USING EDUCATIONAL GAME APPS IN IMPROVING STUDENTS MATHEMATICS' LEARNING: AN EXPLORATORY STUDY ON THIRD GRADER AT-RISK CLASSROOM AT PRIMARY SCHOOL IN SELANGOR, MALAYSIA

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ABSTRACT

Researches on the effectiveness of technology used in learning had shed different light on its affordances in line with the 21st century students. With the student getting savvy by days, this call for newer and relevant approaches towards the use of technology in the classroom. The use of technology should be considered as a tool to meet the demanding of a niche group such as the special need and at-risk learner who need more comprehensive and inclusive tutoring. To fill the gap, this paper explored the use of game apps in facilitating the at-risk third grader's learning at four schools in one districts in Malaysia. Pre- and post-test showed that the used of mathematics-based app improved student mental calculation and reduced time needed to complete the exercise. Much deeper study on the effectiveness use of technology in the at-risk classroom should be conducted in the future.

Keyword: At-risk, math apps, education, game

1.0 INTRODUCTION

1.1 At-risk Learner and Mathematics

Students always view mathematics as one of the most challenging subject. For some of the students, the concept of number was seen as something like an alien language which not only foreign but also incomprehensible (Haag, Heppt, Kuhl & Pant, 2013). Despite that, it can't be denied that mathematics is an important subject that helps students develop their cognitive growth (Harris, 2019; Popat & Starkey, 2019). From the concept of time to the algebra equation, learning mathematics does not only assist the students in establishing their problem solving skills but also strengthen their higher order thinking skills (Runisah, Herman & Dahlan, 2018; Peter, 2012). Therefore, mathematics has long been considered as a core subject for students to master in their pursuit of knowledge. Yet, pertinent trend in regards to students struggling over this subject could be identified at various level of learning. This particularly a serious problem especially on the at-risk students. At-risk students are referring to a group of student who were on the verge of failing or had already failed the subject altogether. Thus, there is a need for a solution to be brought out in order to assist this group of students and ensuring that the holistic learning could be achieved without leaving anyone behind.

The dismal result that Malaysia students gathered from the 2009's Programme for International Student Assessment or indirectly known as PISA, had shown that the students of this country were lagging behind other ASEAN country such as Singapore, Vietnam and Thailand in term of their performance in Mathematics. What's more, further report in 2015, had shown that Malaysia scored 443 in mathematics mastery, which was way below from the global average of 490. This observation might be seen as inconsequential due to the fact that it was tested on a par of the population. Nevertheless, the role of mathematics in contributing to the progress of the world's development has long since been revealed. The integration of mathematics within the modern society provide vital underpinning to other form of knowledge such as economy, technology,

financial services as well as many area concerning to the field of information and technology (ICT). Furthermore, mathematics also enhance one's problem solving skills thus encouraging the talent for innovation and invention. Therefore, this pertinent trend is indeed dangerous and overwhelming if it were to be left alone. If this issue were not properly addressed, it will bring potential threat and risk not only to the development of the skilled workers and the professionals but also to the future growth of the country as a whole.

At-risk students' difficulties with mathematics had often been linked to the insufficient development of their various cognitive skills as opposed to their normal peers (Child, Cirino, Fletcher, Willcutt & Fuchs, 2018; Peng, Wang & Namkung, 2018). Often, these below than average student found themselves unable to find the connection while learning mathematics which led to severe problem in their learning experience. There were several factors that commonly adhered to this under-performing or at risk student such as the lack in their number sense and counting skills (Garon-Carrier et al., 2018; Karakonstantaki, Simos, Michalis & Micheloyannis, 2018); low self-motivation (Abdul Razaq Ahmad & Fadzilah Sulaiman, 2016; Abu-hamour & Al-Hmouz, 2013) as well as faulty outlook towards on one's self-efficacy (Singh, 2014; Joo, Seo, Joung & Lee, 2012). This deficit had consequently brought many difficulties for this student to adapt themselves in the normal mathematics classroom thus led to failure in their overall achievement.

