

Exploring the Impact of Prior Knowledge on Learning Effectiveness of Competitive Game-based Learning: A Case Study on English Reading Courses

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Abstract: This case study on English reading courses explores the impact of prior knowledge on learning effectiveness of competitive game-based learning. This study develops a competitive game-based learning system and conducts an eight-week teaching experiment. The result of the experiment finds significant progress both for learners with high prior knowledge and those with low prior knowledge. Furthermore, the learning effectiveness of low prior knowledge learners is significantly higher than that of learners with high prior knowledge. Also, in the post-test, the former reach the same level as the latter.

Keywords: Prior knowledge, competitive game, game-based learning, learning effectiveness, English reading

1. Introduction

The traditional method in English learning is tedious; this may reduce students' learning motivation. Also, it leads to less learning effectiveness (Hwang, Lee & Tseng, 2012; Yang, Kao & Hwang, 2014). Prensky (2001) argued that incorporating games into learning can enhance students' learning motivation because the elements of games include set-goals, competition, and challenges. These elements activate students' learning motivation (Shi & Shih, 2015). Hwang, Hsu, Lai, and Hsueh (2017) pointed out that integrating games into language learning can enhance students' learning motivation and effectiveness. However, when games and teaching materials are inappropriately combined, it may cause students to neglect the teaching materials (Hsiao, Huang, Hong, Lin & Tsai, 2010). Competition is another strategy commonly used and moderate competition can enhance students' learning motivation and effectiveness (Davis & Rimm, 1985). Hwang and Chang (2016) indicated that mobile learning with competition could increase students' interests in learning more significantly than a traditional one. Nevertheless, some scholars proposed that competition might lead to hostile speech or negative feeling among peers (Yang & Chen, 2013). Thus, competitive strategies may have different impacts on different students. On the other words, it is necessary to consider the impact of human factors on competitive strategies.

Human factors include gender, prior knowledge and learning styles (Chen & Macredie, 2004; 2010). Prior knowledge is the primary factor affecting learning effectiveness (Tobias, 1994). Wang, Chen, Chang, and Chan (2015) pointed out that game-based learning favors students with the low prior knowledge, while it is less favorable to students with high prior knowledge. However, what was used in their study is not a competitive game. On the other words, it is worth exploring that the impact of prior knowledge on competitive game-based learning. Thus, this study develops a

competitive game-based learning system and explores the impact of prior knowledge on learning effectiveness of competitive game-based learning. Therefore, this study proposes three hypotheses:

1. There is a significant difference between pre-test and post-test for high prior knowledge learners on competitive game-based learning.
2. There is a significant difference between pre-test and post-test for low prior knowledge learners on competitive game-based learning.
3. There is a significant difference in the gain score (post-test minus pre-test) for learners with high prior knowledge and those with low prior knowledge on competitive game-based learning.

2. Literature Review

2.1 The Impact of Competition on Learning

Competition is a strategy often used to enhance students' learning motivation and effectiveness (Davis & Rimm, 1985; Hwang & Chang, 2016; Silva, 2010; Yang & Chen, 2013). In the process of competition, students can gain a sense of accomplishment (Vorderer, Hartmann & Klimmt, 2003). Hwang and Chang (2016) integrated competition into learning. Students get points by completing tasks. The points will be shown on a leaderboard. The results show that integrating competition into learning can enhance students' learning motivation. However, there is also a negative impact on the competition. Students failing in competition may also have negative feelings of frustration and disappointment (Vorderer, Hartmann & Klimmt, 2003; Williams & Clippinger, 2002; Yang & Chen, 2013). Yang and Chen (2013) integrated competition into their electromagnetic course. The competition includes fighting, racing, and tasks. In the fighting games, students decrease opponents' health points by answering questions. The result shows that students are actively engaged in the course, but they may make a hostile speech in competition. Students tend to be too focused on the competition rather than understanding the contents of the teaching materials (Van Eck & Dempsey, 2002).

