Injecting Challenge or Competition in a Learning Activity for Kindergarten/Primary School Students

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Abstract. English and Mathematics have always been considered important subjects in schools all over the world but they can also be subjects that people in certain parts of the world fear. A recent poll done by OECD (Organization of Education and Community Development) shows that in certain countries like Tunisia, Argentina, Brazil and Thailand, teenagers have been found to have the "highest levels of Mathematics anxiety". Similarly, English is a difficult subject for East Asians (Japanese, Chinese) as there is too much emphasis on grammar in local classrooms with very little time devoted to actual conversational practice by learners. With today's technology, we can look towards mobile technology in the form of mobile educational game or application. The mobile educational game is one approach that can be beneficial for enhancing pre-school and elementary school education in the world as virtually everyone now owns a mobile smartphone. One will find that current educational games are rather boring and that is because the games were created with a random selection of theme, content and mechanics. This paper attempts to prove that by injecting competition or challenge in a learning activity elevating it to the level of mobile educational game and coupled with the appropriate theme, content and mechanics will lead to better learning experience for kindergarten/primary school students. An experimental study has been carried out and the results are evaluated and discussed at the end of this paper.

Keywords: Mobile game education application learning competition

1 Introduction

English and Mathematics are two subjects that have been consistently used for entry to higher level courses around the world and they have always been considered important subjects for students in primary schools to master. According to a poll done by OECD (Organization of Education and Community Development), teenagers in certain countries like Tunisia, Argentina, Brazil and Thailand have been found to have the "highest levels of Mathematics anxiety" [6]. Once children have the anxiety, it would be difficult for them to score well in Mathematics. Similarly, English is a difficult subject for many East Asian countries where English is only a second language. In Japan for instance,

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it has been found that there is too much emphasis on grammar in classroom with very little time devoted to actual conversational practice by learners [7].

As mobile phones, tablets, and other connected devices are now more prevalent and affordable, these devices can dramatically bring digital content to students and improve learning. Hence, giving kindergarten or primary school students around the world a head-start in English and Mathematics can be a good thing. With today's technology, we can look towards mobile technology in the form of mobile educational game.

As everyone now owns a mobile smartphone, the mobile educational game is one approach that can be beneficial for enhancing pre-school and elementary school education in the world. Students love mobile technology and use it regularly in their personal lives. It is therefore no surprise that young people want to employ mobile devices to make education more engaging and personalize it for their own needs. Children are very fascinated by technological gadgets, toys, games and graphics.

However, a number of factors limit the use of mobile educational game at the moment. First is the high cost involved in making an educational game of a good standard and accessibility is an issue since most educational games are on the PC only. Also, there is the difficulty in determining what kind of game theme and mechanics is suitable for a learning activity given a set of educational content.

People find that current educational games are rather boring and that is because the games were created with a random selection of theme, content and mechanics. How are the feelings of students after playing the educational mobile game? If they do not feel good after playing the game, it will definitely not help maintain sustainability of the mobile game in the market.

This paper attempts to prove that by injecting competition or challenge in a learning activity thus elevating it to the level of mobile educational game and coupled with the appropriate theme, content and mechanics will lead to better learning experience for kindergarten/primary school students.

The structure of this paper is as follows: Sect. 2 introduces the background by summarizing the literature review of mobile game-based learning. Section 3 provide details of the methodology employed. Section 4 describes the results and Sect. 5 discusses the findings of the results. Section 6 then presents the conclusions.

This paper represents the initial foray into wider important research on game theme, content, mechanics and learning experience which is not widely explored at the moment.

2 Background

According to Salen and Zimmermann [5], a game is a "system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome". A game is a kind of play motivating people through entertainment. Its popularity on the PC platform a few decades ago give rise to PC games.

Mobile games, riding on the wave of mobile technology with the time-space advantage [3] can be played anywhere anytime. In recent years, researchers have conducted numerous studies and they saw the immense potential of mobile games enriching the schools learning environment. In this respect, we see the rapid rise of the mobile education game or application.

In a literature review conducted recently, there is a growing number of education games. Indeed, utilization of the educational content in digital games is an increasing trend that sometimes has been described as a "mad rush where sound educational principles often are absent" as mentioned by Shabalina [2]. Games-based learning is still a young discipline and there is not yet agreement on how learning objectives should be integrated into a learning game. Currently, the combination of commercial game mechanics and educational content has been compared to "Shavian reversals" – the resultant product inherit the worst characteristics of both their parents [4]. This implies there is poor integration of game mechanics and educational content. In her paper, she goes on to mention one effective method of integrating learning content and game-flow known as the 3i-approach. In this approach, learning material is first be introduced through the game world; learners then interpret solutions in the game context and the learning results will influence gaming experience.

The various ways of integrating learning and game activities give rise to the following types of educational games:

1) Learning simulation – A typical traditional learning activity. There is no game scenario here.
2) Learning system with game elements. Sequence of activities is defined by the learning scenario.
3) Game with learning elements. Game story determines the sequence. Gameplay does not depend on learning outcomes.
4) Learning game. Game and learning scenarios are connected and synchronized.

Ideally education application should be of the fourth category where learning and game is connected.

