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A STUDY ON USING GAME-BASED METHOD TO IMPROVE LEARNING EFFICIENCY OF JUNIOR SECONDARY SCHOOL STUDENTS

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Abstract

Game-based approaches aim at improving participants' engagement and satisfaction, they might have great advantages in solving the issues of students demotivated and uninvolved in learning activities. However, there are few studies on using games elements in education and examining to what extent game-based educational approaches enhance learning. To bridge this research gap, the objective of this study is to examine whether game-based method improves students' academic performance in the school subject Life and Society.

A total of four classes of Grade Seven students and two teachers participated in the study in Hong Kong. Three classes (n= 75) were assigned to the experimental groups and one class (n=30) were assigned to the control group. The experimental group participated in class sessions where they learned the timeline, major events, and factors affecting economic development of Hong Kong by a group-based card game, while the control group were taught by lecture-based method. Using a pre- & post-tests design, data were collected by a tailor-made survey including 9 fact-based questions to assess the learning outcomes. The contents of the survey were judged two experienced teachers and one panel head.

Paired samples t-tests and two-way ANOVA were used to compare the possible changes, group differences and interaction effects. Results showed that both the experimental group and control group significantly increased their academic performance in the post-tests, indeed the average post-test scores of experimental groups were higher than that of the control group. Only one among three classes in the experimental group showed a significant increase in post-test scores, indicating a possibility of teacher difference. Boys in the experimental groups significantly improved in the post-test while girls did not differ significantly from pre-test scores. Both students with low and middle ability levels improved significantly in their post-test scores, while students with high ability level did not reach statistical significance. The interaction effect between gender and student ability level was statistically significant, indicating that the influence of student ability level on pre-test scores depended on their gender. Finally recommendations, implications, and limitations to the study are discussed.

Keywords: *Game-based approaches, card game method, academic performance, junior secondary students.*

1. Introduction

Recently, game-based approaches are suggested helpful in improving students' cognitive engagement and satisfaction, solving issues of demotivated and uninvolved in learning activities (Surendeleg, Murwa, Yun, & Kim, 2014). As a matter of fact, a related term "gamification" appeared in digital media industry starting from early 2000 which advertisers in marketing used it to attract consumers (Plass, Homer, & Kinzer, 2015; Jett, 2020). The success of gamification in the marketplace has drawn educators' attention to transfer this strategy into learning and classroom context (Surendeleg, et al., 2014).

In Hong Kong, frontline teachers make use of game-based learning to enhance students' learning engagement and effectiveness. In 2018/19, two awardees were awarded the Chief Executive's Award for Teaching Excellence. They transformed daily lesson tasks in Life and Society and Chinese History to board and card games, and it successfully grasped students' attention and fostered student-student interaction and self-directed learning when compared to traditional lessons (Education Bureau, 2018).

However, there is little local empirical research on whether game-based learning could improve students' learning effectiveness, such as any gains in academic assessment tasks which aligned with the learning contents in textbook. This action research would fill in this research gap by implementing a timeline card game in the seventh grade of a school in Hong Kong.

2. Study objectives & significance

As reported earlier, there are few studies on using games elements in classroom and examining to what extent game-based educational approaches enhance school subject learning. To bridge this research gap, the objective of this study is to examine whether game-based method improves students' academic performance in the school subject Life and Society. With this in mind, the current study was conceptualized with the aim of investigating:

1. What are the effects of game-based approach in Life and Society on academic performance?
2. Are the effects of game-based approach on academic performance in Life and Society different in students' gender and academic ability?

3. Literature review

3.1. Game-based approaches in education

The concepts of gamification and game-based learning share similar features and have been used interchangeably (e.g., Jett, 2020; Nah, Zeng, Telaprolu, Ayyappa, & Eschenbrenner, 2014). The former emphasizes the use of actual games to facilitate learning, they are in digital mode usually, but it's not a must. While the latter highlights the process of applying game elements to the design of instruction (Alsawaier, 2018; Jett, 2020). In this case, teachers in game-based learning might re-design the activities, using artificial conflict and rules of play, to make activities more interesting and attractive (Plass et al., 2015). In this paper, game-based learning is used as a broad concept, including the use of actual games and game elements to address specific learning objectives.

