Significance of mobile learning in learning Mathematics

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Abstract. Mobile learning has been expanding due to the significance growth and demand for wireless and mobile computing technologies in recent years. It offers a new paradigme shift in learning dimension that conventional classrooms may fail to offer in the teaching and learning approach. This study explores the integration of mobile learning in mathematics at the higher learning institution as research on the use of mobile learning for the teaching and learning of Mathematics appears to be limited. The study focused to examine student's perceptions and experience of mobile learning in Mathematics classroom and also to examine the significant of mobile learning on attitude towards Mathematics. The study involved a total of 70 students at one of the technical university in Malaysia. The students reported their perceptions and the pre and post experiences through a survey questionnaire. The findings reported that the increase level of students' learning excitement, engaging and positively able to be an independent learner after they experienced mobile learning in formal classroom setting. Hence, mobile learning does significantly increase students' attitude toward significance of Mathematics and reduce Mathematics anxiety.

1 Introduction

The evolution of technology has significance affect in teaching and learning since the past few decades. Mobile devices has been rapidly and significantly evolve to adopt as current and future of primary technology device assistant. Mobile technology are among the tools of the digital age required by students, especially in tertiary level of education. The mobile devices are categorized as 'the must to own' for everyone. The trend has created new perspective and ideas for research especially in educational technology. The educational technology experts termed it as mobile learning or m-learning.

M-learning is acknowledged as the fourth invention of the electronic learning setting [1], where it is an expansion of e-learning [2]. However e-learning is not necessarily m-learning. The delivery of the learning content in m-learning focuses on using mobile computing devices and/or with wireless transmissions as supporting tools, where it can enhance learners' engagement and improve accessibility of course contents as well as increase learners' interaction and collaboration [3].

Referring to [4], m-learning describes as "a process of learning, where learners are constantly on the move and construct a brief, but precise interpretation across space and time in collaboration with peers and teachers". In the same vein, [5] sees m-learning as a novel stage in the growth of technology-enhanced learning using mobile technologies where students can access the information by learning individually or in groups, face-to-face or at a distant place using personal mobile devices as a tool. It is a techno centric, related to e-learning, enriching formal education, student-centred and at the same time must include motivational and affective aspects, such as control, ownership, fun, communicative, learning-in-context and continuity between contexts. These features appear to enhance and make learning more meaningful.

Although there are varying definitions and views of m-learning, the common thread that runs through is that it incorporates the use of mobile technology and mobile devices to facilitate the process of learning or knowledge transfer of user who is always mobile, regardless of within or outside of the formal classrooms, informal learning or lifelong learning [6].

There are subjects cannot just simply learned by only reading and thinking, such as mathematics subject, that involve calculation skills. The subject require students to do mathematics. Learning by doing mathematics is essentially about getting involved in an activity and solving the problem. Through this process, the learners study the theory and practice, as these two components emphasis better understanding and achieve better objectives in the context of learning mathematics. An engagement process between students and the subjects occurs during students' participation in 'learn by doing mathematics', which could leads to positive achievement. A study done by [7] describes positive achievements and successes in mathematics often lead to enhanced attitudes and raised students' confidence,

which resulted in increased effort and persistence and further success. Furthermore, through the process of 'discovery' of knowledge and solutions based on learning by doing, it builds students' self-esteem, which is also contributes to the development of positive attitude towards mathematics.

According to [8], it is more meaningful if 'learn by doing mathematics' is performed in a group because it can assist students in identifying their knowledge gap and hence assist successful task comprehension. During the process of learning by doing, learners within the group rely on each other which create positive interdependence to encourage and assistant. This benefits both group and individual learners.

Furthermore, `learn by doing` method could enhance critical and logical thinking, creative problem solving and visual as well as spatial skills while combating negative attitudes towards higher order thinking questions in mathematics. The engagement level that occurs while learn by doing mathematics in group also increase where more inputs among team members can be assessed. Motivation and encouragement from lecturers are revealed as the main contribution in transforming the cycle from failure to success in mathematics class.

Digital natives, the generation that born in era of digital, spent their daily activities and routine surround gadgets and technological items such as computers, video games, digital music players, smartphones and tablets. Thus, teaching approach need to adapt the digital natives era which mathematics lecturers should integrate technological devices in teaching and learning process.

To facilitate m-learning, mobile devices can be adopted as multimedia access tools, communication tools, capture tools, representation tools, analytical tools, assessment tools, and task managing tools. These tools have been incorporated in various studies.