In another aspect, according to Adams [8], multiplayer games offer opportunities for social interaction that give rise to the players' enjoyment of the experience. The classic Malone theory of intrinsic motivation suggests challenge as one reason that mobile game is so fun and motivating and that is precisely that students in a study [1] were motivated by the game to be able to perform better in an English vocabulary test.

Hence, if it is just a learning system with game elements like in the second category above, the learning activity can be rather boring. To this end, by injecting competition or challenge between two players, the learning activity becomes like a multi-player game, bringing more fun and interest to the players.

3 Methodology

To make this project more focused and specific, the area of study will be on English and Mathematics learning for kindergarten/primary schools. There are two focus groups created – one is looking at English (see Fig. 1 and 2) and the other is handling Mathematics (see Fig. 3 and 4).

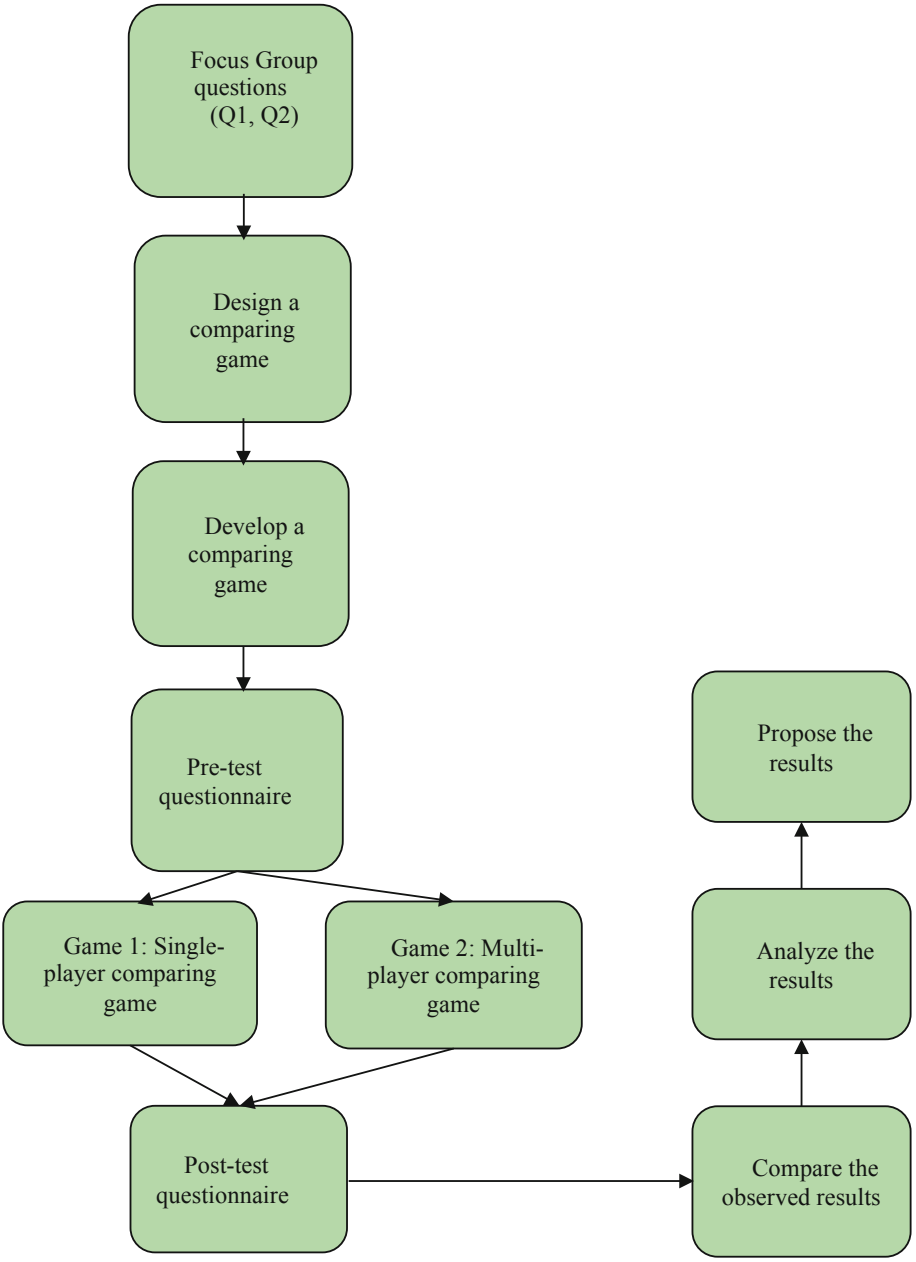


Fig. 1. Methodology employed for mobile game for English

3.1 Hypotheses

The following hypotheses have been created for this project:

H1: Multi-player Comparing game is better than single-player Comparing game for the children learning English which provides a better learning experience.
H2: Multi-player Kick-the-Ball game is better than single-player Kick-the-Ball game for the children learning Mathematics which provides a better learning experience.

3.2 Theory Behind the Hypothesis

Single-player games do not present sufficient challenge for children to play since the player does not feel competitive at all. Allowing two players to participate in the same game gives children more fun and better motivation to learn English and Mathematics as they need to learn and answer the questions to get better scores than another player in the same game.

3.3 Focus Group Study for English

Questions of Study

Question 1: What are the challenges of learning English?