Consequently, for student to constantly face this circle of failure, it might not only affect their motivation but also their own self-efficacy (Muenk, Wigfield & Eccles, 2018). Motivation and self-efficacy has always been considered as an important factor that contributed to the student ability to persist in their learning. Studies had pertinently discussed the deep correlation that came between student's motivation and how the student perceives the learning experience itself (Wang & Antonenko, 2017; Calvo-Ferrer, 2017). Due to this, various researches in the past decades had been trying to find way to improve this situation by suggesting various solution such as through improving the learning environment (Yamamoto, 2014; Di Serio, Ibáñez & Kloos, 2013; Vansteenkiste et al., 2012) as well as introducing new learning strategies (Gabrielle, 2016; Brophy, 2013; Erhel and Jamet, 2013). For that reason, it is important for the researcher to address this aspects in order to come out with a solution that can help the learner to persist in their learning and indirectly promoting them to become as autonomous learner. By doing so, the student will be able to take charges of their own learning and become self-motivated.

1.2 Technology as a Driven Tools for At-risk Learning

With advancement of today technology, educational game through the means of mobile or PC was no longer novel. What's more, in line with the world today, the way children play had changed from mere decade ago. Thus, it is crucial for the education system to embrace these changes in order to become more relevant to this new generation of student. Study by Nor Elleeiana Mohd Syah, Nur Azah Hamzaid, Murphy and Lim (2016) on the intervention for children with low mathematics achievement in the school in east Malaysia, shown student's positive feedback in terms of their understanding of basic mathematical function through the development of computer play pedagogy. This pedagogy had given focus on the dyscalculia-remedy-oriented approach which includes

repetition of numbers and operation manipulation. Apart from that, a study by Gunawan, Bahari and Kartiwi (2017) also mentioned the effectiveness of educational game in attracting student attention in learning difficult subjects such as mathematics.

As the nature goes, children are innately imaginative, therefore by giving them the opportunity to learn through play, it will help them not only to expend their own understanding of the lesson dimension but also provide depth to their own knowledge comprehension as well as their sense of self-worth from being able to figure out the lesson by themselves. What's more, by helping them to change their perception that mathematics was not something difficult (Mutodi & Ngirande, 2014) but instead something that can be considered as a fun and tailored to their need (Gooch, Vasalou, Benton & Khaled, 2016) it will help the students to be more determined and motivated in facing the given challenge. From another aspect, learning through play also helps them sharing their own knowledge, especially when it involved a collaborative kind of activities (Kwak, 2017). Therefore, the use of games can be seen as a way that can help the teacher to provide positive outlook to the students in regards to difficult subject like mathematics (Hung, Huang & Hwang, 2014).

Yet, it is remains unclear whether the same effect also contributes to the at-risk achievement in learning mathematics. Hence, it is desirable for further investigation made to prove the effectiveness of math based game apps in facilitating the at-risk third grader's mathematics learning. For that reason, the current study aims to explore the used of educational mathematics game apps in improving at-risk third grader mathematics achievement, motivation and self-efficacy.

2.0 METHODOLOGY

2.1 Setting

This study took place at third grader's at-risk mathematics classroom in four different Primary Schools in Central Malaysia. National School was selected as the setting for the current study. The teachers who were responsible for the classroom instruction have at least five years' of experience in dealing with at-risk students. The students were paired and each pair were give 1 tablet each with pre-installed apps that had been selected earlier on. Prior to this study, even though the students rarely used tablet but they already familiar with the used of smartphone. Only several instructions were needed before the students managed to run the app all by themselves.

2.2 Participant

32 third grader at-risk Mathematics' students from four different schools participated in this study. 22 of them were boys while the remaining 10 were girls. Some students had been identified with at least one disability such as dyslexia and learning disability. The average age of the students at the time of study were nine years old.

