INTEGRATING ENGLISH MEDIUM MATHEMATICS MOBILE APPLICATIONS TO TEACH LOW ACHIEVER UNIVERSITY STUDENTS

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ABSTRACT

This paper investigated the implementation of smartphone mobile application in assisting teaching and learning towards low achiever's student in tertiary education. Specifically, this study concentrated on teaching and learning mathematics in English at tertiary level where English is considered as a second language in Malaysia and used as a medium of instruction in the learning process at Universiti Teknologi MARA (UiTM). Unbalanced quasi pre and post-test experimental design was used in this study to determine the impact of English medium mathematics mobile application towards the performance of low achievers' students. This study limited the participation of the students to students whose scores were under the low achiever's category only. As such, students who entered the undergraduate's diploma program through a special entrance program (i.e., the MDAB program under UiTM) were selected in this study. These students were divided into two groups, one of which used the mobile application (Treatment Group, n = 24) and the other one did not used the mobile application (Control Group, n = 27). Bayesian t-test using JASP open-source statistical software was carried out to test the existence of significant change in students' performance based on the marks they scored on a test for a specific topic before and after the introduction of mobile applications in students learning process. Based on the analysis carried out, results show that the treatment group which introduced the use of mobile application in learning process had a slightly better performance compared to the control group. In the future, it is recommended that a specific mobile application is developed respective to the syllabus content and introduced in the early schooling process in order to fill the students with a better understanding on the fundamental concepts before they enter the tertiary education.

Keywords: *Mobile application, Smartphone, Interactive, Mobile learning, Bayesian.*

Introduction

The rapid growth of digital technology has made in-class and out-of-class learning activities more enhanced with the existence of mobile devices such as

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notebooks, smartphones or mobile phones, and personal digital assistants (Sung, Chang & Liu, 2016). In parallel with the Industrial Revolution 4.0 and Education 4.0, these devices are considered as popular learning tools in the 21st century. As we entered a new decade and a new blueprint of Education 5.0, with the creation of cloud technology and the growth of Artificial Intelligence (AI) technology, these devices are a must-have item for everyone including students. Though there are qualitative analyses of the employment of mobile devices in education, systematic quantitative analyses of the consequences of mobile-integrated education are lacking. The challenge of experimenting with new mobile technological innovations for teaching and learning may be a constant issue for educators in schools and even for lecturers in higher academic institutions.

Hussin, Manap, Amir, and Krish (2012) were convinced that Malaysian university students were highly familiar with computing and communicating activities using their mobile phone. In addition, computer games that encompass educational objectives and subject matter are believed to hold the potential to motivate students to learn academic subjects more as they are more learner-centered, easier, more enjoyable, more interesting, and more effective (Kafai, 2001; Malone, 1980; Prensky, 2001). Furthermore, studies on learning through games as compared to traditional learning reported that the results were equivocal regarding the differences between games and traditional teaching methods. Randel, Morris, Wetzel and Whitehill (2012) discovered that 38 studies reporting no differences, 27 studies preferring games and 3 studies preferring traditional methods. A more recent research project namely Teachers Evaluating Educational Multimedia (TEEM) and Computer Games in Education (CGE), investigated the use of commercial games in schools, producing positive benefits mainly concerning skills development and motivation, whereas curricular-specific learning outcomes were seldom mentioned (Facer, 2003; Kirriemuir, 2002). In another study, the Electronic Games for Education in Math and Science (E-GEMS) project demonstrated that games boost children’s motivation and educational accomplishment in science and mathematics education in middle school (Klawe, 1999). Kim and Kwon (2012) reviewed 87 English as a Second Language (ESL) Smartphone apps and the results revealed that the ubiquitous accessibility and flexibility nature of current ESL apps seems to be effective in offering personal and learner-centered learning opportunities. In addition, result of analysis obtain from recent studies on the use of mobile learning encountered that in general, it enriches the traditional learning process (Viberg, Andersson & Wiklund, 2018).