Game-based approaches could be used in any of these three directions: using serious games (games designed with a purpose), repurposing commercial games in educational contexts, and having students create their own games (van Eck, 2006). Plass et al. (2015) summarized four functions of these approaches: 1) Preparation for later learning activities, 2) Teach new knowledge and skills, 3) Practice and reinforce existing knowledge and skills, and 4) Develop 21st-century skills. Teachers could select these functions with reference to their learning goals of the lesson.

3.2. Game-based teaching and students' performance

After a systematic literature review on studies of game-based learning from 2003 to 2013, Jabbar and Felicia (2015) concluded that there is insufficient empirical evidence on the relationship between game design and learning outcomes. They reported that more than half of the studies were in primary education, only around 15% of them were on secondary education. Besides, current empirical findings on the impacts of game-based learning on students' motivation and academic performance are inconsistent.

First, the impacts of game-based learning on students' intrinsic motivation were mixed (Dichev & Dicheva, 2017; Jett, 2020). The elements of social aspects such as competition and collaborations positively affected intrinsic motivation (e.g., Surendeleg, et al., 2014). However, Dichev & Dicheva (2017) reviewed that factors like students' negative perceptions of competition, some game elements undermining feeling of competence, and short duration of the approach negatively influenced intrinsic motivation, in particular for students with low ability. In Christy and Fox (2015)'s study, they found that female participants performed negatively because of stereotype and social comparison. These indicate game design and student individual differences might affect the impacts on motivation.

Similarly, the impacts on academic performance are inconclusive also. Some studies (e.g., Hwang, Wu, Huang, & Huang, 2012; Tan, Goh, Ang, & Huan, 2013) found that game-based learning is effective in students' knowledge acquisition because of the opportunities of repeated practice. A meta-analysis study by Sailer and Homner (2020) reported that cognitive learning outcomes gain across various studies. However, these positive impacts were not found across all types of cognitive assessment tasks (Jett, 2020). For example, it found that high school chemistry students enjoyed the game, but their final exam scores did not significantly improve (Hanus & Focx, 2015).

In sum, the impacts of game-based learning on motivation and academic performance were mixed, and most of these studies targeted at games in digital mode. They also showed that students' characteristics make a difference on the outcomes. These uncertain findings urged more empirical studies, particularly on secondary students should be conducted to inform the uses of games in classroom setting. Thus, this study would focus on the impacts of a card game on the academic performance of junior secondary school students.

4. Study design & methods

4.1. Context

The study participants comprised of seventh grade students (or Secondary 1 students in Hong Kong context) studying Life and Society (L&S). The school is a Direct Subsidy School (DSS) in Hong

Kong, which allows ample opportunities and flexibilities in curriculum development and resource allocation. The seventh grade consists of six classes. Two L&S teachers oversee the curriculum implementation, each takes up three classes. The author, a third-year teacher, takes up the high, middle and low achiever classes. He is also the seventh grade L&S form coordinator who provides support and collaborative lesson planning with a first-year L&S colleague who also oversees another batch of high, middle and low achiever class.

Life and Society (L&S) is one of the strands under the Personal, Social and Humanities Education (PSHE) Key Learning Area in Hong Kong secondary schools. The curriculum covers the understanding of oneself and ways to facilitate one's interpersonal relationships and cultivates students' sensitivity in local, national and global issues (Curriculum Development Council, 2010).

4.2. Game design and implementation of the study

The subject topic chosen for this study is about Hong Kong economy. Prior the study, students across the whole form were assigned to design the game in October, and the best game sets in terms of content knowledge and aesthetic design were selected and used for this current study in November.

