which makes the learning process more exciting and compelling.

Additionally, researchers have claimed that DGBL can help learners stay motivated by providing different challenges and gradually enhancing their learning outcomes (Chen et al., 2020). Yeh et al. (2017) conducted a quantitative study that employed the DGBL approach to show two groups of university students' English learning performance, demonstrating its positive outcome of improving their academic achievement. Lin et al. (2020) used DGBL to examine its effect on first-year college students' grammar learning outcomes in Taiwan, showing that the treatment significantly decreased students' errors in the empirical group. In China, Deng et al. (2020) conducted a case study on primary school students to show the effect of DGBL in Shanghai, showing the positive effect of increasing students' mathematical scores. Above all, literature has shown that digital games can positively impact students' learning outcomes.

Due to the advantages and increasing popularity and the ubiquitous presence of digital games, research has also revealed that learning based on digital games (DGBL) has shown positivity (Dixon & Christison, 2021; Reinhardt, 2019). The studies described that DGBL is a creative and productive instructional approach within the teaching and learning area, thus facilitating students to enhance their language learning performance, improving cooperation and motivating their study as well (Belkhouche et al., 2014; Mei et al., 2018; Sahrir & Yusri, 2012). Despite the aforementioned benefits of DGBL, there is a dearth of studies conducted to explore the effectiveness of using DGBL to increase students' grammar learning outcomes at the secondary level, especially in Chinese high school. Therefore, this study set out to investigate the following questions:

RQ1: What is the effect of using DGBL on Chinese secondary school students' grammar learning?
RQ2: Are there significant differences between students using DGBL and those using conventional methods?

Methodology

The quasi-experimental study was designed according to its objective of this study. Figure 1 shows the design procedures in detail. To ensure the equivalence of the participants in this

study presented, a t-test was employed to make a comparison after both of these groups were administered a pretest before the experiment, which consisted of the revision topics of an English grammar test with 15 multiple-choice questions.
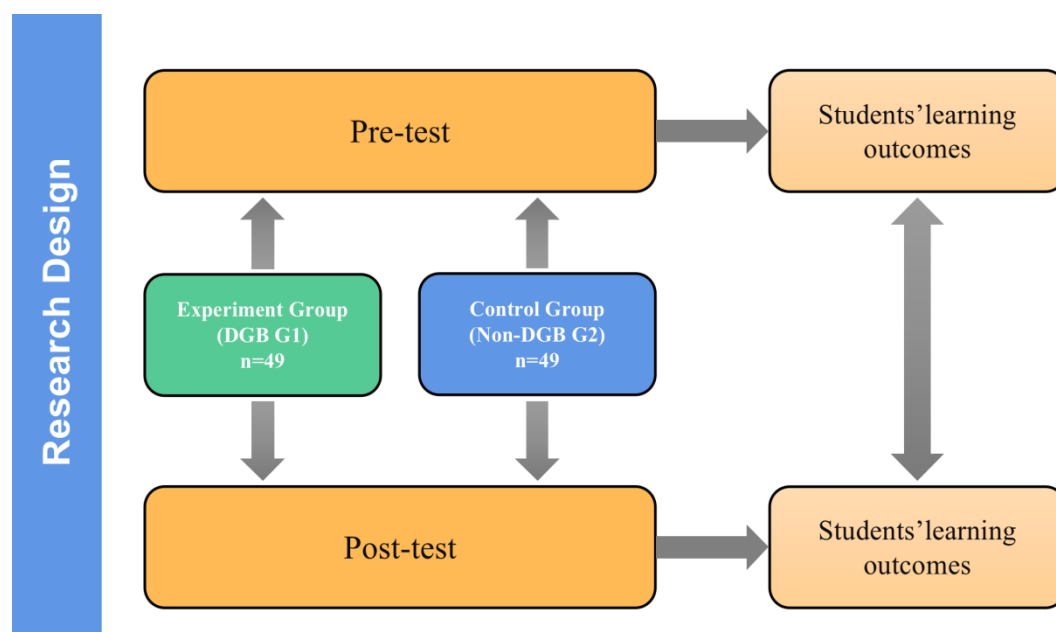

Figure 1: Design of the study

Participants

The participants of this study consisted of 98 first-year students of two classes studying in a public high school in Guangzhou during the second semester of the 2020/2021 academic year. As the researcher was also the English instructor for these sessions, convenience sampling, a non-probability sample methodology (Dornyei, 2007), was used to recruit the participants. In this study, class A (n=49) and class B (n=49) were selected as an experiment group adopting the DGBL method, and the control group employed the traditional one, respectively, where all students had compulsory English grammar lessons per week.

Procedure

Following the presentation of the same grammar learning content, the post-test was then applied to both groups during the class, in which the form and content of the formative assessment test were identical to the pre-test, emphasizing the chosen topics from the English grammar lessons.This exam consisted of fifteen multiple-choice questions, which were assigned by professionals in the English teaching department, and assessed the knowledge of the themes covered in the lectures. The control group completed the exam using a standard paper-based format, whereas the experimental group utilized the DGSRS Wordwall.net. The purpose of this procedure was to explore the difference between the experimental group and the control group in the formative evaluation test, from which quantitative data were collected and transferred into analysis with the help of the IBM SPSS Statistics Version 26 software platform, performing the descriptive analysis further, independent sample t-test and paired-samples t-test. Next, we illustrated the details of two formats of formative evaluation tests, respectively.