At present universities around the world are finding the application of mobile learning to be boundless, and that mobile phones are now becoming the most commonly used devices amongst students. However, the use of mobile application in learning still at low utilization level and depends on several other factors encompasses the teaching and learning process either in schools or in the universities. According to Tu and Hwang (2018), some of the elements that need to be considered in carrying out mobile learning included but not limited to factors such as learning and teaching strategies, research issues, sample groups and methods, and its application domains. In additions, previous study also found that there also exist barriers in the implementation of mobile application learning process such that the effectiveness of mobile learning in schools is the lack of teacher professional development and this barrier may also extend to universities’ instructors (Crompton, Olszewski & Bielefeldt, 2016). Thus, taking into consideration the limitation, factors, and barrier in the development of mobile application from scratch, this study aims to investigate the effectiveness of selected mobile applications available in the mobile apps store to teach mathematics in English. Therefore, this study extends the previous studies by Kim and Kwon (2012) and Viberg et al. (2018) and explore the use of mathematics mobile application in the teaching and learning of mathematics in UiTM and specifically on the low achievers' students. Of course, the selected available mobiles apps will not entirely cover the whole syllabus but will provides some ideas in the development of a customize mobiles apps for a specific content.

Since this study was done in UiTM Kedah branch campus, it is important for UiTM lecturers to understand that some students may face difficulty adjusting to the transition from Malay medium of instruction in schools to English medium in UiTM. In addition, low proficiency students faced greater challenges in understanding subject-specific lectures (mathematics) delivered in English. The following approaches were considered for the implementation of this study and data collection which includes, investigation of suitable mobile applications to meet the research objectives, preparation of teaching and learning environment (smartphone, internet connection, downloading mobile applications, etc.), integration of mobile applications for teaching and learning mathematics in English, integration of mobile applications in real learning environment, and setting up an evaluation framework that integrates technology, performance, efficiency, usability, and effectiveness. Thus, this paper will quest for answer on the question of how can mathematics mobile application be adopted in UiTM mathematics classes and its effectiveness? In doing so, the main objective of this study is to analyze the effectiveness of using English medium mathematics mobile applications toward low achiever students' performance in mathematics.

Methodology

This is a case study carried out in UiTM Kedah Branch Campus which mainly involve the Diploma level students. This study employed a mixed method research design approach that combined the quantitative and qualitative data analysis techniques. However, this paper only discussed the quantitative analysis part with respect to the research objective mentioned earlier. The population under study are all the first semester students who enrolled in a program that contain Business Mathematics course in the first semester of their study plan. Since this study mainly focus on low achievers' students, we have limited our sample scope only to those who entered the diploma program through a special program organized by UiTM. This program which called MDAB is designed for low achievers from their secondary school who failed to enter the UiTM diploma program through the normal enrollment intake. For easy management of the sample, purposive sampling was applied such that two different classes have been chosen as sample with both classes consist of students from the special program MDAB. In order to avoid bias in the traditional learning process, these classes were chosen from the same instructor to ensure that both classes will have a control environment in term of the learning style using the traditional face-to-face teaching and learning process.

In this paper, the quatitative analysis follows a quasi-experimental pre- and post-test design. The students that participated in the study are assigned to two groups, one of which use the mobile application (Treatment Group) and the other one did not use mobile application (Control Group). Since the study followed a pretest/posttest experimental design, taking before and after measures of each group, enable the researcher to explore the effects of application used (mobile or non-mobile) on students' achievement as measured by a knowledge test on mathematical concepts and problem-solving.

Based on the overview of the research literature and the research design employed, the hypotheses of the study are formulated as follows: H_1: The students of Treatment group show no different performance with the Control group during the pre-test evaluation. H_2: The students of Treatment group show a different performance with the Control group on the post-test evaluation after the introduction of mobile apps. H_3: The students of Treatment group would exhibit significantly greater achievement in terms of mathematical knowledge than those of Control group.

The following approaches were considered for the implementation of this study and data collection process. Task 1: investigation of suitable mobile applications to meet the research objectives. Task 2: preparation of teaching and learning environment (smartphone, internet connection, downloading mobile applications, etc.) Task 3: integration of mobile applications for teaching and learning mathematics in English. Task 4: Integration of mobile applications in real learning environment. Task 5: Setting up an evaluation framework that integrates technology, performance, efficiency, usability, and effectiveness.