The game aimed to enable students to understand different major events that affect the economy of Hong Kong and to identify Hong Kong is an externally oriented economy. It is a card game based on the timeline game consisting of 20 cards, consisting four to five players. This game was being carried out in understanding the economic performance of Hong Kong. Students had the prior knowledge of the indicators measuring economic performance of an economy previously. When the game was about to hold, the teacher did a warm-up in hinting students the said game objectives and recalled the past economic transformation of Hong Kong (i.e., Hong Kong has transformed itself from primary industry to tertiary industry). Students were also instructed to recall the indicators measuring economic performance.

4.3. Method, participants, and analysis

Using a pre- & post-tests design, a total of four classes of Grade Seven students and two teachers participated in the study. The experimental group participated in class sessions where they learned the timeline, major events, and factors affecting economy development of Hong Kong by a group-based card game, while the control group were taught by lecture-based method.

The academic performance was measured by a tailor-made survey including 9 fact-based questions relating different major events of Hong Kong that affect its economy and factors affecting the city's economic performance, which are in line with the game and lesson objectives. The range of the possible scores is from 0 to 20. The contents of the survey were judged by three experts consisting of two experienced teachers and one panel head. Students finished the online pre-test and post-test survey consisting the same set of questions at the beginning and the end of the card game respectively. The study planning and implementation are also supervised by the Head of Department, who oversees Life and Society in seventh to ninth grade and Liberal Studies in tenth and twelfth grade respectively.

5. Study results

5.1. Effects of card game on academic performance

Table 1 presented descriptive statistics for mean academic performance scores at pre- and post-tests for experimental (n=75) and control groups (n=30) using paired samples t-tests. Results showed that both the experimental group and control group significantly increased their academic performance in the post-test, indeed the average post-test scores of experimental groups (M=14.21) were higher than that of the control group (M=14.03). Only one (Experimental group 3: M=16.70) among three classes in the experimental groups showed a significant increase in post-test scores, indicating a possibility of teacher difference. Both the control group and experimental group 3 were taught by the same teacher while other two experimental groups were taught by another teacher.

Table 1. Paired Samples t-tests comparing pre-post test scores on academic performance.

Group	Pretest: Mean (SD)	Posttest: Mean (SD)	*t* value	*p* value
Control group (N=30)	13.03 (3.46)	14.03 (3.41)	-2.76	0.00
Experimental groups (N=75)	13.17 (3.44)	14.21 (3.79)	-3.48	0.01
Experimental group 1 (n=30)	10.53 (2.73)	11.13 (3.69)	1.52	0.14
Experimental group 2 (n=25)	15.60 (2.68)	15.92 (2.18)	-0.74	0.47
Experimental group 3 (n=20)	14.10 (2.51)	16.70 (1.95)	-3.77	0.00

5.2. Effects of game-based approach on academic gains students by gender and academic ability

As indicated in tables 2 and 3, paired-samples t-tests were conducted to evaluate the impacts of gender and academic ability levels on academic gains. Boys (M=15.15, SD=3.00) in the experimental groups significantly improved in the post-test while girls (M=13.44, SD=4.21) did not differ significantly from pre-test scores.

Students were divided into three academic ability / knowledge levels according to their pre-test scores (Low: 11 scores or below; Middle: >11-16 scores; High: >16 scores). Both students with low (M=10.63, SD=4.00) and middle (M=15.04, SD=2.32) ability levels improved significantly in their post-test scores, while students with high ability level (M=16.96, SD=1.49) did not.

Table 2. Paired Samples t-tests comparing pre-post test scores of the experimental groups on academic performance by gender as conducted to evaluate the impact.

Experimental Group	Pretest: Mean (SD)	Posttest: Mean (SD)	*t* value	*p* value
Boys (N=30)	13.61 (3.19)	15.15 (3.00)	-3.07	0.00
Girls (N=41)	12.80 (3.65)	13.44 (4.21)	-1.81	0.08

Table 3. Paired Samples t-tests comparing pre-post test scores of the experimental groups on academic performance by student ability level.