Participant 1	The difficulty of learning synonyms where a word or a phrase means directly or exactly the same as another word or phrase
Participant 2	The difficulty of learning English which is a foreign language
Participant 3	The difficulty of learning homophones where the words sound alike but have different spellings and different meanings
Participant 4	The difficulty of having a limited vocabulary and cannot expand them

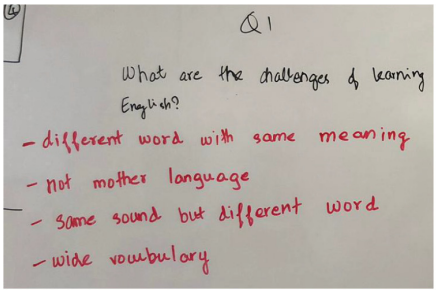
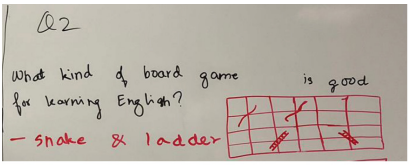
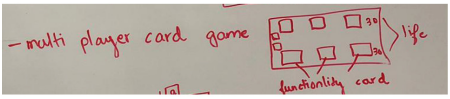
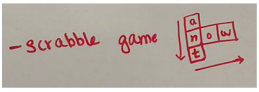


Fig. 2. Sketches by English focus group

Question 2: What are the kind of game plays for learning English?

Game play 1	Snake and ladder game where the ladders will take the player up but the snakes will take them down. At some point on the board, the player must play the picture card game. 
Game play 2	Multiplayer card game where the players take turn and can pick up cards to attack or defend themselves from the other opponent only when the answer is right. 
Game play 3	Rescue game where the player has to travel to the other side of the board to rescue a character. The pathway to the character will only be opened if the answer to the question is right. 
Game play 4	Scrabble game where the players place the meaningful English words on the board reading left to right in rows or downward in columns. 