2.2 The Impact of Game on Learning

In order to eliminate the negative impact of competition, this study adds games. Johnson, Christie, and Yawkey (1987) argued that games could keep students in a positive mood. Also, Prensky (2001) pointed out that games can enhance students' learning motivation because they include set-goal, competition, challenges, and so forth (Shi & Shih, 2015). Therefore, Hwang, Hsu, Lai and Hsueh (2017) showed that integrating games into language learning can enhance students' learning motivation and effectiveness. However, the degree of difficulty of the teaching materials on game-based learning can also affect students' academic performance. If the teaching materials appear to be too difficult, students may tend to avoid learning (Tsai, Yu & Hsiao, 2010). Furthermore, Hsiao, Huang, Hong, Lin, and Tsai (2010) suggested that inappropriately combined games and teaching materials should lead students to focus only on the games. Accordingly, this study will integrate competition and games into the learning system. We hope that it can enhance students' learning motivation and effectiveness.

2.3 The Impact of Prior Knowledge on Learning

Human factors influence students' academic performance. Human factors include gender, prior knowledge and learning styles (Chen & Macredie, 2004; 2010). Tobias (1994) pointed out that prior knowledge is the main reason that influences learning effectiveness. Chen and Huang (2013) argued that prior knowledge has a positive impact on learning descriptive knowledge. Hwang, Lee, and Tseng (2012) pointed out that game-based learning favors students with the low prior knowledge, but is less favorable to students with the high prior knowledge. Chen, Wong, and Wang (2014) indicated that game-based learning improves the learning motivation of students with high prior

knowledge and low prior knowledge. Therefore, this study explores the impact of prior knowledge on learning effectiveness of competitive game-based learning.

3. Competitive Game-Based Learning System

This study develops a competitive game-based learning system which includes three modes: “competition game,” “personal practice” and “learning history.” This study incorporates character development as the element of the game. Students can gain the experience point by answering questions in either a “competition game” or “personal practice” mode. As the experience point increases, the game characters will grow. The character’s growth is shown in Figure 1.

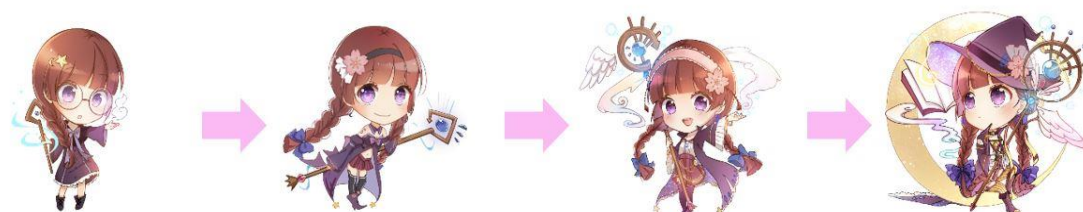


Figure 1. The Character’s Growth

In the “competition game” mode, students can work with classmates in the classroom. In the competition, the system shows the real-time leaderboard of the top ten players. Students thus compare their results with one another. It stimulates students’ learning motivation. Please see Figure 2 provides an example below.

15 Cuisine may be seen as a pride in the culture of cooking and food. Children may be deprived of their heritage and health ____ they do not learn to shop for ingredients and then cook them.

目前得分：20

名次	姓名	分數
1	吳 焜	30
2	葉 璧	26
3	陳 錦	26
4	蔡 敏	26
5	曾 瑜	24
6	陳 庭	22
7	鄭 亭	22
8	翁 婷	22
9	李 琦	20
10	吳 欄	18

A. or
B. as
C. when
D. if

Figure 2. Competition Game

In the “personal practice” mode, students can preview before class and review after class. In this mode, the system does not provide correct answers. Instead, it provides commentary that is designed by professional teachers. Please see Figure 3 and Figure 4 provide an illustration.