Paper test

A single score was given for each question for the correct answer and zeroed for the incorrect answer. This resulted in the highest score on the test being 15, while the lowest score was 0. While giving the class lectures, all control group participants were evenly distributed the paper test during this study with a duration of 10 min. Students used pens to select answers from four options in the paper, and the researchers closely monitored the course to make sure no one had a chance to copy another student's answer. After the class, all the participants' papers were collected at the end of the class, and then the paper was given to the students with grades and feedback on their performance in the following lecture.

Wordwall.net: Digital Game-based Student Response System (DGSRS)

The questions appeared on a big display screen showing the title of the TV QUIZ SHOW, followed by fifteen multiple-choice questions. Each question entailed a picture related to the topic has only one correct answer, and students tried to answer each question as quickly as possible to obtain more points. Additionally, there are two bonus rounds in the game provided to the participants. However, the researcher excluded the bonus point due to the consideration of the final score of equivalence of the two groups.

As the formative assessment, Wordwall.net allowed the researcher and teacher to understand the students' comprehension of the selected topics quickly. Students received their scores based on their performance on their tablets personally, such as the total number of points, the ranking on the leader board, and the answers. On accomplishing the Wordwall.net section, the leader board then appeared, showing the Top 10 winners of the game and correlated points on the whiteboard. In the test procedure, Wordwall.net employed a creative graphical user interface, together with related pictures of the questions, music, and sounds, which created an amusing and competitive atmosphere, acting similar to a real television quiz show (see Figure 2). Eventually, students' scores on Wordwall.net were allowed to export to the Excel format.
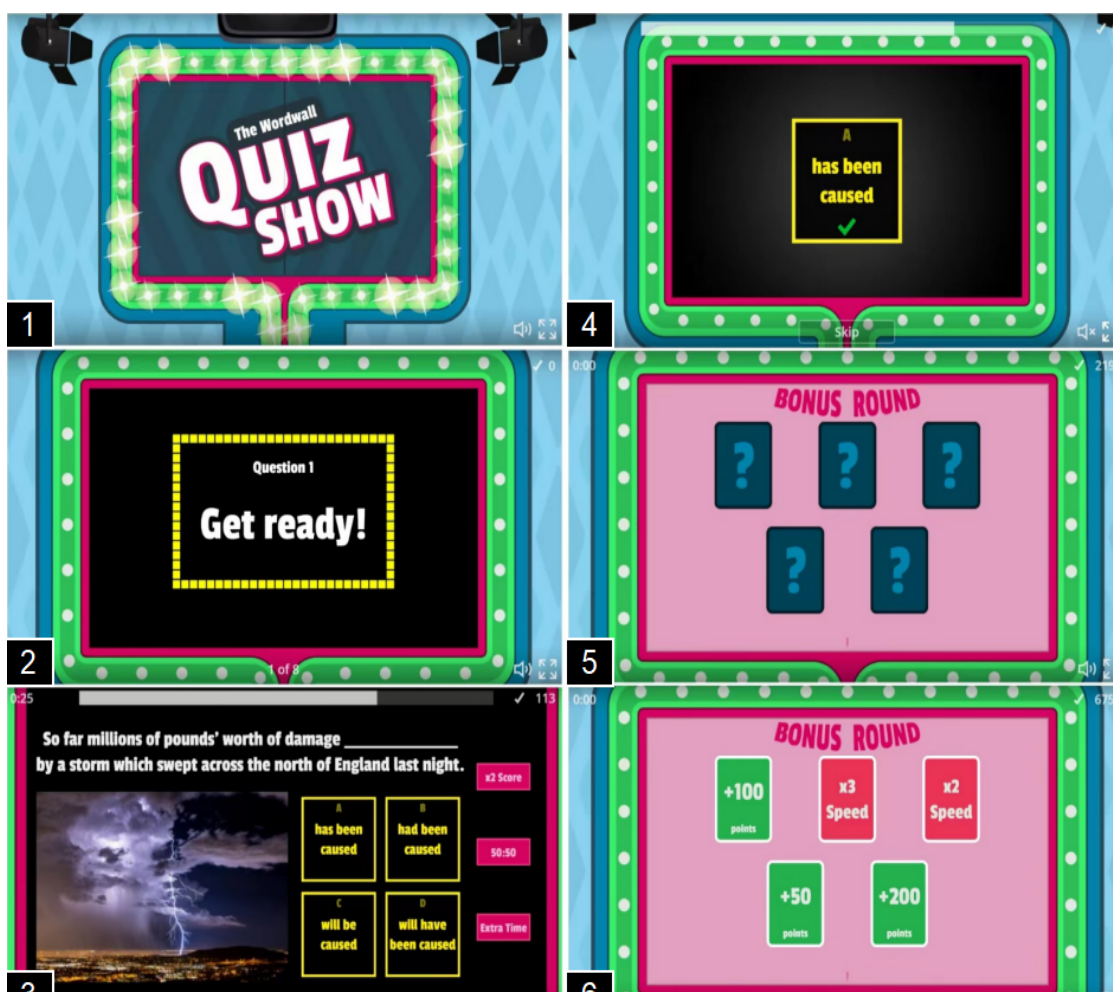
Figure 2: Screenshot of Wordwall.net

Additionally, several factors have been considered, such as topics, period of test and instruction, and question similarity. In other words, the groups had the same instructional period and grammatical topics and answered a similar formative assessment test consisting of fifteen multiple-choice questions in ten minutes.