3.4 Focus Group Study for Mathematics

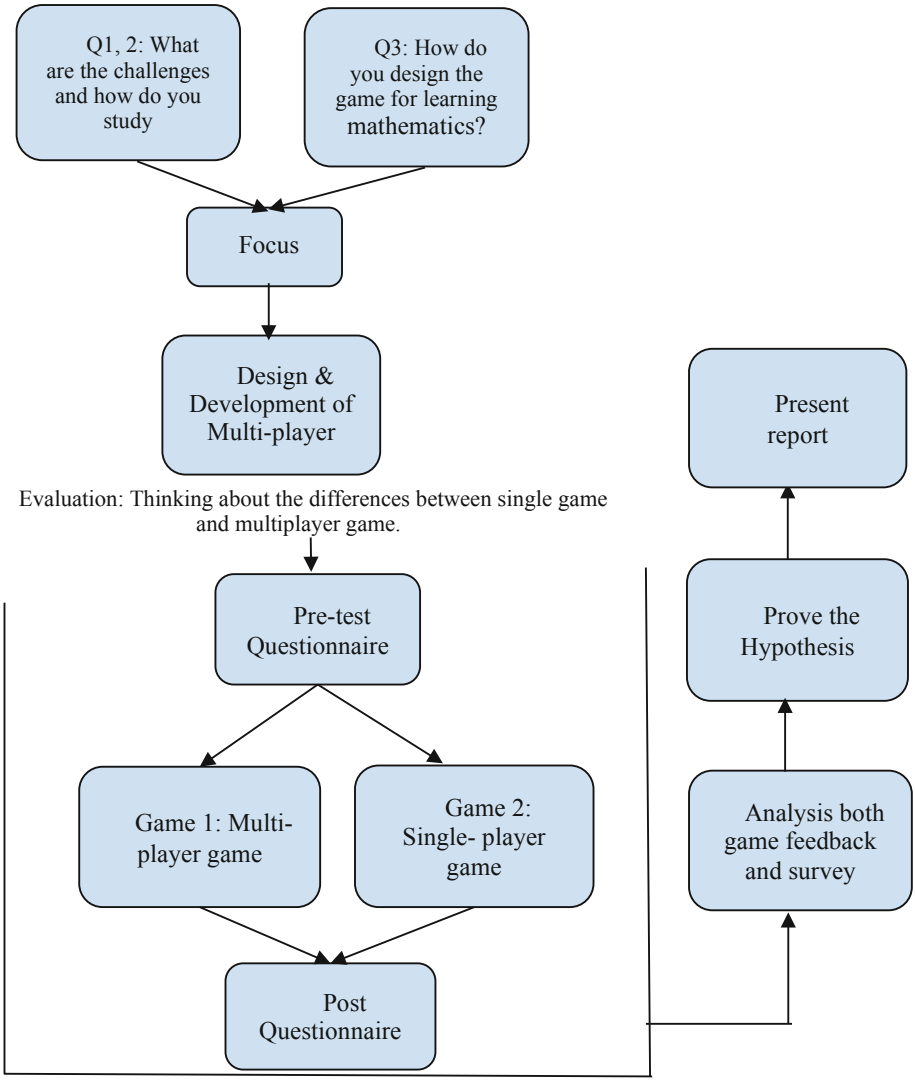


Fig. 3. Methodology employed for mobile game for Mathematics

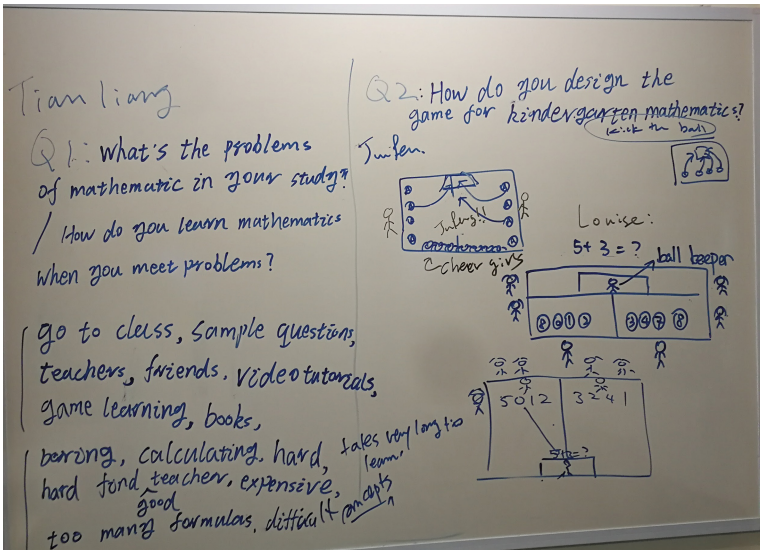


Fig. 4. Sketches by Mathematics focus group

Questions of study

Question 1: How do students study Mathematics?

Participant 1	Attend class, do sample questions, check with teachers, friends
Participant 2	Video tutorial, game-based learning, books

Question 2: What are the challenges of studying Mathematics?

Participant 1	Boring, calculating, hard to study, hard to find a good teacher
Participant 2	Expensive to hire tutor, too many formulas, difficult concept.

Question 3: How would you design the game for Kindergarten Mathematics?

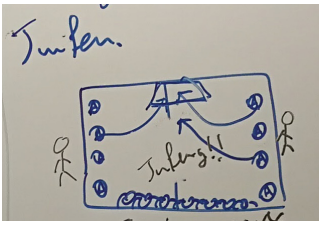


Fig. 5. Kick-the-Ball game designed by Participant 1

The first participant designed a multi-player game (see Fig. 5 above). He mentioned that children tend to learn more during competition. Most children like to play games with friends, and they always like to win over their friends. In this game, the player will play at different sides, and they will "shoot ball" at the football goal frame in the middle. The question is placed in the middle of the court, and the answer is placed at the edges on both sides. Each player answers the question. If the player answers correctly, the goal will show "Great" word when the ball flies towards goal. However if player answers wrongly, the goal will show "Bad" word when the ball flies towards goal.

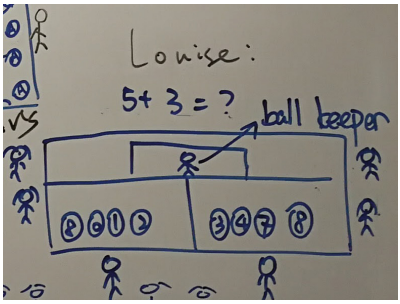


Fig. 6. Kick-the-Ball game designed by Participant 2

Second participant also designed a multi-player game (see Fig. 6 above). He split the game into 3 parts - one football goal frame, two player answer parts. In goal frame, he place the goalkeeper in the goal. The players will play at same side, but answer at different parts. The question will appear above the goal. Players have to answer quickly. If the player answer incorrectly, the goalkeeper will catch the ball that flies to him. But if player answer correctly, the goalkeeper will not catch the ball that flies to him. In order to attract the attention of the players, some cheerleaders will cheer for the player who shoot correctly to goal.

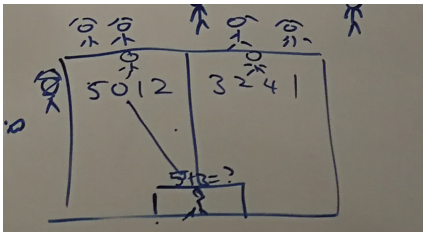


Fig. 7. Kick-the-Ball game designed by Participant 3

For the third participant, he also divided the screen into two parts (see Fig. 7 above). Two players will stand on the same side, but in different areas to answer question. The answers they can select are not the same except for the correct answer. The football goal frame is placed directly below with the question placed above the goal. When player

select the correct answer, the ball will fly direct to the goal frame with the sound of cheerleaders cheering for him. If it is the incorrect answer, the ball will bounce off the goal frame.

As this project is a pilot run, instead of getting real kindergarten/primary school students, participants were recruited on the James Cook University Singapore campus to help with the initial pre-test survey questionnaires. The participants then play the mobile games. With that completed, a post-test questionnaire is given. All data collected is subsequently analyzed.

3.5 Design and Development of "Comparing" and Kick-the-Ball Mobile Games

Both the Comparing and Kick-the-Ball mobile games were designed and developed on Kopo application server. Figure 8 shows the Kopo home page where the default and already playable games exists. First, a user account has to be created before one can start implementing the games in Application Designer.

