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An Empirical Research on the Use of Mobile Phones to Support Students' Mathematics Learning

Nguyen Danh Nam and Trinh Thi Phuong Thao
Thai Nguyen University of Education
Thai Nguyen, Vietnam

Abstract. This paper presents some empirical findings on the use of mobile phones to support students' mathematics learning in some Vietnamese schools, specifically for facilitating self-study among students. An empirical research was carried out aimed at investigating the mobile phone as a portable learning device in the high school mathematics classrooms. It also finds out how the potentials and functionality of the mobile phones can be effectively used and facilitated in educational settings. A web-based learning model was proposed to assist K-12 students to learn mathematics beyond the activities in the classroom. The research also shows that mobile web-based content provides students with opportunity to learn at their own pace, to learn in accordance with their preferences, and to guide them self-study at home.

Keywords: m-learning; self-study; mobile learning; mathematics

Introduction

Mobile phones are becoming a vital part daily life of almost student and teacher. Most of students had high access to Internet on mobile phones. Therefore, recently, much research has been done in exploiting the potentials of mobile phones for their pedagogical uses and many researchers have announced effectively case studies at mobile learning in different contexts. According to Sharples, Taylor and Vavoula (2007), mobile learning is described as a type of learning that creates flexible learning environments which enhances the mobility of learners, the mobility of technology and the mobility of learning (p.222). Nowadays, most of handheld devices (including mobile phones) can run various types of application software and be equipped with Wi-Fi, Bluetooth, GPRS capabilities to connect to the Internet. Therefore, mobile phones will provide students with opportunity to learn anytime and anywhere. In other words, mobile learning with the support of mobile phones offers new chance for empowering the learning experiences in some aspects that other devices cannot collaborate effectively (Lam & Duan, 2012).

The presentation of mobile phones in the daily life of students positively assists the integration of technological world into mathematics education and there have been a number of studies of effective learning models with mobile phones all over the world. Tatar, Roschelle, Vahey & Penuel (2003) investiagated the influence of mobile phones in mathematics teaching and learning by organizing some interactive tasks such as: (i) distribution: transmitting the same learning resources to all students; (ii) differentiation: offering different tasks and assignments to each student; (iii) contribution: forwarding an exercise or real-life data investigation done individually and then shared to other classmates; and (iv) harvesting: managing the team work of some groups of students. Kukulskae-Hulme and Traxler (2005) revealed that learning with mobile devices provides learners with comprehensive instruction in all educational settings. Moreover, mobile phones creates a learning environment to enhance current face-to-face learning and improve student-teacher interaction. In fact, Wei and Chen (2006) designed an e-book interface on mobile phones that allowed students to type their questions, feedbacks and comments on the text which were moved to a discussion section. Other studies such as Genossar, Botzer & Yerushalmy (2008) found that the mobile phone encouraged students to do exercises that connect to real world. The students were able to percieved useful mathematical knowledge in such situations.

Franklin and Peng (2008) offered a model for using iPods to support students' mathematics learning. They could use the device to solve algebraic equations and graph them. In this research, videos were used to assist students' out-of-school learning. In order to enhance instantaneous learning interaction, Kinsella (2009) designed a program on mobile phones which engaged students to send their unsolved problems to teachers. The teachers had responsibilties of giving concise, objective comments to all learners intantaneously. In addition, Symbian Tweet (2010) confirmed that mobile learning was able to enhance students' motivations in some contexts. More recently, Kearney, Schuck, Burden and Aubusson (2012) espoused a pedagogical framework of mobile learning informed by a socio-cultural perspective, comprising three features: personalization, authenticity and collaboration. Other research, Vani & Permanand (2012) designed *MobileMath* in order to examine the effect of mobile devices in supporting learning mathematics, especially to determine whether they can maximize students' learning outcomes in mathematics or not. This program used a lot of techniques (e.g. games, puzzles, authentic tasks, personal differentiation, instant feedbacks) to assist students during learning process. The results of the study indicate that the application would create a positive environment for supporting students to learn secondary school mathematics.

There exists a huge gap between the school life of students and their daily life. According to Freudenthal (1983), there is a strong connection between mathematics and the real life. As a result, it must be close to students in the classroom (p.113). Almost every student consider mobile phone as a part of the after-school activities. However, the students have restricted access to mobile phones and Internet because school managers and teachers do not encourage their students using mobile phone during the class. For that reason, the aim of

this research was to gain an understanding of the way mobile learning approaches can enhance real-life mathematics teaching and learning as well as how mobile phones support students to self-study at home. Moreover, using mobile phones are effective way for teachers to keep in touch with parents and communicate with students instantaneously. Students can work with other classmates and share their results by using chat, SMS, MMS, e-mail, video sharing, blogging, working screen without being in same place. Nevertheless, there has been little research conducted on identifying the actual functionalities that mobile phones could support students to self-study. Therefore, this research would demonstrate that mobile phones facilitate students to gain mathematical insight, promote mathematical understanding, assist self-study at home and approach ubiquitous learning.