For instance, [9] adopted mobile devices as multimedia access tools, where the participants in the study study a five-minute video clip on how to measure blood pressure; [10] employed mobile devices as communication tools, where the participants in the study communicated with the supervisors during a teaching practicum; [11] used mobile devices as representational tools, where the participants were required to compose music using software in their mobile devices; [12] used mobile devices as analytical tools, where the participants were required to find mathematical relations in the real world phenomena using Math4Mobile midlets software; other researchers, such as [13], [14] used mobile devices as assessment tools where summative or formative assessments were carried out using students' mobile devices.; and a study by [15], [16] used mobile devices as task management tools, where students utilized the devices as personal information managers.

A student-centered environment requires students to be active learners and participate in their own learning process in order to achieve meaningful learning. Students learn the content by the process of constructing knowledge and interacting with their peers. While the teacher acts as a facilitator who provides support and guidance during students' learning process.

In the context of this study, the learners have the ability to make their own decision regarding what to learn, what navigation paths to take, and how to learn within the context. Students have the control over their learning in terms of content delivery and interactivity using 'learn by example' principle. Learning by worked-out example which consists of a problem formulation and the solution process that lead to final solution of the problem, is used widely in Mathematics and Physics subjects. Learning by examples provides quicker algorithm and solutions of problems, requires less time for learning, needs less time for solving problems and helps to minimize mistakes.

In addition, learning by worked-out examples can effectively and efficiently assist students to get better understanding of the problem solving of that particular subject mainly during the early cognitive skill achievement [17].

Furthermore, [18] stressed that the American Statistical Association recommends using active learning, technology, and formative assessment in teaching mathematics. Thus, incorporating technology, activities, and cooperative learning motivates students and leads to effective learning of mathematics. Apart from that, [19] proposed to include learning environment, learning interaction and learning design in implementing online collaboration among learners and lecturers, especially in mobile learning environment.

Referring to study done by [20], there were two components extracted by factor analysis in determining students attitude towards one of the mathematics courses, which are, the significance of the subject and the students' anxiety. Based on these two factors, this study examines the significance different when students utilized mobile learning in their learning method.

The objectives of this paper are:

i. To examine students' perception on mobile learning in mathematics

ii. To examine significant differences of mobile learning on significant of mathematics and anxiety towards mathematics

2 Research Methodology

2.1. Sample

A group of 70 university students who register a mathematics class at technical based university in Malaysia, aged between 20 to 24 years old and agreed to participate in the study. They filled in a consent form to participate in this study.

2.2 Research Design

Prior to implementation stage, a questionnaire was on assessing students' attitude towards Mathematics was distributed. The mobile learning activities were conducted in line with the subject's course outline. It started in Week 3 based on the academic calendar of the institution, and it took 2 weeks to complete the activities. During the session, students were encouraged to use their own mobile devices since they were familiar with the features of their own mobile devices. After the implementation stage, a questionnaire regarding students' perception on mobile learning in mathematic class and student's attitude towards Mathematics was distributed.

3 Results

Out of the 70 sample, 38 (54%) were males and 32 (46%) were females. Hundred percent of the participants owned a mobile device. The most common activities performed using mobile devices by participants are communication through social media (97%), followed by making calls (91%). More than half of the participants used their mobile devices for leisure activities such as listening to music (75%) and watching video (69%). Checking emails or emailing and sending or receiving SMS/ MMS were the least common activities (31%).

3.1 Students' Perceptions of Learning Using Mobile Learning Platforms

The following result in Table 1 displays a descriptive analysis on the student's perception of mobile learning.

Table 1 Students' Perception Of Mobile Learning

	Mean, M	Standard deviation, SD
Mobile learning is an exciting experience	4.11	0.202
Mobile learning can assist me to be an independent learner	4.30	0.914
Activity in mobile learning helped me learn the course content	4.04	0.850
Mobile learning captures my interest to focus on my study	3.97	0.979
It is helpful to learn using my mobile devices	4.21	0.951
Mobile learning engages me more in my own learning	4.43	0.884
I would like to continue learning using mobile learning platform in any course in future	4.40	0.914
Mobile learning increases my interest in the topic being discussed	3.97	0.985

More than half of the participants agreed that mobile learning is an exciting experience (mean = 4.11), and could assist them to be an independent learner (mean = 4.30). They also agreed that learning through their mobile device was helpful (mean = 4.21), and it could capture their interest to focus on their study and increases interest in the topic being discussed (mean = 3.97). Almost half of them agreed that they would like to continue learning using mobile learning platform in any course in the future (mean = 4.40). Through mobile learning, they agreed that they were engaged in their independent learning (mean = 4.43).

3.2 Significance Differences on Students' Attitude Towards Mathematics After Experiencing Mobile Learning

This section reports on the students' attitude towards Mathematics before and after experience learning through mobile learning. This analysis was obtained based on the paired sample t-test, and divided into two components; the significant of Mathematics and anxiety of taking Mathematics course.