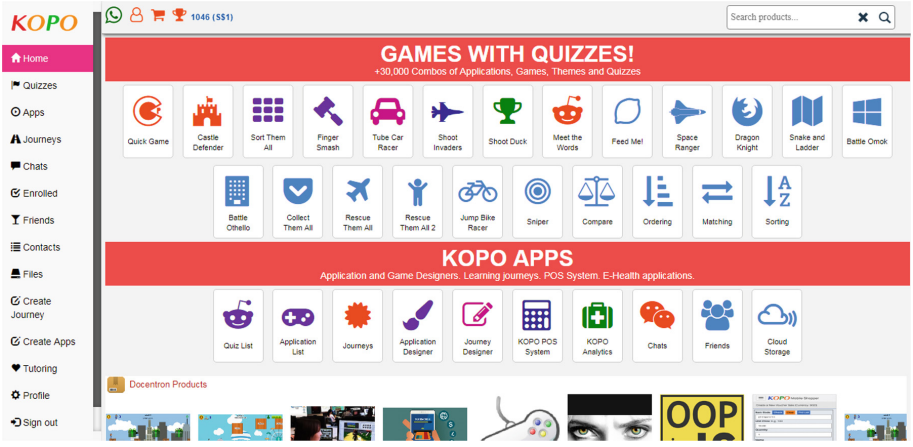


Fig. 8. Kopo home page

Figure 9 shows the code in JavaScript to implement the game to allow activities in the game such as removing joystick, placing game assets, checking levels, and matching the correct answers. Game themes such as the background, audio, video and dialog boxes can be edited according to the content.

The single-player version seems more like a learning activity instead of a mobile game.

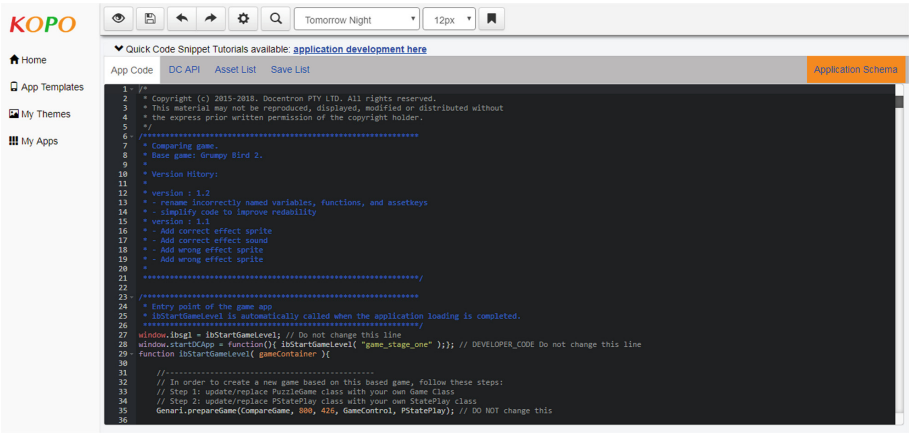


Fig. 9. Kopo coding page

The Multi-player versions are actually two single player versions merged together and played side by side. The existing code for single-player therefore has to be modified to create the multi-player version.

3.6 English Mobile Game Titled "Comparing Game"

See Figs. 10, 11, 12 and 13.

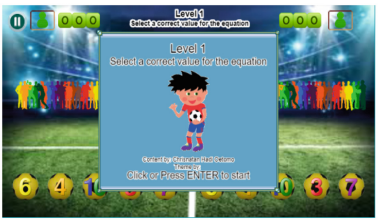
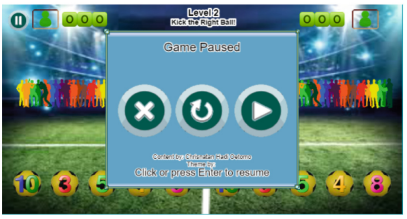
Fig. 10. Opening game screen

Fig. 11. Game play screen

Fig. 12. Level one game play

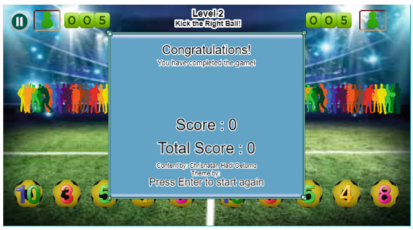
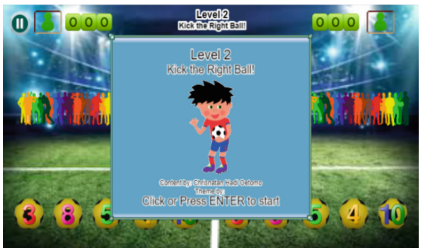
Fig. 13. Level two game play

Table 1. Kick-the-Ball game

Multi-player	
App Opening Background Image	
Level 1 and Dialog Box Frame Image	
Gameplay and Background Image	
Game Processing	
Different Button Dialog Box	

(*continued*)

Table 1. (*continued*)

Congratulation Dialog Box	
Level 2 and Dialog Box Frame Image	

3.7 Mathematics Mobile Game Titled "Kick-the-Ball"

As seen in Fig. 10, 11, 12 and 13 and Table 1 above, once the mobile games (both single-player and multiplayer versions) have been designed and developed, it is time to test the games with the students. The usual pretest-posttest sequence is employed here.

4 Results

4.1 Comparing Game

Figure 14, 15, 16 and 17 below shows the demographic information of the ten participants that were recruited at James Cook University Singapore.