Data were collected based on two methods, empirical and survey. In addition, in depth understanding on the research objectives were obtained from an interview session with a specific group of students. However, result from the survey and interview session will not be presented and discuss in this paper. In this study, empirical data were collected through pre-test and post-test respective to the materials covered in the syllabus. In the first stage, the students in both groups were first taught using the same techniques (traditional face-to-face teaching and learning) for a chosen topic. This was done through a two hours lecture and two hours tutorial session. After the session, the students were given three days over the weekend to prepare themselves for a pre-test on the topic covered. Result from the pre-test were recorded. In the second stage, the same procedures were repeated for the post-test for a different topic, but this time a mobile application was introduced together with the traditional teaching method to the treatment group and the result from the posttest were then recorded. Next, the recorded empirical data were tested for the existence of significant differences between the treatment group and the control group using JASP Version 0.1 software (JASP Team, 2019). The hypothesis proposed earlier were tested using Bayesian independent *t*-test running under JASP software using *BayesFactor* R package (Morey & Rouder, 2015).

Results and Findings

51 students have participated in this study, such that 27 of them were in the Control group while 24 of them were in the Treatment group. Among the respondents, 13 (25.5%) of them are males and 38 (74.5%) of them are females. The Bayesian Independent t-test were first carried out on the pre-test data for both the Treatment and Control group. As illustration purposes, a nondirectional t-test using default Cauchy prior width to its JASP default r = 0.707 were specified. Rejecting or fail to reject a proposed hypothesis is based on the critical t-values for JZS Bayes factors 1/10, 1/3, 3, and 10 as a function of sample size (Rouder, Speckman, Sun, Morey & Iverson, 2009). The Table 1, Table 2, and Figure 1 summarized the results obtained.

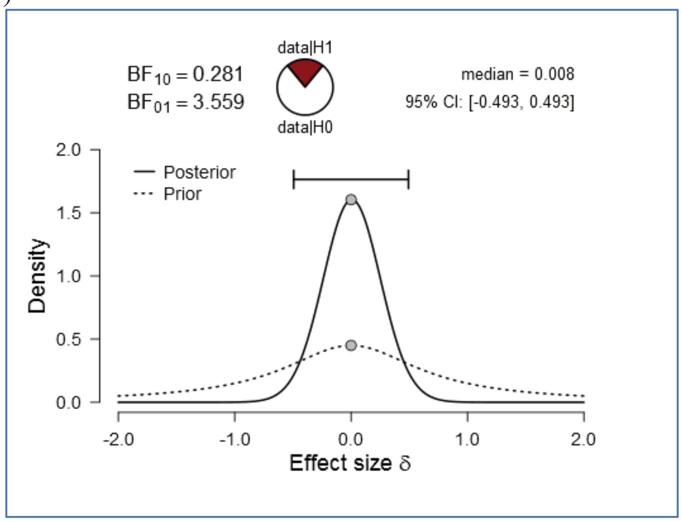
Table 1 *Bayesian Independent Samples T-Test*

	BF_{01}	error %
Pre-Test	3.559	0.018

Table 2 *Group Descriptive*

						95% Credible Interval	
	Group	N	Mean	SD	SE	Lower	Upper
Pre - Test	Control	27	43.93	14.02	2.699	38.38	49.47
	Treatment	24	43.79	12.71	2.595	38.42	49.16

Figure 1 JASP output for prior and posterior plot (Pre-Test between Treatment and Control groups)



Since the students in both groups come from very similar background in mathematics and English, descriptively there was not much difference in the average score obtained by both groups with a slightly higher average in the control group which can be negligible. In addition, the standard error in the treatment group is slightly lower compared to the control group which indicate a more consistent distribution in the treatment group. This was presented in Table 2. The Bayes factor also reflected that it is 3.559 times in favor of the null as compared to the alternative hypothesis (refer Table 1). This indicates that before introducing the use of mobile apps to the treatment group, both groups can be considered to have the same achievement level. Furthermore, the posterior median score is -0.008 with a 95% credible interval ranges from -0.493 to 0.493 indicate evidence that the posterior mass is evenly distributed (see Figure 1) which further support the Bayes factor result earlier. The height of the prior distribution line (i.e., represented by the point on the dotted line) in Figure 1 was below the height of the posterior distribution line that further support the result in favor of the null hypothesis.