A proposal for teaching K-12 mathematics using mobile phones

The effect of mobile learning may well depend on the learning assignments that mobile phones are used for, and on the integration of activities within a well designed learning contexts. Lubega et al (2004) realized that most students used the mobile phones for communicating purposes like web browsing, emails, phone calls, SMS and MMS. Inparticular, they used mobile phones for teamwork, real time discussion with their classmates and received personalized supports from their tutors and teachers.

In order to investigate the real situation of using mobile phones to support the process of teaching and learning mathematics, we conducted a large-scale survey in eight public high schools in Vietnam, where five schools were located in urban areas and three other schools were located in rural and mountainous areas. The survey was conducted to analyze the strategies of using handheld devices such as mobile phones and how students use these devices to support their learning. Consequently, we have designed an interactive mobile website for teaching and learning K-12 mathematics. This website integrates a sequence of modules in each e-lesson. These e-lessons were constructed based on the national curriculum as well as school knowledge and skill standards. They can be accessed from mobile phones at the website: www.mlearningvn.com. During the course, students could read their e-books, did their pre-tests, completed assignments, raised questions and listed diffculties to teachers. The teachers took their responsibility to check, evaluate and respond them.

In this research, we proposed a model that integrates web-based e-lesson on the interactive website for supporting K-12 mathematics students to self-study. Every e-lesson contains four following modules:

1) Theoretical Review: The content of this module presents basic knowledge and a series of typical examples. Students can read the content of the lesson, try to understand the problems and methodological knowledge which was provided in these examples.

2) Instructional Exercises: This module includes the exercises that were designed based on differentiated system. The solution of an exercise was divided into "dose". In order to complete one "dose" and move on the next "dose", students must reply to all of the questions correctly. In the process of solving the problem

in each "dose", students were given some suggestions or hints if they met difficulty in finding the answer. In this case, students had to spend much more time to review theory or even took different steps to reach a full solution.
3) Drilling Exercises: This module was designed for knowledge reinforcing as well as differentiated purposes. These exercises contain the suggestions for the answer but not full solution. The levels of difficulty of each exercise will be automatically adjusted based on the students' responses to the preceding exercises.
4) Test and Feedback: Students were able to participate in discussion boards and undertake online activities such as surveys and quizzes. The test was designed based on different levels of students. In other words, questions and exercises in the test depend on the preliminary results and the whole process of doing them. After completing the test, students were provided constructive feedback and consequently made a good progress in their learning.

At the end of the course, we conducted a pilot study with 474 students in two high schools in Thai Nguyen City which located on the north of Vietnam. They were allowed to access to the Internet using their mobile phones and use providing resources on the website throughout their school day. Moreover, teachers encouraged them to self-study at home by doing individual homework and assignments. Finally, we conducted a small-scale survey to examine the attitudes of students towards this pedagogical model and to explore how mobile phones support their mathematics learning. At the same time, we took an semi-structuted interview with participating teachers to gain an insight into teaching process and instructional methods to guide their students self-study at home using mobile phones.

Results

Mobile phones offer solutions to the following education challenges such as: providing teachers with opportunity to design different difficulty levels which are suitable to students' ability and enabling teachers to realize which student have difficulties in interpreting mathematical concepts in real time, support students both independent and collaborative learning, and track students' progress.

Findings from the large-scale survey indicate that mobile phones are highly popular in Vietnamese high schools. Although we predicted a huge usage of mobile phones than computers in schools, the collected data were amazing: 86.47% of students have their own mobile phone (see Table 1 below) and researchers predict that by the end of 2015, more than 90% of K-12 students will own one mobile phone on average. This is appropriate to the nationwide trend of mobile application development. More importantly, about 71.71% of students possess mobile phones that can access to the Internet and other mobile applications. In other words, a considerable percentage of students possess smart phones that integrate Internet access, audio record and player, integrated camera and interactive learning applications. It is also said that the mobile phone penetration among students is very high in high schools. This situation suggests a lot of empirical research on how mobile phones could be used for

promoting learning and teaching purposes in different educational systems. Therefore, there is a technical support at schools for students to improve their learning performance in mathematics. As a result, teachers can provide students with a rich opportunity to engage them in learning activities which are facilitated by mobile phones.

Table 1: K-12 students' possession of mobile phones.

Name of High School	Numbers of Students	Numbers of Mobile phones	Percentage (%)	Mobile phones with Internet Accessibility	Percentage (%)
Dong Hy	142	116	81.69	95	66.90
Khanh Hoa	133	107	80.45	97	72.93
Thai Nguyen	250	236	94.40	198	79.20
Luong Ngoc Quyen	150	138	92.00	121	80.67
Chuyen	292	290	99.32	276	94.52
Chu Van An	150	124	82.67	114	76.00
Phu Binh	136	102	75.00	64	47.06
Dinh Hoa	129	82	63.57	26	20.16
Total	1382	1195	86.47	991	71.71

The data from Table 1 shows that students from urban areas (such as Thai Nguyen, Luong Ngoc Quyen, Chuyen, Chu Van An) have significantly higher access to the Internet than their rural peers (such as Dong Hy, Khanh Hoa, Phu Binh, Dinh Hoa). Hence, we chose two urban high schools to investigate how students use the mobile phones and Internet supporting their study. We found that entertainment, reading newspapers and accessing social networking services are the basic functions of mobile phones that students use to support their learning. About 30.8% of the students have access to mobile phones to exploit math websites and only 10.6% of the students enroll in online math courses (see Table 2 below).