2.3 Procedure

The students used the selected app (Zeus vs Monster by Peaksel) in four mathematics class's sessions over the course of 2 months. Each session lasting for about 60 minutes to 90 minutes. The students learnt the concept of addition and subtraction at the start of the session. According to the activities of the day, the teacher spent 5 to 10 minutes during the instruction session. The app was then used to supplement the regular instruction while functioning as a classroom activities. The students were then left to their own device while the teachers facilitated the classroom interaction. The students worked in pair but they were allowed to communicate with others as long as it was within the boundary of the lesson. 20 minutes were dedicated for the use of game app.

Four pre-test and post-test assessment were administered to the students to measure their learning from the used of educational mathematics game app. 10 minutes was used for each session for the pre-test, which was conducted before the game intervention, while another 10 minutes was spent on the same assessment (post-test), right after they finished with the intervention. The assessment was made similar to the problem practiced in game, though some was differed in their context in order to check the students' mathematics skills. The questions in the assessment were done in both form of mathematical sentence and standard written methods. Each question in the assessment was assigned 1 point.

Four topics were tested throughout the timeline of this quasi-experimental session as illustrated in figure 1. The setting of the app was also synchronised according to the topic of each session as well as reflecting the student capabilities. Apart from that, the level of game difficulty was adjusted accordingly once the students felt that they were unable to progress throughout the intervention session. This was done to improve their interest and sense of achievement as well as strengthening their basic calculation skills.

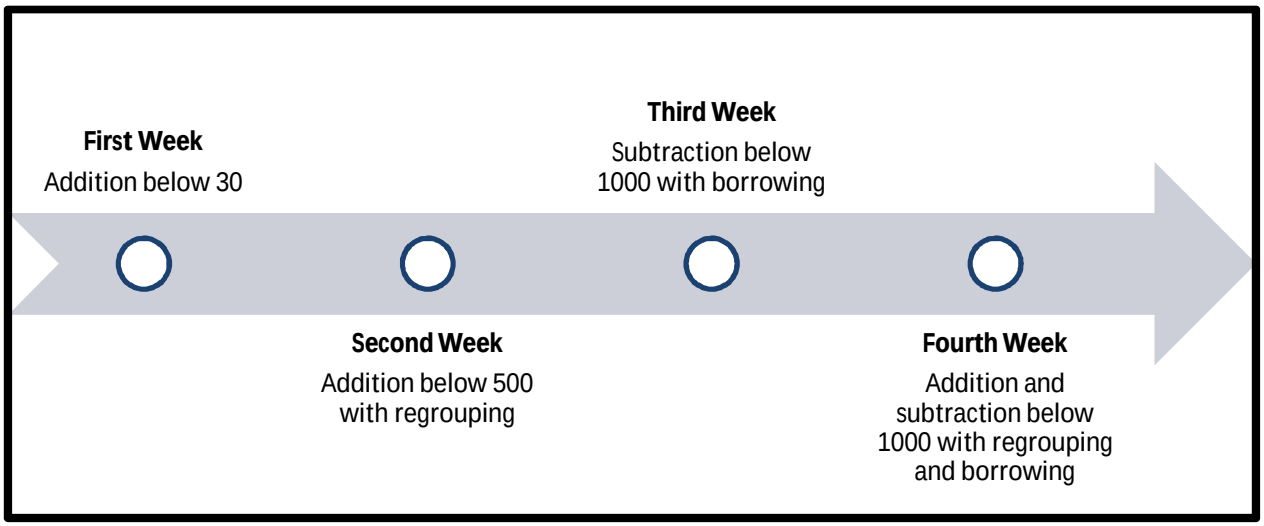

Figure 1: The Progression of the Experimental Session.

Wilcoxon Signed-Rank Test was used to analyse three aspect of this quasi experiment which were 1) data gathered from pre- and post-test, 2) the differences in time student need to complete both test and 3) the improvement in the number of question students' answered between the pre- and post-test. The analysis will determine whether the use of math game app has any significant association towards at-risk achievement in mathematics learning. On the side notes, this analysis was also used to determine the association between the used of game towards student motivation as well as their self-efficacies based on the improvement of the time students used to complete the task as well as the increase in the number of question answered.

