International Journal of Engineering & Technology, 7 (4.21) (2018) 80-85

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Mobile Game-based Learning for Online Assessment in Collaborative Learning

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Abstract

Mobile technologies have impacted the educational scenario by allowing connectivity and seamlessness in teaching and learning. Previous studies have indicated that there is a lack of studies on mobile game-based learning, especially in real time blended learning settings. In addition, previous researches have also indicated that competitive aspect is able to enhance the learning process. As such, to solve the problems and fill the gaps, we investigated mobile game-based learning in an ethnic relations course at higher educational settings. The software used was Kahoot and it allowed assessing students' achievement via a mobile game-based learning approach. The approach applied was single-group experiment using a massive open online course (MOOC) on ethnic relations. We analyzed the achievement of students using mobile game-based learning and assess after pre- and post-sessions in a period of two months. Findings show that there are three types of learners in mobile game-based learning which are: high achievers, gradually-increasing achievers, and gradually-decreasing achievers. Findings also indicate that mobile-game based learning can potentially be used for promoting engagement in learning. In sum, the paper showed that there are different type of learning in mobile game-based learning and it can be used to increase the level of engagement in learning.

Keywords: mobile-game based learning; collaborative learning; single-group experiment; achievers; massive open online courses; higher education

1. Introduction

In the recent World Economic Forum (WEF), a new shift has been highlighted on the Fourth Industrial Revolution (4th IR); bringing a new dimension on education context towards a digitalized, automated and advancement of artificial intelligence or better known as Education 4.0. Gamification is one of the most highlighted aspects in the shift of new educational dimension (Education 4.0). Positive encouragement in gamified context motivates users to complete routine tasks through recognition of achievement and collectible rewards. Gamification also has the ability to fuel motivational power of individuals especially in the context of students' learning. In online learning context such as MOOC, maintaining students' motivation and interest towards the pedagogical process is the major challenge [6, 31, 33]. Understanding the role of gamification in education, therefore, means understanding under what circumstances game elements can drive learning behavior [7, 27, 32].

Studies on use of mobile game-based learning as an assessment tool in classroom are still limited. The implementation of students' assessment is generally conducted in conventional manner whereby the instructors provided exam-oriented materials to be completed by the students [28]. However, the use of aforementioned approach in assessing the students could increase students' anxiety; therefore, hinder their ability to perform well in the lesson. Motivation and interests towards the lesson will gradually decrease due to the unfavourable approach of learning assessment. Therefore, this study was conducted to investigate the use of mobile game-based learning for online assessment in collaborative learning. Discussion of the findings is presented in the form of learners' category transition from low achievers to gradually improving learners and high achievers to gradually decreasing learners. Another category of students, the "stagnant learner" is also discussed.

Previous studies have noted various results from research conducted in gamified contexts [8]. Learning in a gamified context has proven to significantly result in positive improvement to students' motivation, attitude and performance. Development gamified learning experience occurred in various context through diverse types of games educational games (e.g. serious games, simulations, educational, edutainment), entertainment games and mobile games [9, 19, 35]. However, a systematic review by previous researchers showed that development of instructional materials for leaning is highly inclined towards educational games or serious games compared to entertainment games and mobile games. It is noted that most frequently used game genre was educational (e.g. serious games, simulations, educational, edutainment) (50%), and a relatively small proportion of the studies employed entertainment games (25%) or mobile games (15%), although the latter remains very popular as daily entertaining activities [29, 34].

In a study by Yildirim, a positive correlation between the usage of game-based learning and English language performance was noted primarily in listening and speaking skills [26]. The game-based learning employed by the students was recorded in a video for the researcher to analyse the types of activities that could enhanced the students' performance. The researcher also found out that, students who actively involved in the teaching and learning session showed notable progress in academic performance. Therefore, successful students who employed various types of activities are more motivated to improve their learning [26]. Yildrim also asserted that gamification-based teaching practices have a positive impact upon student achievement and students' attitudes toward lessons [26]. However, the most effective activities that were preferred by the

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successful language learners were not scrupulously discussed. Despite of a short duration of experiment conducted by him, he suggested further investigation on the use of games in classroom learning. Rachels and Rockinson-Szapkiw discovered a contradict findings on the use of games to elementary students on the use of games in language learning [20]. In the experimental study, the researchers asserted that there is no significant difference in students' Spanish achievement or in academic self-efficacy between students who used Duolingo® and students who were taught with traditional face-to-face instruction.