Table 2: Some K-12 students' popular activities on mobile phones.

Activity	Thai Nguyen High School	Percentage (%)	Chuyen High School	Percentage (%)
Listening to online music	183	92.4	242	87.7
Watching online movies	183	92.4	193	69.9
Reading newspapers for latest news	154	77.8	182	65.9
Accessing school's website	163	82.3	276	100.0
Using SMS for peer discussion	32	16.2	95	34.4
Using social networking for peer discussion	131	66.2	244	88.4

Taking online tests or quizzes	140	70.7	257	93.1
Exploiting mathematics websites and resources	61	30.8	105	38.0
Participating online mathematics courses	21	10.6	9	3.3
Total	198	100.0	276	100.0

In particular, there were only a few students in a class who access to the Internet to look for learning resources because of low quality content websites as well as high cost for using mobile services. In order to find a suitable solution for this situation, we designed the interactive mobile website to support students learning mathematics at home. This pedagogical model would encourage individual learning by providing each student with a device and students can access the website on the mobile phones every time throughout their personal life. During the course on the website, students were offered opportunities to gain access to learning experiences by using some popular functions of mobile phones like messaging, imaging, games, sharing, media, etc.

The survey on students' attitudes towards their satisfaction with the interactive mobile website showed a surprising result. There was a different evaluation among four groups of students (see Table 3 below). About 71% average students and 68% good students satisfied with the content on the website and it helped them to learn mathematics effectively and we observed that they only focused on two modules during their learning (theoretical review and instructional exercises). Conversely, only 33% excellent students and 35% bad students satisfied with modules and "dose" in each module. These percentages show that we need to design the content of each "dose" in every module such that it can support all students. In other words, the knowledge contained in each "dose" requires a higher level of differentiation which allows students to self-study at home with their own pace and to learn in accordance with their preferences.

Table 3: Levels of students' satisfaction with the interactive mobile website.

Level of satisfaction	Excellent students	Good students	Average students	Bad students
Very satisfied	12 %	27 %	19 %	7 %
Satisfied	21 %	41 %	52 %	28 %
Neutral	23 %	22 %	13 %	32 %
Dissatisfied	30 %	3 %	11 %	23 %
Very dissatisfied	14 %	7 %	5 %	10 %

Data collected from the teacher's take notes as well as data from surveys, interviews were used to evaluate the effectiveness of the interactive website www.mlearningvn.com in supporting students self-study K-12 mathematics at home and the model of using the mobile phone to deliver learning resources as well. The purpose of this research was to investigate how the web-based learning model on mobile phones could be exploited to assist mathematics learning. The results show that there are a lot of benefits to use mobile phones to

support students learning mathematics because they can facilitate students learning anytime, anywhere, from any source, at any pace. In other words, mobile phones can support students learning with high flexibility and personalizing: each "dose" in a certain module suitable for a group of students; online forum allows students communicate, arguments with other members and learn from each other; integrate testing modules which allows students to self-evaluate and make a plan for their progress; SMS services help the students get instantaneous feedbacks and comments from their teachers,…

In general, the research shows that most students using mobile phones for web-based learning purposes and private communication. We have also recognized that mobile phones were used successfully by some of the teachers for personal support with information gathering, timetabling, lesson observations, records of meetings, calculating and graphing, students' attendance and grades, and online assessment. Moreover, a large number of teachers realized that the mobile phones are useful and flexible for teachers, especially people who have no experience with computers. However, data from interview also indicate that mobile phones did not significantly influence students' performance including students who using these devices to learn mathematics for the first time.

Conclusion

The purposes of this paper were to provide an overview of great potentials for using mobile phones to support the students learning mathematics whenever and wherever they want. Students can access to the Internet on mobile phones to review theory, do differentiated exercises, post comments on a forum, take online quizzes and choose the strategy of learning on their own. The designed website was also explored to determine if it can motivate and offer the advantages of learning mathematics anywhere and anytime.

The results of this empirical research would contribute to further investigation of the benefits of mobile phones in educational setting. Although most of the schools in Vietnam banned or limited the usage of mobile phones, but these devices are available and are part of the daily culture of almost Vietnamese student. Therefore, our proposed model of using mobile phones aimed at providing a rich opportunity for students to learn mathematics at home. Teachers can also use different "dose" on the website to facilitate students to self-study in a differentiated approach with different types of learning. It is realized that this approach can facilitate the mobility of the students and decrease location limitations of learning. More importantly, the research reveals that the students were able to improve their learning performance and they were also satisfied with using mobile phones as a tool for supporting to learn mathematics at school and at home as well.

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