Next, we examine the posttest data using similar approach. The results for the nondirectional test using the Post-Test data set were presented in Table 3, Table 4, and Figure 2. The nondirectional analysis result were summarize and presented as follows:

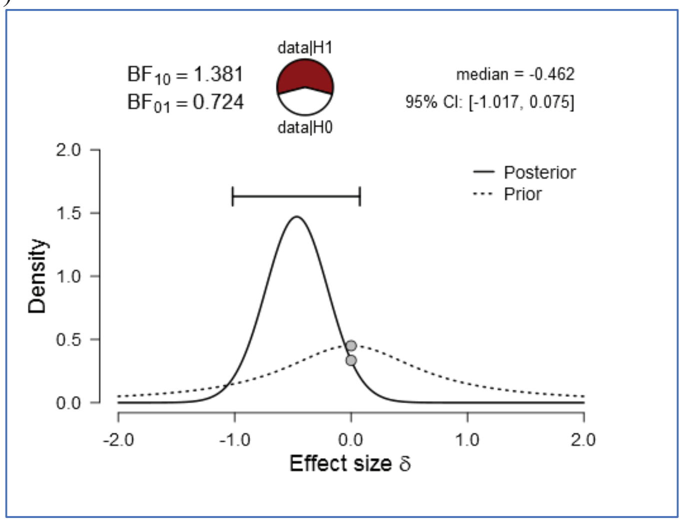
Table 3 *Bayesian Independent Samples T-Test*

	$\mathbf{BF_{01}}$	**error %**
Post Test	0.724	0.002

Table 4 *Group Descriptive*

						95% Credible Interval	
	Group	**N**	**Mean**	**SD**	**SE**	**Lower**	**Upper**
Post - Test	Control	27	43.89	16.13	3.103	37.51	50.27
	Treatment	24	52.38	14.14	2.886	46.40	58.35

Figure 2 JASP output for prior and posterior plot (Post-Test between Treatment and Control groups)



The descriptive mean score for both the control and treatment group were presented in Table 4. Based on the result it clearly shows that the mean score for treatment group (i.e., N = 24, M = 52.38) was slightly higher than the control group (i.e., N = 27, M = 43.89). The post-test mean score for the treatment group also shows an increase of 8.59 marks (i.e., 52.38 – 43.79) or a percentage increase of 19.6% as compared to the pre-test mean score. Investigating the Bayes Independent t-test on the post-test data shows a significant rejection of the null hypothesis with BF_{01} statistic equal to 0.728 or equivalently 1.381 times in favor of the alternative hypothesis (i.e., $BF_{10} = 1.381$). This is further supported by result shown in Figure 3 such that the height of the prior distribution is slightly higher than the height of the posterior distribution. In addition, the result also reveals that the posterior median score is -0.462 with 95% credible interval ranges from -1.017 to 0.075 which provides evidence that most of the posterior mass is negative. Thus, further investigation on the post-test data was carried out such that based on the previous result obtained, a directional test was performed. The result is presented in Table 5, Figure 3, and Figure 4 shown below.

Table 5 *Bayesian Independent Samples T-Test*

	BF_{0+}	error %
Post Test	9.418	~ 6.501e -5

Note. For all tests, the alternative hypothesis specifies that group *Control* is greater than group *Treatment*.

Figure 3 JASP output for prior and posterior plot (Post-Test between Treatment and Control groups)

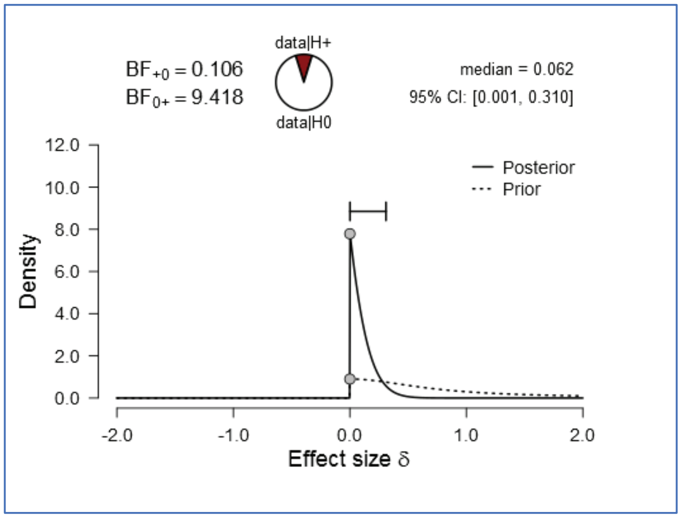
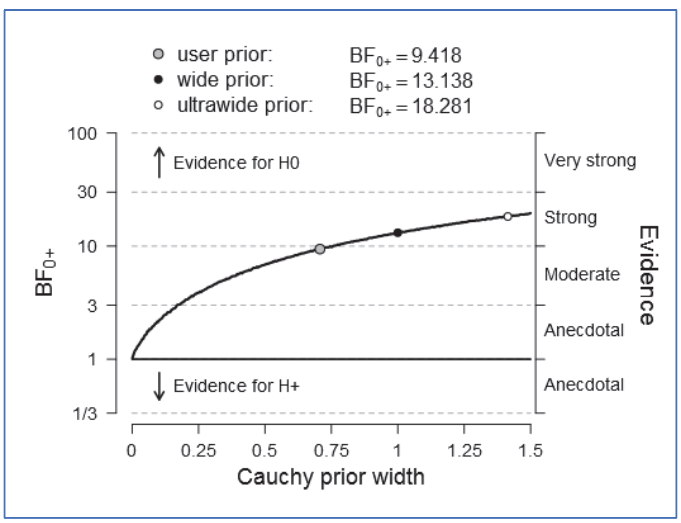