Çakıroğlu et al. conducted a study in a Canadian high school to identify to reveal the effect of gamified instructional process to student engagement and the relationship between engagement and academic performances in a real classroom [3]. The study includes reflections from the design of a one-term ICT course in which the participants were pre-service primary school teachers enrolled at a school of education. The results revealed that using the combination of elements provided quite a positive motivational impact on engagement [36]. Also the use of gamification elements indirectly affected the academic achievement due to their positive effects on engagement in the classroom [3]. However, the researchers suggested a longitudinal study may be useful for shedding light on the relationship between gamification dynamics and meaningful learning outcomes as the current study only focused on student engagement and the relationship between engagement and academic performances.

In 2015, Reinders and Wattana adapted the game-based learning to discover the how game-based learning affects students' willingness to communicate in digital game-based learning context [4, 21]. The study was conducted to gain in-depth the experiences of five Thai students who had participated in a fifteen-week game-based learning program at a university in Thailand. Six interviews with each of them (for a total of 30 interviews) were conducted to identify what impact gameplay had in particular on their willingness to communicate in English. The researchers discovered interesting findings in regards to students' willingness to communicate in English. The results showed that gameplay had a number of benefits for the participants in this study, in particular in terms of lowering their affective barriers to learning and increasing their willingness to communicate. In addition, the researchers also suggested wider researches to be conducted on the affective effects of digital game-based learning out of the education context for a different perspective.

In the recent study by Rachels and Rockinson-Szapkiw, the researchers discovered the effects of a mobile gamification app on elementary students' Spanish achievement and self-efficacy through a quasi-experimental, pretest-posttest, non-equivalent control group design [20]. In this study, the treatment group's Spanish language instruction was through the use of Duolingo®, a computer and mobile app that uses gamification and adaptive learning technology to teach foreign languages. After 12 weeks, students were assessed with a 50-question, multiple-choice English to Spanish and Spanish to English pretest covering vocabulary and grammar to control for prior Spanish language achievement. The results showed that there is no significant difference in students' Spanish achievement or in academic self-efficacy between students who used Duolingo® and students who were taught with traditional face-to-face instruction.

Previous studies related to game-based learning aimed at discovering the effects of game-based learning towards students learning performance are still limited [1, 35]. Discovery on the use of games and gamification to enhance student engagement, experience and achievement on a theory-based course has recorded varied findings by previous researchers [3, 20, 21, 32]. Despite of positive discovery of learning improvement in terms of motivation showed by the students, the students' performance only showed small improvement in academic. Yildrim also asserted that gamification-based teaching practices have a positive impact upon student achievement and students' attitudes toward lessons [32]. His findings are in-line with researchers who conducted experimental study to discover the effects of famification on students' engagement in classroom [3]. In a study by Yildirim, a positive correlation between the usage of game-based learning and English language performance was noted primarily in listening and speaking skills [26]. The game-based learning employed by the students was recorded in a video for the researcher to analyse the types of activities that could enhanced the students' performance. The researcher also found out that, students who actively involved in the teaching and learning session showed notable progress in academic performance. Therefore, successful students who employed various types of activities are more motivated to improve their learning [26]. Yildrim also asserted that gamification-based teaching practices have a positive impact upon student achievement and students' attitudes toward lessons. However, the most effective activities that were preferred by the successful language learners were not scrupulously discussed. Despite of a short duration of experiment conducted by him, he suggested further investigation on the use of games in classroom learning. Rachels and Rockinson-Szapkiw discovered a contradict findings on the use of games to elementary students on the use of games in language learning [20, 24]. In the experimental study, the researchers asserted that there is no significant difference in students' Spanish achievement or in academic self-efficacy between students who used Duolingo® and students who were taught with traditional face-to-face instruction.