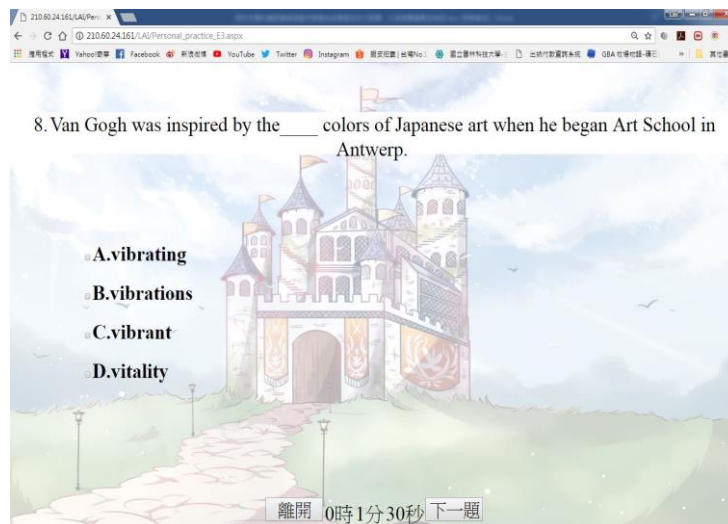


Figure 3. Personal Practice

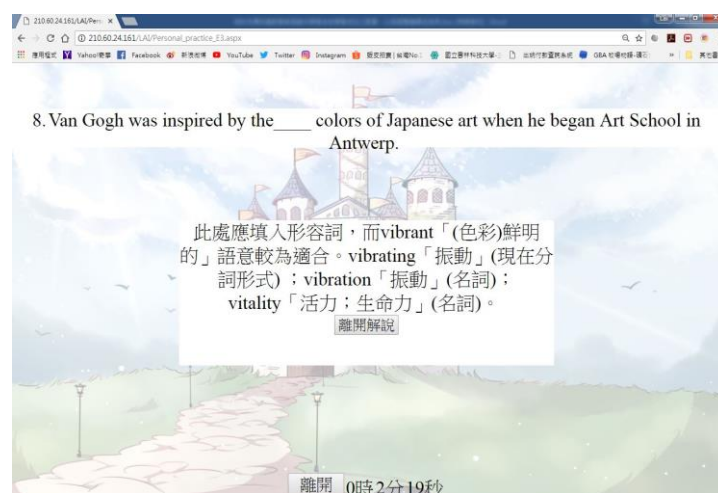


Figure 4. Explanation of the Topic

In the “learning history” mode, the system keeps learning records that students have already practiced, the time they have spent, and the number of questions they have answered, correctly or incorrectly. According to the learning records, students can go back to the chapters where they have most of the questions answered incorrectly, and they can spend more time practicing them. Figure 5 demonstrates example.

章節	開始時間	結束時間	總時間(分)	答對題數	答錯題數
1.	2018/3/6 下午 04:04:12	2018/3/6 下午 04:06:25	2	11	6
1.	2018/3/6 下午 04:08:16	2018/3/6 下午 04:10:21	2	12	7
6.	2018/3/6 下午 04:10:36	2018/3/6 下午 04:14:14	4	25	7
6.	2018/3/6 下午 04:32:43	2018/3/6 下午 04:36:00	3	40	1
6.	2018/3/6 下午 04:36:29	2018/3/6 下午 04:36:43	0	2	1
7.	2018/3/20 下午 01:27:41	2018/3/20 下午 01:30:28	3	18	5
7.	2018/3/20 下午 01:35:11	2018/3/20 下午 01:38:13	3	32	3
7.	2018/3/20 下午 01:38:38	2018/3/20 下午 01:39:18	1	9	0
6.	2018/3/20 下午 04:22:01	2018/3/20 下午 04:22:26	0	2	2
7.	2018/4/16 下午 07:53:55	2018/4/16 下午 07:59:45	6	60	10
6.	2018/4/17 下午 04:43:26	2018/4/17 下午 04:45:08	2	17	5
9.	2018/5/29 下午 03:32:38	2018/5/29 下午 03:33:44	1	1	6
9.	2018/6/19 下午 03:28:17	2018/6/19 下午 03:36:09	8	51	9
8.	2018/6/19 下午 03:36:39	2018/6/19 下午 03:48:12	12	87	13