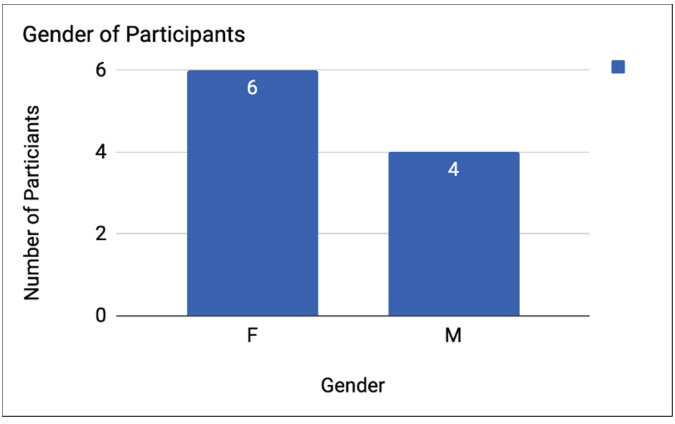


Fig. 14. Gender distribution of the participants

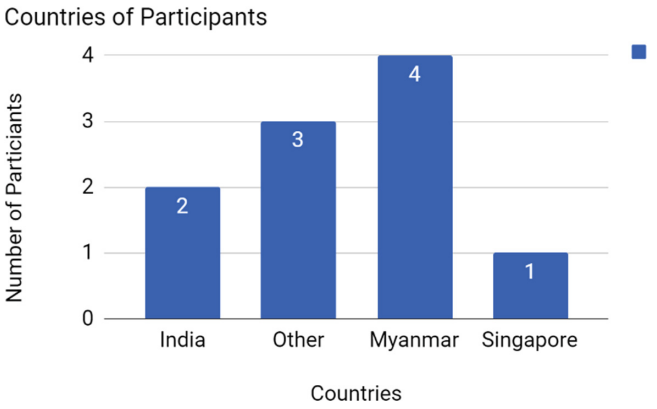


Fig. 15. Country distribution of the participants

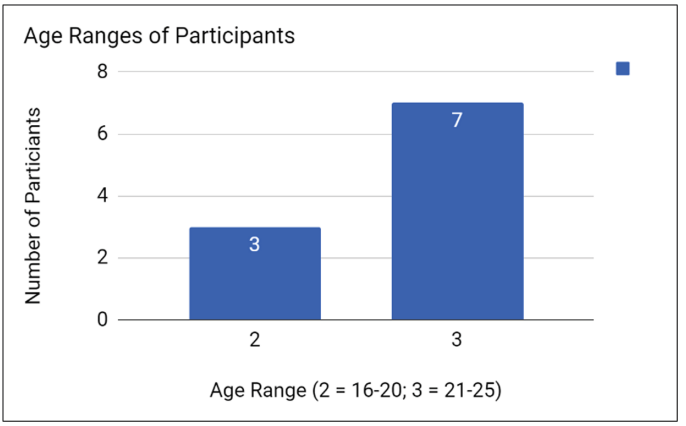


Fig. 16. Age range of the participants

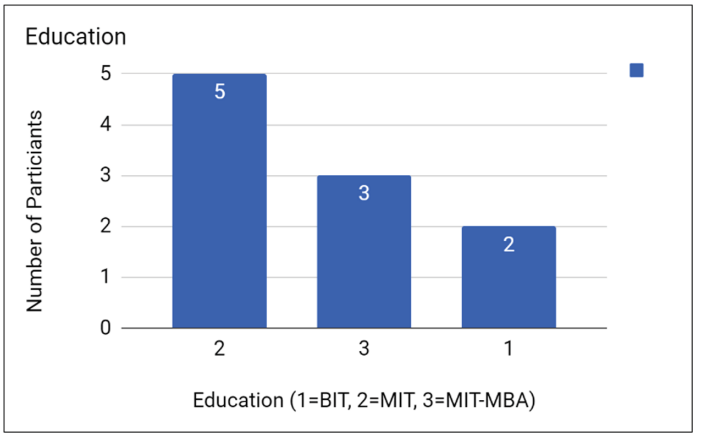


Fig. 17. Education of the participants

Table 2. Pre-test questionnaire responses

	Average	Std	Confidence (P = 0.1)
I have difficulties in learning English	2.5	0.71	0.37
I want to know how others learn English	2.3	1.16	0.6
I want to know if others are also having the same problems as me in learning English	1.9	0.99	0.52
I want to know if learning English is easy	1.9	0.99	0.52
I play some games, but I do not know if any educational game exists	3.1	1.2	0.62
I find that educational games are helpful and fun to learn	1.8	0.79	0.41

In Table 2 above, on interpreting the data, one discovers certain patterns from pre-test questionnaire. All participants have to answer six general questions about how they perceive game-based learning and how they learn English. Each participant answers the question from their own perspective. It is observed that most of them experienced difficulty in learning English and want to know how others study English.

Another interesting fact found is that for many of the students who play games, they do not even know if there is such a thing as educational game. Thus, from the pre-test questionnaires, we deduce that educational game might in fact be an effective approach for teaching English.