2. Method

The participants consisted of 91 students from economic and science social faculties from a local university who were taking an ethnic relations course. The course is a foundation course that is required to be completed by all undergraduate students in Malaysia public universities. The course is aimed in exposing students to the issues related to ethnic relations in Malaysia from the perspective of social cohesion. The method applied for assessment of mobile game-based learning was the single case experimental study.

In the study, a mobile game-based learning tool was used on mobile phones for online assessment. The software that was selected is Kahoot, an online real-time game-based learning tool designed for social learning [30]. The learning tool allows users/instructors to create online quizzes, surveys or discussions called "kahoots." The tool uses a typical blended learning setting where learners are gathered around a common screen. Quizzes are usually carried out in real-time and promote students to be involved with social interaction with teachers and peers. This is designed via the gameplay where players are required to look up from their mobile/laptop/PC screens to answer questions as well as check for their peers' progress on a centralized screen controlled by the "kahoot leader" (instructor/peer initiating the kahoot). Moreover, the peer progress on "leaderboards" are designed to promoted positive competition during learning [2, 26].

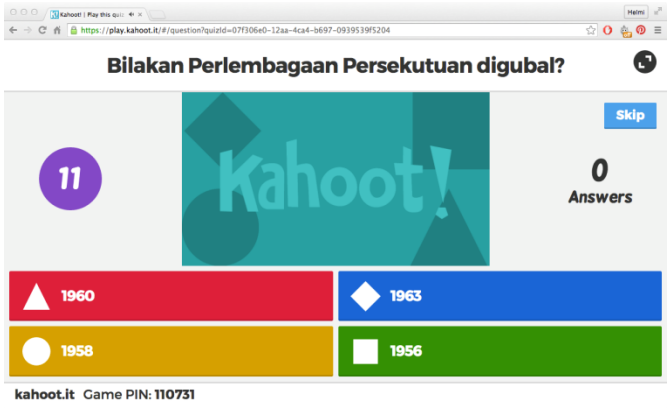
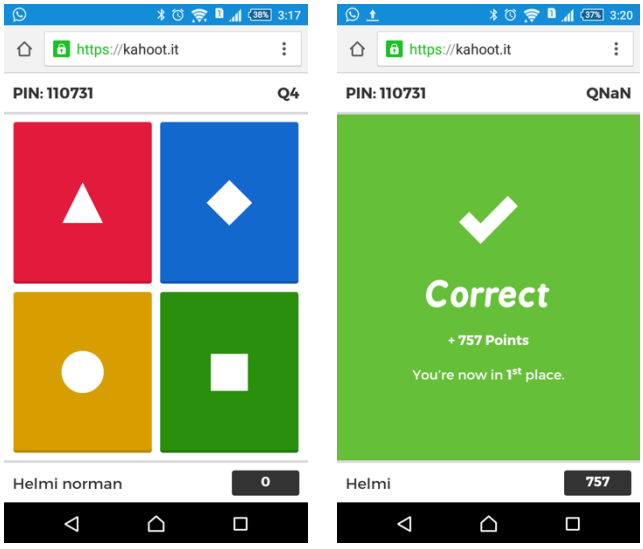


Fig. 1: An example of multi-choice question of a mobile quiz on a centralized screen

A mobile quiz or "kahoot" was created consisting of ten multiple choice questions related to ethnic relations. The quiz was carried out as follows. First, students accessed the developed quiz on their web browsers of mobile phones using a unique pin generated by the cloud game-based learning tool. Second, all students were required to wait at the waiting screen (called the "lobby") while waiting for their colleagues to register in the system. Third, the instructor initiates the quiz after all the students are ready to start the quiz. During the gameplay, the students are given multiple-choice questions on a centralized screen (Figure 1).