Figure 5. Learning History

4. Research Method

4.1 Experimental Participants

The experimental participants are learners of English reading courses at the University of Science and Technology in northern Taiwan. Forty-six students participated in the research. This study is based on the average scores of the pre-test. Scores higher than the average belong to high prior knowledge, while those lower than the average belong to the low prior knowledge. Afterwards, they are equally distributed into two groups. There are twenty-three students in each group. Please see Table 1 provides an example.

Table 1

Statistics of the Sample Size of the Prior Knowledge

Group	N	Percentage	Total number
High Prior Knowledge	23	50.00%	46
Low Prior Knowledge	23	50.00%	

4.2 Experimental Tools

The learning effectiveness of this study is based on the scores of the pre-test and mid-term exam (post-test). There are twenty multiple-choice questions, and each question is worth 5 points. The results of the mid-term (post-test) scores minus the pre-test ones are used to measure students' progress of English reading abilities after using the competitive game-based learning system.

4.3 Experimental Flow

This study conducted an eight-week teaching experiment from March 6, 2018, to April 23, 2018. The pre-test was carried out in the first week, and the competitive game-based learning system was introduced in the first week as well. From the second week to the seventh one, students can access the competitive game-based learning system. The post-test is held on the week of the mid-term exam. The experimental flow is shown in Figure 6.

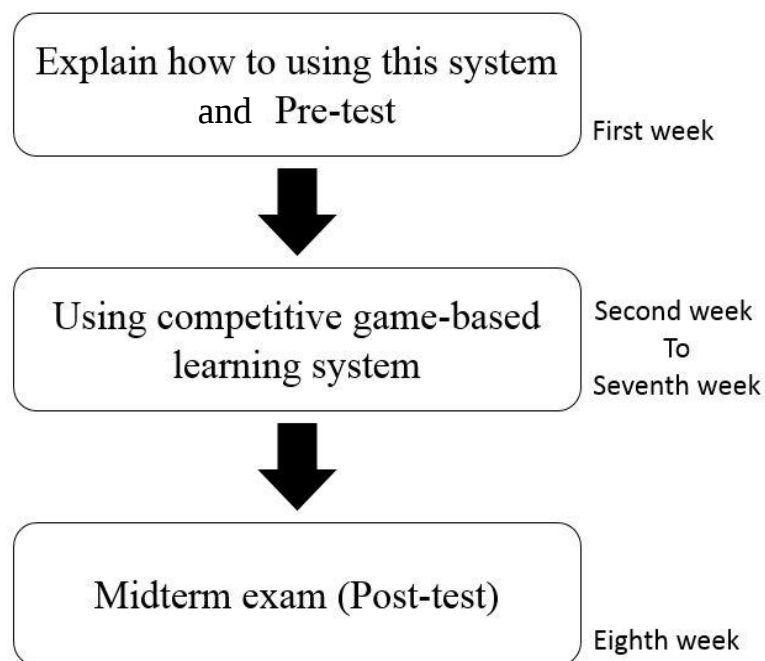


Figure 6. Experimental Flow

5. Results and Discussions

This study uses a paired sample *t*-test to analyze the impact of prior knowledge on the advancement of competitive game-based learning. The results show that both students with the high prior knowledge and low prior knowledge have made significant progress in learning effectiveness after using the competitive game-based learning system. Please see Table 2 and Table 3 offer the details for the result. They indicate that competitive game-based learning can effectively improve students' learning effectiveness.