Table 3. Single player and Multiplayer post-test questionnaire responses

	Single-player post-test questionnaire responses			Multi-player post-test questionnaire responses		
	Average	Std	Confidence (P = 0.1)	Average	Std	Confidence (P = 0.1)
Annoying to enjoyable	5.4	1.07	0.56	6	0.67	0.35
Not understandable and understandable	5.5	1.08	0.56	6.3	0.67	0.35
Dull to creative	5.4	1.17	0.61	6.3	0.67	0.35
Difficult to learn to easy to learn	6.4	0.52	0.27	5.7	0.95	0.49
Inferior to valuable	5.2	0.79	0.41	5.6	0.84	0.44
Boring to exciting	5.1	1.1	0.57	6	0.67	0.35
Not interesting to interesting	4.5	1.18	0.61	5.9	0.57	0.3

(*continued*)

Table 3. (*continued*)

	Single-player post-test questionnaire responses			Multi-player post-test questionnaire responses		
	Average	Std	Confidence (P = 0.1)	Average	Std	Confidence (P = 0.1)
Unpredictable to predictable	5.3	1.06	0.55	5.3	0.82	0.43
Slow to fast	5.4	0.84	0.44	5.9	0.74	0.38
Conventional to inventive	4	1.41	0.74	5.2	1.32	0.68
Obstructive to supportive	4.3	1.57	0.82	4.5	1.65	0.86
Bad to good	5.7	0.67	0.35	5.8	1.48	0.77
Complicated to easy	5	1.49	0.78	5.1	1.6	0.83
Unlikable to pleasing	4.5	1.27	0.66	5.4	0.7	0.36
Usual to leading edge	3.8	1.4	0.73	4.9	1.66	0.87
Unpleasant to pleasant	4	0.82	0.42	4.9	1.6	0.83
Unsecure to secure	5.8	0.79	0.41	5.8	0.92	0.48
Demotivating to motivating	4.5	1.78	0.93	6.3	0.67	0.35
Does not meet expectations to meet expectations	4.5	1.08	0.56	5.2	0.79	0.41
Inefficient to efficient	5.9	0.57	0.3	5.6	0.52	0.27
Confusing to clear	5	1.63	0.85	6.1	0.57	0.3
Impractical to practical	5.3	0.95	0.49	5	1.41	0.74
Cluttered to organized	4.8	1.32	0.68	5.2	1.03	0.54
Unattractive to attractive	4.7	1.25	0.65	5.4	0.97	0.5
Unfriendly to friendly	5.9	0.74	0.38	5.9	0.74	0.38
Conservative to innovative	4	1.15	0.6	3.8	1.4	0.73

Table 3 above shows the average post-test responses of both games (single-player and multi-player). The responses were analysed. Based on the findings, the two games are not significantly different in improvement of learning experience on the average.

The single player game had an average value of 5.35 with interval ranging from 4.83 to 5.87 with 0.52 interval ($p < 1\%$). The multiplayer game had an average value of 5.89 with interval ranging from 5.51 to 6.27 with 0.38 interval ($p < 1\%$). These two average values overlap at $p < 1\%$ indicating that there is no significant difference between the two games in terms of improving learning experience. The results are statistically the same showing that multi-player comparing game is not considerably helpful. Therefore, the particular hypothesis (H1) of multi-player game providing better learning experience than single player game is not proven. The used assessment cannot provide evidence of the positive impact of implementing multiplayer game on improving the learning experience.

Table 4 below shows the participants' preferences on gameplay and their contents. It is found that multi-player game (average 8.4) is more preferred than the single-player (average 7.3) but it is not significantly obvious. In terms of game content, the results of game level ratings are almost the same at an average value of 8 in finding synonyms and 8.2 in finding homophones which indicates students like to learn on both contents.

Table 4. Game rating responses

Responses	Single-player	Multi-player	Finding synonyms	Finding homophones
1	8	9	7	7
2	8	9	7	9
3	7	8	8	8
4	7	8	8	8
5	8	8	9	9
6	7	9	9	7
7	6	7	8	8
8	7	9	9	9
9	7	9	7	9
10	8	8	8	8
Average	7.3	8.4	8	8.2
Std	**0.67**	**0.70**	**0.82**	**0.79**
Confidence (P=0.1)	**0.35**	**0.36**	**0.42**	**0.41**

4.2 Kick-the-Ball Game

Figure 18, 19, 20 and 21 below shows the demographic information of another ten participants that were also recruited on James Cook University Singapore campus to play the Mathematics Kick-the-Ball game.