Results

Considering that the extracted p (0.97) is more significant than 0.05, the test is insignificant at the 0.05 scale, which indicates that there is no significant difference between the experimental and control groups. The results showed that the experimental and the control groups were equivalent prior to the experiment.

The paired sample statistics (see table 1) shows the mean and standard deviation before and after the intervention in the experimental group. It can be observed that the average or mean evaluation of the experimental group before the intervention of DGBL is 8.61, while after the intervention, the mean evaluation is 10.98.

Table 1: Paired Samples Statistics

		Mean	N	SD	Std. Error Mean
Pair 1	EG pretest	8.61	49	2.65	0.38
	EG postest	10.98	49	2.04	0.29

The actual result of the t-test is provided in the paired samples test table below (see Table 2). From the sig. (2-tailed) column, it can be observed that the p-value is 0.00, and the paired sample T-test revealed that there was a statistically significant increase in effectiveness or evaluation of the students in the experimental group from 8.61 ± 2.65 before the intervention to 10.98 ± 2.04 after the DGBL intervention (mean difference = -2.37), t(48) = -6.84, p < 0.05.

Table 2: Paired Samples T-test

		Mean	SD	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper	t	df	Sig.
Pair 1	EG pretest-posttest	-2.37	2.42	0.35	-3.06	-1.67	-6.84	48	0.00

Additionally, a t-test was used for the independent samples, as presented in Tables 3 and 4. It can be observed from the group statistics (see Table 3) that the mean or average post-test score for the experimental group is 10.98, while that of the control group is 9.69. The actual result of the independent samples test is provided in table 4 below. It can be observed that the test is not significant, p= 0.69 (p > 0.05). Hence Lavene's test for equality of variances is met. Additionally, it can be observed that the p-value is 0.002 (p < 0.05), which implies that the independent samples t-test is statistically significant.

Table 3: Independent Samples Statistics

	Group	N	Mean	SD	Std. Error Mean
Post-test	EG	49	10.98	2.04	0.29
	CG	49	9.69	1.87	0.27

Table 4: Independent Samples T-test

		Levene's Test for Equality of Variances		T-test for Equality of Means						
		F	Sig.	t	df	Sig.	MD	SD	95% Confidence Interval of the Difference	
									Lower	Upper
Post-test	Equal variances assumed	0.17	0.69	3.25	96.00	0.00	1.29	0.40	0.50	2.07
	Equal variances not assumed			3.25	95.34	0.00	1.29	0.40	0.50	2.07

Therefore, the independent sample t-test conducted revealed that the posttest score of the experimental group (10.98) is statistically significantly higher than that of the control group (9.69), t((96) = 3.25, p < 0.05.

Conclusion

The results of this study revealed a substantial difference between the experimental group's learners' performance before and after DGBL intervention, indicating that DGBL was productive. Regarding the post-test findings, the independent t-test demonstrates a statistically significant difference between the two groups of students' grasp of the English grammatical themes addressed in the lectures. In other words, the students who were taught with Wordwall.net, as appeared in Table 4, namely the experimental group (DGBL group), were higher than those who were taught through the control group, namely the non-DGBL group, which suggests that the DGBL group is more effective than the control group, namely the traditional learning. Concerning students' comprehension of issues discussed in language grammar in the classroom, it is noted that the use of Wordwall.net had a significant impact on students' learning outcomes of targeted content. The results of this study are consistent with previous research confirming that DGBL can boost student achievement.

In short, the purpose of the study was to investigate the effectiveness of DGBL on Chinese secondary school students' academic achievement in an English Grammar Lesson among Chinese Secondary School Students. The study's findings assured that applying DGBL to grammar teaching and learning in secondary level students positively influenced students' grammar learning. Additionally, it has been proven that DGBL is more effective than the conventional learning methods when students learn grammar in Chinese secondary school students. Moreover, this study also proves that Wordwall.net could be used as one of the digital game-based learning tools in the process of grammar learning. Other than that, the findings fill the aforementioned research gap and align with previous literature on the positive impact of DGBL in language learning. As for the implications, it is suggested that teachers may apply DGBL in their instructional procedures and possibly adopt it in their assessments, such as formative assessments. Despite the key findings, it is noteworthy that this study's limitations needed to be addressed. First, the sample size of the study is relatively small. Second, this study is mainly focused on first-graders within a short period in China,

which may influence the effect of DGBL. Therefore, future studies may conduct more large-scale and longitudinal studies on the impact of DGBL.

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