Table 2 shows the summary of descriptive statistics in terms of mean, standard deviation and standard error mean for each condition of the students' attitude towards the significance of learning Mathematics before and after mobile learning.

Table 2 Paired Sample Statistics Of Attitude Toward Significant Of Mathematics

	Mean	Standard Deviation	Std.Error Mean
Before mobile learning	4.0159	.38898	.06575
After mobile learning	4.5111	.52546	.08882

Based on Table 2, the mean of significance of learning Mathematics before mobile learning and after mobile learning slightly differs, in which the mean 'after mobile learning' greater than 'before mobile learning'.

Table 3 shows the Pearson correlation between the two conditions; before and after mobile learning.

Table 3 Pearson Correlation

	Correlation	Sig.
Significance before and after mobile learning	.480	.003

For these data the experimental conditions yields a positive correlation coefficient (r= 0.480) and are significantly correlated since $p < .05$ (Sig= 0.03 < .05).

This is mainly because the data in each condition come from the same people and there are possibility consistency in their response. Since the correlation coefficient is positive, it will be more useful to conduct the test using a paired sample *t*-test.

Table 4 shows a summary of the paired sample *t*-test for the students' attitude towards significance of learning Mathematics.

Table 4 Paired Samples Test For Attitude Towards Significant Of Mathematics

	Paired Differences		Sig. (2-tailed)
	Mean	Std. Deviation	
Significance before and after mobile learning	.09524	.48067	.02

The significance value shown in the table is 0.02, which is less than the 0.05, therefore, it showed that there was enough evidence to support the claim that students' attitude towards significance of Mathematics was different after experiencing mobile learning.

Table 5 shows the summary of descriptive statistics in terms of mean, standard deviation and standard error mean for each condition of the students' attitude towards Mathematics anxiety, before and after experiencing through mobile learning.

Table 5 Paired Samples Statistics For Mathematics Anxiety

	Mean	Standard Deviation	Std. Error Mean
Before Mobile Learning	3.119	.57957	.09797
After Mobile Learning	2.5476	.74817	.12646

Based on Table 5, the mean for attitude towards Mathematics anxiety before the mobile learning and after the mobile learning slightly differs, where the mean 'after the mobile learning' is less than 'before the mobile learning'.

Table 6 shows the Pearson correlation between the two conditions, i.e. before and after mobile learning.

Table 6 Paired Samples Correlations For Mathematics Anxiety

	Correlation	Sig.
Anxiety before and after mobile learning	.508	.002

For these data the experimental conditions yield a positive correlation coefficient (r= 0.508) and are significantly correlated since $p < 0.05$ (Sig= 0.002 < 0.05). Since the correlation coefficient is positive, it will be more useful to conduct the test using a paired sample *t*-test.

Table 7 shows a summary of the paired sample *t*-test for the students' attitude towards Mathematics anxiety.

Table 7 Paired Samples Test For Mathematics Anxiety

	Paired Differences		Sig. (2-tailed)
	Mean	Std. Deviation	
Significance before and after mobile learning	.07143	.67433	.005

The Table 7 also reports the significance value less than 0.05. Thus, it does support the claim that there was a significant difference on the mean of the students' attitude towards mathematics anxiety, before and after learning through mobile learning. Thus, there was enough evidence to support the claim that there was a significant different on attitude towards significance of Mathematics and attitude towards Mathematics Anxiety, before and after learning through mobile learning.

4 Discussions

A number of participants agreed on the items which having positive feeling towards the mobile learning. They mentioned through mobile learning activity, their understanding of the subject was enhanced. Thus, in the proses their critical thinking were developed. Higher percentage of students agreed that it was fun activities and learning Mathematics through mobile learning. The participants also agreed that they enjoyed and could feel the positive impacts of the mobile learning to their understanding, learning satisfaction and motivation level.

Mobile learning platform able the participants to exchange opinions, ideas, and participate in active discussion through the project's guidelines. The platform also enhance their critical thinking as the participants challenge themselves think creative ways to problem solving and having fun and enjoyable moments at the same time. Thus, mobile learning activity was preferred by the participants.

In terms of learning objectives, the participants agreed that they understood the subject better through discussions and guidance from the lecturer who plays role as facilitator. Apart from the positive feeling reported by students on mobile learning, a positive discussion among students could be observed, as most of the students enjoyed and participate the discussions to increase positive output for the mobile learning activities.

This is a positive sign indicate that students could be actively engaged in their independent learning if a student-centered classroom learning environment created and less formal as the conventional type of teaching and learning.

The findings showed mobile learning brought positive impacts in learning motivation and engagement among students in Mathematics class. Moreover, mobile learning did significantly increase student's attitude toward significance of Mathematics, and also it did significantly reduce students' Mathematics anxiety. Further research should improvise more on framework of effective instructional design for mobile learning in learning mathematics subject.

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