Figure 4 JASP output for Bayes Factors Robustness Check (Post-Test between Treatment and Control groups)



The result on the directional test was presented in Table 5 and Figure 3. Taking into the consideration the direction observed from the previous non-directional test, as expected it has increased the relative evidence on the null hypothesis (introducing the mobile app in teaching and learning environment improved the students' performance). In general, the Bayes factor has increase from 0.721 to 9.418, such that the observed data collected are 9.418 times more likely in favor of the null hypothesis as compared to the alternative hypothesis. Figure 4 provide the results on the Bayes factor robustness check for a different level of prior and based on the result, the observed data shows moderate to strong evidence supporting the null hypothesis as compared to the alternative hypothesis. Thus, based on the result reported, we have enough evidence to support the hypothesis that introducing mobile apps in teaching and learning mathematics to low achievers' students significantly improved their performance. Summary of the hypothesis test is provided in Table 6 shown below.

Table 6: *Summary of hypothesis testing results*

Description	**BF_{01}, *BF_{0+}**	**Decision**
H_1: The students of Treatment group show no different performance with the Control group during the pre-test evaluation.	3.559	Supported
H_2: The students of Treatment group show a different performance with the Control group on the post-test evaluation after the introduction of mobile apps.	0.724	Supported
H_3: The students of Treatment group would exhibit significantly greater achievement in terms of mathematical knowledge than those of Control group.	9.418*	Supported

Conclusion

This study enhanced teaching and learning mathematics in English way beyond the traditional face-to-face and whiteboard process. This study provides researchers and lecturers on the increasing trend of using mobile applications to teach mathematics and its effectiveness towards students' performance without jeopardizing the traditional way of teaching and learning. This study had explored the utilization of mobile technology in higher learning education and based on the results obtained, teaching and learning mathematics can be enhanced by integrating mobile application in classroom and promote independent learning for the students. This finding is also supported by previous literature search such that from the study they discovered that informal learning is signified to be more enriching than the formal learning (Viberg et al., 2018). Similar result reported that semi-informal learning like flipped classroom significantly outperformed the traditional learning (Lo & Hew, 2018). In short, firstly, the research findings are beneficial to the students where it can promote interactive, independent learning to learn mathematics using their Smartphone. Secondly, Mathematics lecturers can enhance their teaching strategies with the integration of mathematics mobile application in teaching and learning. Finally, this research is beneficial to English language lecturers where they can engage in collaboration with the mathematics lecturers in analyzing the best or suitable mobile applications that suits the UiTM course syllabus. In fact, with the collaborations among different expertise may ease the development of a better mobile application that suits not only the syllabus but also the needs of the students in motivating them to install and use the mobile apps in their smartphones and use them in their learning process. The empirical findings provide evidence that learning effectiveness is affected by user satisfaction and intention to reuse, which, in turn, are determined by system quality, information quality, perceived enjoyment, and perceived fee (Wang, Wang, Lin & Tsai, 2019).

Recommendation

A recommendation on the current study for future development is to design the appropriate mobile applications that suits the Malaysian students, i.e., the UiTM students, not only in term of syllabus coverage but also in term of the English instruction that is at par level with the knowledge and skill of this low achievers' students. In fact, this model of collaborations among different departments or academics fields can also be applied to the education systems of any countries where English is not their first language. For future research, it is recommended that a study is carried out in determining the best contents at par with the student knowledge in order to motivate the students in accepting mobile apps as part of their learning tools, either in understanding the mathematical fundamentals or performing the problem-solving procedures correctly.

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