The students then key-in their answers based on a distinctive color and shape where each color and shape represent their chosen answer (Figure 2a). The students are given 20 seconds for answering each question. At the end of each question, the number of points based on answer accuracy and response time are displayed on each student's screen (Figure 2b). The highest number of points are displayed on the centralized screen of the instructor. The same gameplay procedure is continued to the end of the online quiz. Scores are calculated based on two criteria: correct answer and speed of answering. The default points of a player are 1000 Kahoots and then it is counted down to 500 (at zero seconds). For example, if a question is 30 seconds long, and a player answer correctly after 15 seconds, the player is awarded with 750 Kahoots.



(a) (b)

Fig. 2: An example of a student's mobile phone screen: (a) with the option of keying in their answers based on a distinctive color and shape; (b) displaying individual performance of a student in terms of current score and ranking among peers

Learning Environment

The MOOC was designed for ethnic relations course, which is a compulsory course for undergraduate students in Malaysian tertiary institutions. The MOOC content and activities were developed in *Bahasa Malaysia* (Malaysia Language) by the Universiti Kebangsaan Malaysia. The MOOC is used across Malaysia in all public universities and has a usual enrolment of over 12000 students per cohort. The MOOC consists of video lectures in the form of "live action" videos and animation, as illustrated in Figure 1. In this study, the ethnic relations MOOC was provided to the participants as learning materials. The course content includes the study of social, political, and economic interrelatedness among races and ethnicities of different levels of society. The MOOC content were designed in tandem with higher education curriculum run on the OpenLearning platform.

Fig. 3. Video lectures (animation) in the ethnic relations MOOC

Analysis of students' performance was conducted using Kahoot, a free game-based learning platform as the assessment tool. The students were assigned with a video production assignment as in collaborative learning settings. The task was loosely structured as the students were given the autonomy to produce their own ideas into a video related to ethnic relations (which was presented via MOOCs). General instructions were given to the students to standardized students' assessment. Each group was instructed to produce a 5-minute video on their chosen topics and share their final products on the MOOC using mobile devices. The period of task completion was in a period of four months (one academic semester). A mobile game-based learning application, Kahoot was used as the assessment tool to assess students' achievement in the course after the implementation of collaborative learning context in group assignment with the loosely structured task.

The analysis of data was conducted using Kahoot score analysis for further investigation on students' performance in the MOOC after the implementation of the collaborative learning assignment with a loosely structured task. Four categories of students were identified: (i) high achievers (ii) gradually improving students (iii) gradually decreasing students and (iv) low achievers. To further analyze these categories, two stages of the assessment using mobile game-based learning approach were applied, which were: at the beginning of the course and at the end of the course.

3. Results

This section displays the analysis of students' achievements after the implementation of loosely structured task. Students' achievement was evaluated using Kahoot, a mobile game-based learning application. Four categories of the students were identified, and three types of learning growth were discovered through students' performance. Categories of the students are used to illustrate the improvement and decline of students' scores throughout four months of the course. Students' anonymity is also concerned; therefore, the students were referred to as S1 for student 1.

Table 1 presents an overview of students' performance in the course using Kahoot as a mobile game-based assessment tool. From the table, it is noted that the highest score of students is 10 (100%) in the pretest and 9 (90%) in the post-test. The average time spent on each question has also decreased from 6.146s to 4.607s. The decrease on average time spent for each question implies students' familiarity and acceptance to Kahoot as an assessment tool after four months (February to May). Four categories of students are discovered in this study which reflected significant changes in terms of students' performance.