3.0 RESULT AND DISCUSSION

The current study explored the use of math game app in improving at-risk third graders mathematics learning. Table 1 illustrates the full analysis of the experiment according to each session.

Table 1
Overall analysis of the intervention according to each session

Session	Topic	Number of question	Post Test result			Student achievement ($p<.05$)
			Number of students who managed to complete all question (N=32)	Increase of Question Answered	Decrease of Time to Answer the Question	
1	Addition below 30	40	17	28%	8%	0.060
2	Addition below 500 with regrouping	16	31	8%	27%	0.062
3	Subtraction below 1000 with borrowing	28	8	18%	2%	0.083
4	Addition and subtraction below 1000 with regrouping and borrowing	28	23	16%	18%	0.019

The result for the first session of intervention, showed an improvement in students' results as the number of correct answers answered by them increase up to 28% as opposed to their previous pre-test. Apart from that, the student also decrease the time needed to answer the question by 8%. Despite that, there was no concrete significant evidence ($p = 0.060$) could be seen over the effect of educational mobile game apps towards student achievement.

In the following second session of the intervention, the researcher tweaked the test by using as different form of mathematics question which were the standard written method type of question as opposed to the mathematical sentences that was used in the previous session. This method was used in order to observe students ability in regrouping the number and making sense of the relationship between the digit placements. However, the result indicated that the students' mathematics skill was proven to be poor. Despite the data showing the students' ability to finish answering all questions during the pre-test, many of them failed to display the skill in regrouping the number and move it to the next place value. Due to this, they failed to answer the question correctly despite managed to calculate the number correctly. In conjunction to the current predicament, the teacher observed the need for an immediate tutoring on the particular skills and after the intervention conducted by the teacher, the students able to correct their misconceptions which reflect on the increase of 8% of correct answers by the student. Moreover, the students also managed to decrease time needed for answering question up to 27%. Nevertheless, the Wilcoxon Signed Ranked test showed that there was no significant evidence could be found on the effect of the intervention towards student result with $p= 0.062$

The result for third session once again showed the improvement in students' ability as they managed to increase the number of correct answer by 18% after undergoing the intervention. Despite that, it was evident that the time they needed to answer the test seemed to prolong as they only managed to decrease it by 2%; way below from all previous session. This is probably due to the fact that two different kinds of skills were tested in this session (Addition and subtraction); therefore students might get confused over it. Additionally, the Wilcoxon Signed Ranked test analysis on the achievement score also indicated that there is no significant influence over the intervention towards students' achievement with $p = 0.083$.

For the last intervention session, the data has concluded with the student managed to increase 16% of correct question answer. Furthermore, the students also managed to decrease time needed to answer the question by 18% in overall. Additionally, with the basis of $p<.05$, Wilcoxon Signed Rank analysis also proven that the fourth intervention has a significant influence on student achievement with $p = 0.019$.

Further analysis using Wilcoxon Signed Ranked test was also conducted in order to evaluate the intervention session as a whole. Table 2 below illustrates the result of such analysis on all the data gathered from the pre-test and the post-test from all four sessions.

Table 2
Wilcoxon Signed Ranked Analysis on Mathematics' Score

		N	Mean Rank	Sum of Ranks	Z	Asymp. Sig. (2-tailed)
Posttest – Pretest	Negative Ranks	6[a]	13.42	80.50	-2.345[d]	0.001
	Positive Ranks	25[b]	16.62	415.50		
	Ties	1[c]				
	Total	32				

a. Posttest< Pretest
b. Posttest < Pretest
c. Posttest= Pretest
d. Based on negative rank

With p< .05 as its basis, the analysis illustrated on table 2, the mathematics' score of the at-risk students indicated a significant result [p = .001] throughout the four session of intervention. 25 students had shown significant improvement in their mathematics' score while undergoing the educational game apps intervention. Contrariwise, 6 students had shown that the use of educational game apps in the classroom had negatively affected their mathematic score. Finally one student found that the used of educational game apps in the classroom did not help in improving the score nor did it affected it negatively. Table 3 below illustrates the analysis on the time student used to complete the test during the whole intervention.