Experimental Group	Pretest: Mean (SD)	Posttest: Mean (SD)	*t* value	*p* value
Low (n=24)	9.13 (1.41)	10.63 (4.00)	-2.26	0.03
Middle (n=28)	13.39 (1.23)	15.04 (2.32)	-3.42	0.00
High (n=23)	17.13 (1.32)	16.96 (1.49)	0.75	0.46

To further explore the impact of gender and student ability level on their academic gains, a two-way ANOVA was conducted. There was a statistically significant main effect for ability level, $F(2, 69)= 26.63$, $p=0.00$. The main effect for gender, $F(1, 69)=3.53$, $p=0.06$, did not reach statistical significance. The interaction effect between gender and student ability level was statistically significant, $F(2, 69)= 4.82$, $p=0.01$. The results indicated that the influence of student ability level on pre-test scores interacted with their gender.

6. Discussion, implications and conclusion

The major findings showed that both the experimental group and control group significantly increased their academic performance in the post-tests. Among the three experimental groups, only one showed a significant increase in post-test scores. Boys and students with low and middle ability/knowledge levels significantly gained in academic performance using this game-based method.

The game-based approach had positive impacts on students' academic gains. These findings are consistent with some studies (e.g., Jett, 2020; Yildirim, 2017), indicating this approach could increase students' knowledge acquisition. As a matter of fact, games could give students repeated opportunity to practice skills and apply knowledge, helping them transfer their learning in later situations such as homework and assessment tasks (Plass et al., 2015).

The impacts of game-based learning on students were varied, such as difference in gender and existing knowledge level. The challenges and conflicts in game-based learning environment can be enjoyable and motivating on one hand, on the other hand might generate frustration in some cases. Students' engagement was found depending on the availability of clear goals, unambiguous feedback, and a good fit with students' knowledge levels and skills (Hwang, Wu, Huang, & Huang, 2012; Tan, Goh, Ang, & Huan, 2013). In addition, boys performed better than girls in this study might because girls likely prefer a well-structured and systematic summary of learning objectives and modules. Learning through sorting a series of cards might not fit their learning preference. This gender difference is also raised by Christy and Fox (2015). These individual differences might explain the impacts of game-based learning are mixed among students with different characteristics and readiness.

A number of possible factors affects the impacts of game-based learning. The findings of this study also indicated a possibility of teacher difference on students' learning outcomes. Indeed, scaffolding in terms of feedback and support from teachers and game mates is important to maintain the enjoyment and progress throughout the game (Jabbar & Felicia, 2015). Like other teaching approaches, timely feedback, feedback on progression toward goals and feedback on the state of the game from teachers are essential to achieve educational objectives (Killi, 2005). These feedbacks might carry out differently among teachers and in turn affect students' learning outcomes. Teachers need to respond to the players' in-game actions to provide guidance and feedback appropriately (Plass, et al., 2015).

The current study provided empirical data on the impacts of game-based approach on students' academic gains in Hong Kong secondary school students in particular. Findings in this study indicated that students' characteristics and readiness contribute to their gains in game-based learning environment, informing the possible factors affecting the implementation of game-based approach. As this study focused on Grade 7 (Secondary 1) students who learnt the contents in a card game, further research is recommended to focus on students with other characteristics, examine the impacts of various game designs on academic gains and motivation. Besides, to understand the experiences of game-based approach on learning in depth, qualitative feedback from students could be included in future studies.

In conclusion, the present study has contributed to the literature by exploring the impacts of game-based approach on secondary school students' academic gains in a school subject by providing empirical evidence, which filled research gaps in previous research. Positive impacts of game-based approach on academic performance were observed, and it was different by students' gender and existing ability or knowledge level. These results can inform those teachers who are interested in using game-based approach in engaging learning process and improving learning outcomes in classroom settings.

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