Table 1. Pre- and post-test results of Kahoot sessions

Students	Pre-test Results		Post-test Results		Pretest-Posttest Difference		Category of Students
	Score	Avg. time taken for each question (ms)	Score	Avg. time taken for each question (ms)	Score	Time	
S1	7	6029	5	4374	-2	-1,655	Gradually decreasing
S2	7	5742	3	2295	-4	-3,447	Gradually decreasing
S6	9	7791	8	6728	-1	-1,063	High achiever
S7	5	3.666	9	7.447	4	3,781	Gradually increasing
S9	10	8443	7	5686	-3	-2,757	Gradually decreasing
S10	10	7273	4	2716	-6	-4,557	Gradually decreasing
S13	7	5792	3	2247	-4	-3,545	Gradually decreasing
S14	5	5	0	4237	4413	176	Stagnant
S28	7	5682	2	1096	-5	-4,586	Gradually decreasing
S29	9	7775	3	2305	-6	-5,470	Gradually decreasing
S30	1	0.671	5	3.984	4	3,313	Gradually increasing
S31	8	7138	4	3313	-4	-3,825	Gradually decreasing
S32	8	6986	6	5342	-2	-1,644	Gradually decreasing
S33	10	8.996	5	4.349	-5	-4,647	Gradually decreasing
S35	10	9212	8	6644	-2	-2,568	High achiever
S36	9	8123	5	4488	-4	-3,635	Gradually decreasing
S38	6	4166	2	1618	-4	-2,548	Gradually decreasing
S39	9	7.994	0	7.994	-9	-7,994	Gradually decreasing
S40	8	6460	5	3998	-3	-2,462	Gradually decreasing
S45	9	7504	7	5747	-2	-1,757	Gradually decreasing
S46	7	5752	5	4050	-2	-1,702	Gradually decreasing
S51	5	3835	6	5008	1	1,173	Stagnant achievement
S53	0	6.667	8	6.667	8	6,667	Gradually increasing
S54	6	5284	8	7066	2	1,782	Gradually increasing
S77	9	7785	7	6263	-2	-1,522	High achiever
S79	9	6.982	2	1.601	-7	-5,381	Gradually decreasing
S80	9	7735	7	6156	-2	-1,579	High achiever
S92	5	3576	2	1387	-3	-2,189	Gradually decreasing
Average	5.01	6146	3.80	4607	-121	-106,555	

Low achiever to *gradually improving*. From Table 1, it can be seen that low achiever students were changing to the *gradually improving* category. The analysis showed a possible pattern of improvement, which is an increment from a total score of 0 to 8. S53 has improved of category from low achiever to *gradually improving*. Thus, S10 is categorized as a *low achiever* in the initial stages of the course. However, as the course progressed to the final four weeks, S30 shifted her role – from being a *low achiever* to becoming a *gradually improving* student. In Table 1, it is observed that S30 position has moved into the *gradually improving* category, with a total of score of 5.

Higher achiever to gradually decreasing. Table 1 shows the change of students' achievement after the implementation of the course from a high achiever to a *gradually decreasing* student. S9 is considered as high achiever at the beginning of the course and at the end of the course, his score significantly decreased by 30%. A similar case is also noted in S10 whereby his score decreased from 10 to 4. A significant decrease of score is noted from his score; therefore pushing him to another category of students which is *gradually decreasing* student.

Stagnant achievement. From the table, it is also noted that some of the students did not show any improvement or changes after the course ended. The students' scores from Kahoot analysis showed that the students' scores remained the same at the beginning of the course and at the end of the course. At the beginning of the course, S15 scored 5 out of 10 questions in Kahoot and the score remained the same at the end of the course.

Higher achievers. High achievers are referred to students to main their performance throughout the lesson before the implementation of unstructured tasks and after the implementation of the task. S6 scored high marks in the pre-test and maintained his high scores in the post test. The average time taken to answer each question only differs by 1.063 seconds. The findings revealed that this student could be due to the students' familiarity with the use of Kahoot before.

4. Discussion

Low achiever to *gradually improving*.
In general, cooperative and collaborative strategies require students to work together in groups to address problems, provide feedback and communicate and interact with each other in a structured manner. In this course, the students were given the opportunity to communicate freely with their peers and express their thoughts without any restrictions and limitation from the instructors. Therefore, transition of students from low achievers to gradually improving learners could be due to their preferences to work with their peers instead of instructors. Communicating with instructors could somehow increase the students' anxiety in the lesson; therefore hinder their ability to perform well in the classroom [22]. Collaborative learning strategies are one of the strategies that can be used in effective teaching and learning where by the students are encourage to conduct their own discussion with peers with minimal supervision from the instructors. Previous researchers have asserted that low achievers generally have more preferences to communicate with their peers instead of the instructors [10, 16, 18].