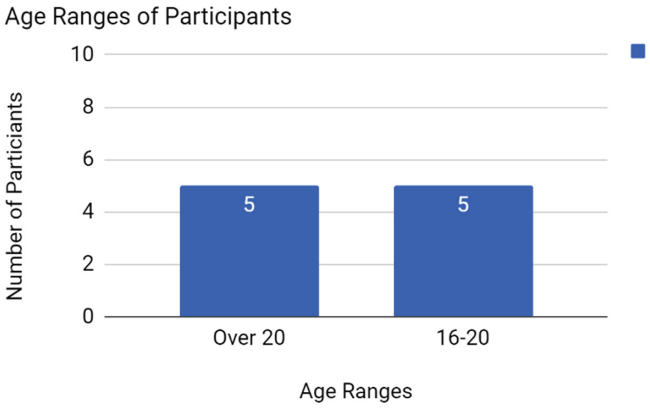


Fig. 18. Age Ranges of Participants

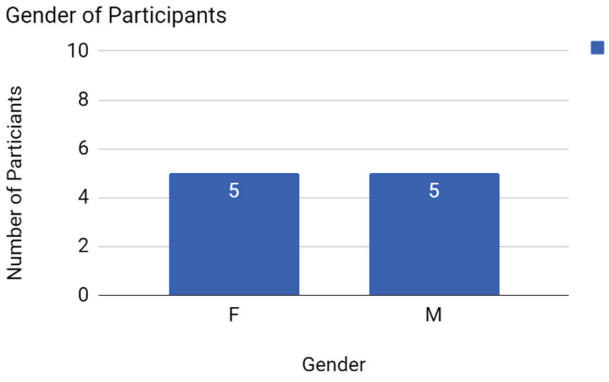


Fig. 19. Gender of Participants

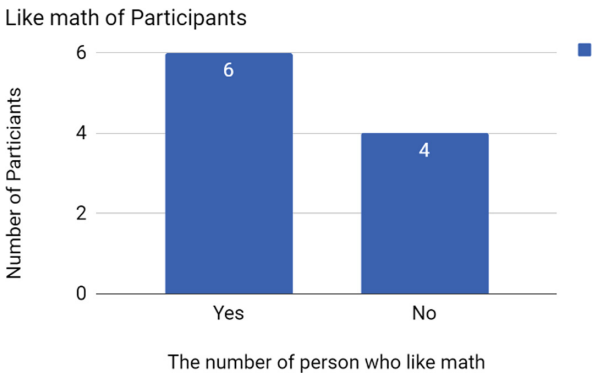


Fig. 20. The number of Participants who likes Mathematics

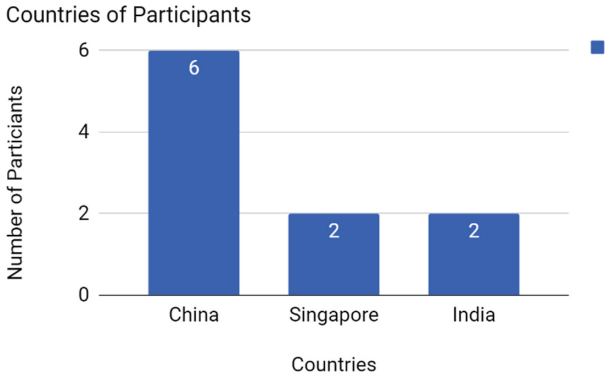


Fig. 21. Countries of Participants

From the pre-test questionnaire answers for multi-player games, most students agree that online education is beneficial to them. Most students agree that the multiplayer game learning style is effective for learning. Most also believe that even with online education, Mathematics is still a difficult subject for them. They agreed that when they have a Mathematics problem, they do not know whom to approach, thus causing Mathematics to remain a difficult subject for them. According to the survey, the influence of multiplayer game on primary school students is much higher than that of single-player game.

From the single-player pre-test questionnaire answers, most students think that online education is definitely beneficial. More than half of the students think that an interesting game can effectively help reduce the difficulty of Mathematics. However, according to the survey, for this group of the population, Mathematics is not too difficult for them, and some people even think that Mathematics is easy. This may be the reason why the average of single-player games is higher than that of multiplayer games. This group of students has a different attitude towards Mathematics.

From the post-test questionnaires, the multi-player game is said to provide excellent user experience (4.73 out of 7) with standard deviation of 1.36 and confidence interval of 0.71 ($P < 0.1$).

Similarly, for post-test single-player game, students provided feedback that in general the single-player game provides excellent user experience (4.48 out of 7) with standard deviation of 1.28 and confidence interval of 0.66 ($P < 0.1$).

5 Discussion

For the first game. from the responses of the pretest questionnaires, one can say that students face difficulties when they study English and they perceive utilizing educational games as a useful approach. This is despite the fact that the average values are overlapping which make it impossible to say the proposed hypothesis is completely true. The results from post-test for both single-player and multi-player game do indicate multi-player comparing game outperform the single player version.

As for the second game of Kick-the-Ball, the average range of multi-player game (4.02 to 5.44) is higher than that for single-player game (3.82 to 5.14). There is some slight overlap between the multi-player game and single-player game.

Although some people like both types of game, the number of students who like multi-player game is still higher than that for single-player game.

Also, it is found that when students play the multi-player game (5.2), they feel it is much easier than playing the single-player game (2.2). Additionally, more students think multi-player (5.2) mode is more attractive than single-player (5.0) mode.

6 Conclusion

There is no significant evidence that multiplayer Comparing and Kick-the-Ball games provides better learning experience than their single player versions. Responses from user feedback of both games have overlapping values. Hence, hypotheses H1 and H2 cannot be proven. It is noted however that different people may have their own preferences and there is no better learning experience.

One limitation of the mobile education application evaluated in this study is it is better played on devices with touch screens. With touch screens, the players can play the game simultaneously. Therefore, one improvement to the game will be to use different keys to control the gameplay for each player on the non-touch screen devices. In future tests, there is also a need to test the game with a bigger group of students as the ten participants may not be a good sample representation of user feedback. Future studies will focus on integrating learning into educational games and also on the social interaction aspects of games that can help motivate students in their learning.

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