Table 3
Wilcoxon Signed Ranked Analysis on Time used to Complete Test

		N	Mean Rank	Sum of Ranks	Z	Asymp. Sig. (2-tailed)
Pretest Week – Posttest Week	Negative Ranks	1[a]	1.00	1.00	-4.918[d]	.000
	Positive Ranks	31[b]	17.00	527.00		
	Ties	0[c]				
	Total	32				

a. Pretest Week < Posttest Week
b. Pretest Week < Posttest Week
c. Pretest Week= Posttest Week
d. Based on negative rank

As illustrated by table 3, only one students did not show any improvement in the time use to complete the test throughout the experimental process. The remaining 31 students had shown improvement to a various degree. With p<.05, there was a significant association between the use of game apps towards students' time improvement [p = .000]. Table 4 displays the analysis on the improvement on the number of question answered by student during the whole intervention.

Table 4
Wilcoxon Signed Ranked on the Number of Question Answered

		N	Mean Rank	Sum of Ranks	Z	Asymp. Sig. (2-tailed)
Pretest Week 4 – Posttest Week 4	Negative Ranks	1[a]	31.00	31.00	-4.359[d]	.000
	Positive Ranks	31[b]	16.00	497.00		
	Ties	0[c]				
	Total	32				

a. Posttest Week 4 < Pretest Week 4
b. Posttest Week 4 < Pretest Week 4
c. Posttest Week 4 = Pretest Week 4
d. Based on negative rank

Table 4 above showed the analysis on the number of question students' answered throughout the experimental study. In overall there was significant result of [p = .000] in regards to the improvement on the number of question answer after the intervention. Only one students showed negative improvement in regards to the number of question answer after the intervention. For the remaining 31 students, the improvement could be seen to a various level of degree. Thus, based on the current study analysis, the use of educational mathematics game apps capable in enhancing not only their mental calculation skills but also indirectly enforced their motivation and self-efficacy in finishing the task given to them. This is in line with study by Gooch et al., (2016) and Gunawan, Bahari and Kartiwi (2017) who stated that by tailoring the lesson according to the students' need it can improve their learning as well as their interest and determination to complete the given task.

4.0 CONCLUSION

This study provided clear answer on the use of math based game apps in facilitating at-risk third graders' mathematics achievement. Even though games are often presented for enjoyment instead of an offline-task for the young learner, data gathered from this study has proven the effectiveness of math based game apps in helping the at-risk student specifically in improving their counting skill as well as their mental computation. Therefore, the effectiveness of educational game apps in helping

the struggling student to improve their mathematics skills should be further investigated in order to ensure its full potential usage within formal classroom setting. Due to this, there is a need for a transformation in the mind-set of the student as well as the educators on the affordances of game apps in learning. Hence, it was important for the educators to prepare a classroom environment which can help them to interact positively with these type of learning medium. Furthermore, it is also beneficial for researcher to offer guidelines which can help the teacher to choose appropriate available apps in market to be used for the student in classroom. By having certain guidelines, it will help the teacher to improve their own resources for the classroom while keeping their budget, time and money at bay.

Lastly, the use of technology should no longer be avoided. The young learners are already adapting with the latest technological devices. The teacher, therefore, needs to step up their game in order to provide relevant and rich learning experience for this 21st century learner (Siefert, Kelly, Yearta & Oliveira, 2019). With its affordances and functions which enable not only self-pacing but also interactive feature, the implementation of game apps can help the student to feel at ease while exploring their potential in a competitive yet supportive environment in line with their greater interest. Perhaps, the implementation of math based game apps should be considered and supported by the learning institution and the Ministry of Education (MoE) for the betterment of the students especially among the niche group such as the at-risk learner.

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