Table 2

Paired Sample t-test between Pre-test and Post-test for High Prior Knowledge Learners

High Prior Knowledge	N	Average score	SD	<i>t</i>
Pre-test	23	59.78	11.43	-9.699***
Post-test	23	81.13	12.08	

*** $p < .001$

Table 3

Paired Sample t-test between Pre-test and Post-test for Low Prior Knowledge Learners

Low Prior Knowledge	N	Average score	SD	<i>t</i>
Pre-test	23	39.57	8.11	-9.862***
Post-test	23	76.43	20.65	

*** $p < .001$

This study further adopts an independent sample *t*-test to explore whether there is a significant difference between the gain score (the scores of the post-test minus the pre-test) of students with the high prior knowledge and those with low prior knowledge, and how competitive game-based learning influences their academic achievements. The analysis shows that students from both groups made significant progress. The average gain score of low prior knowledge learners is higher than that of high prior knowledge ones. Table 4 shows the information to support the findings. Moreover, this study finds that there is a significant difference in learning effectiveness on the pre-test for both learners with high prior knowledge and low prior knowledge, while there is no significant difference on the post-test. Please see Table 5 and Table 6 outlined the information. They indicate that competitive game-based learning can improve the learning effectiveness of low prior knowledge learners to the level of high prior knowledge ones.

Table 4

Independent Sample t-test for the Gain Score between High Prior Knowledge Students and Low Prior Knowledge Students

Group	N	Average of gain score	SD	<i>t</i>
High Prior Knowledge	23	21.35	10.56	-3.578**
Low Prior Knowledge	23	36.87	17.93	

** $p < .01$

Table 5

Independent Sample t-test for the Pre-test between High Prior Knowledge Students and Low Prior Knowledge Students

Pre-test	N	Average score	SD	<i>t</i>
High Prior Knowledge	23	59.78	11.43	6.920***
Low Prior Knowledge	23	39.57	8.11	

*** $p < .001$

Table 6

Independent Sample t-test for the Post-test between High Prior Knowledge Students and Low Prior Knowledge Students

Post-test	N	Average score	SD	<i>t</i>
High Prior Knowledge	23	81.13	12.08	.941
Low Prior Knowledge	23	76.43	20.65	

The result of this study differs from those of previous researches. Hwang, Lee, and Tseng (2012) pointed out that game-based learning can enhance the learning effectiveness of students with the low prior knowledge, but it is not conducive to learners with high prior knowledge. However, in this research, it shows that competitive game-based learning contributes to the learning effectiveness of students from both groups. Furthermore, competitive game-based learning can especially enhance low prior knowledge students' learning effectiveness. The reason for this result might differ because different types of games are applied. Hwang, Lee, and Tseng (2012) researched leveling games, while this study worked on development ones. Students have to practice on developing their characters.

6. Conclusions and Future Work

This study developed a competitive game-based learning system and conducted an eight-week teaching experiment to explore the impact of prior knowledge on learning effectiveness of competitive game-based learning. The results showed that: 1. Students with high prior knowledge and low prior knowledge both made significant progress in learning effectiveness after adopting the competitive game-based learning. It showed that competitive game-based learning can effectively enhance students' learning effectiveness. 2. The advancement of learning effectiveness of low prior knowledge learners is significantly different from that of high prior knowledge ones. The progress of low prior knowledge learners is higher than that of high prior knowledge ones. Moreover, the post-test scores of low prior knowledge learners are comparable to those of high prior knowledge ones. It represents that competitive game-based learning can help learners with low prior knowledge achieve the same level of learning effectiveness as high prior knowledge learners.

In the future, this study can be improved from some aspects. First, this study explored only the case of English reading. In the future, we may also integrate different subjects to explore the impact of different disciplines on competitive learning. Second, this study only takes students' prior knowledge of English reading abilities into consideration. In the future, we can consider incorporating students' prior knowledge of game experiences. Third, apply different teaching methods with a control group other than game based learning. Fourth, add more questions and the testing types other than multiple-choices. The reason for this study to use multiple-choices was due to its popularity for testing student's knowledge about the vocabulary. However, it may only see student's knowledge but not competence from the reading contents. Therefore, other question types should be applied in this study.

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