Higher achiever to gradually decreasing.
Autonomous students have their own values and beliefs, indirectly affecting them while studying [12, 15]. In collaborative learning strategies, instructors only play the role as the facilitators and promote students to be self-reliant and have self-direction to be responsible for their own learning experiences. However, due to different preferences and learning styles of the students, there are quite a number of students who showed unsatisfying performance after the end of the course. Learners with heavy reliance to the instructors are constantly in need for feedbacks, instructions and assistance form the instructors [22, 23]. Due to less preferred learning strategies, these students could not progress in the learning process and their performance is reflected on the scores in the post-test. Henceforth, there a transition of students' category from high achievers to gradually decreasing learners was noted in this study.

Stagnant achievement. Students with stagnant achievement scored the same marks in the pre-test and posttest. These students are not considered as high achievers due to their scores in the pretest. Interestingly, these students scored the same marks and do not show any decrement. This could be due to their flexibility to adapt to a newly introduced learning strategies and approaches by the instructors. In comparison to the previous category of students (high achievers to gradually decreasing learners), these students retained the same score and showed flexibility to work in a newly introduced context [13, 17]. In this course, instructors are still the experts and played the role as the facilitators to the students. Hence, it is important to discover their preferences and learning styles to further improve their achievement in the lesson.

Higher achievers. Assigning students with unstructured tasks give them more autonomy to have control t their own learning; therefore, shifting a teacher-centred approached to a more student-centred approach [12]. High achievers students are individuals who are responsible for their own learning and at the same time being actively involved with tutors and other students. These students also prefer to work with their peers instead of heavy reliance from the instructors. From the analysis, high achiever students showed scored high marks before and after the end of course. The students' performance could be due to their preferences to work collaboratively with their peers and these students need less attention and assistance from the tutors [14]. High performance students generally require more autonomy for their own learning. In this MOOC, the students were assigned with loosely structured task and they were given the flexibility to produce a video with an open topic. Flexibility of the loosely structured tasks gives more freedom to the high achiever students; therefore, fulfill their learning expectation and needs [5,11].

5. Conclusion

Game-based learning is gradually becoming the topic of interest for researchers in education field. Integration of games in teaching and learning has profoundly resulted meaningful insights for instructors to improve their pedagogical skills. Points, rewards and badges have significantly affected students' attitude towards learning particularly in an online context such as MOOC. Analysis of the study revealed integration of a loosely structured task in a collaborative learning environment have resulted diversified categories of students in an online learning namely high achievers, gradually-increasing achievers and gradually-decreasing achievers as well as stagnant learners. This study concluded that providing autonomy to the students in managing their task could further develop students' achievement and performance in learning. Transition from one category to another has also been discovered.
Results presented in this study are useful for future researcher to further investigate the aspects of games that could enhance students' motivation and performance in an online learning context. The results of this study could generally benefit instructors in a blended learning context to further improve their teaching. Interesting findings on the transition of students' category are also beneficial for the students to further develop their autonomy in managing their own learning.
It is also worthwhile to note several limitations of this study such as the homogeneity of participants background, limited duration of course implementation and the scale of students enroll in the MOOC. Assessment of students' achievement was conducted to students with homogenous education background. Since the enrolment of the students are mainly consisted of postgraduate students who enroll for postgraduate studies; therefore, the findings of this study are limited the abovementioned category. Next, the duration of the course was short (approximately four months). Therefore, further growth of learners' achievement is expected to be discovered if the duration of the course is longer. Lastly, the results of this study is only limited to a small –scale MOOC, which is around 660 enrolment of students. Varied findings are expected from a MOOC with larger number of students' enrolment.
Further investigations on the use of mobile game-based learning could be further explored in different context of learning. Since this study focuses on the students' assessment in an online learning context, therefore, it is worthwhile to conduct extensive studies in traditional, face-to-face learning environment. Next, it is also worthwhile to investigate the students' perception ad views on the use of mobile game-based learning for online learning in collaborative learning.

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