Chapter #11

MOBILE LEARNING IN HONG KONG TEACHER EDUCATION
Pilot implementation and evaluation

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ABSTRACT
To align with the international trend on using information and communications technology in education, the Hong Kong government has recently announced a policy to broadly implement e-learning in schools through a more pervasive use of mobile devices (such as smartphones and tablets) and electronic textbooks to support classroom teaching and students' self-regulated learning. However, many local schools and their teachers are not yet ready and confident enough (in terms of their teaching methods, strategies, and approaches) to adopt mobile devices in their classroom activities. The present chapter reports a few case studies showing how a team of teacher educators initiated a pioneer e-learning project to support the education sector, by offering relevant training to pre-service student-teachers and in-service teachers. The team designed, developed, and applied a number of innovative mobile learning activities in five different classes of undergraduate teacher education courses. A total of 364 undergraduate students completed a survey collecting information on their prior experiences, attitudes, and views on mobile learning, in order to evaluate their learning effectiveness in technology-enhanced lessons. To illustrate the educational implications of the present study, selected qualitative and quantitative findings will be presented together with some examples on the implementation of innovative mobile learning activities in some classes of teacher education courses.

Keywords: mobile learning, e-learning, teacher education, higher education, Hong Kong.

1. INTRODUCTION AND LITERATURE REVIEW

The use of mobile technology to enhance students' learning (also known as technology-enhanced learning or e-learning) is drawing increasing attention and interest in recent educational research (Attewell & Savill-Smith, 2004; Berge, Muilenburg, & Crompton, 2013; Kukulska-Hulme & Traxler, 2005; Peng, Su, Chou, & Tsai, 2009; Wang, Wu, & Wang, 2009), due to the widespread usage of different mobile devices, such as smartphones and tablet computers, in many teenagers' daily lives for communication, web surfing, social networking, video/photo-taking, and entertainment (e.g. playing electronic or online games, listening to music and songs, and watching TV, videos, or movies). Many researchers anticipate that there will be extensive adoption of mobile learning, not only in open and distance education, but also in formal classroom education and informal out-of-school learning (Brown & Mbati, 2015; Sharples, 2007).

The term mobile learning (or m-learning) has been cloned to describe any learning taking place with learners using mobile computational devices, including mobile phones, smartphones, tablet computers, laptop PCs, Personal Data Assistants (PDAs), pocket PCs, etc. (Peng, Su, Chou, & Tsai, 2009; Quinn, 2000). The key feature of this type of learning is being mobile, but a more educationally-relevant definition has been put forward by Laouris and Eteokleous (2005). Furthermore, Traxler (2005) advocated that the definition of mobile learning: “Should address also the growing number of experiments with dedicated mobile devices, such as game consoles and iPods, and it should encompass both mainstream industrial technologies and one-off experimental technologies.” The advantages of mobile learning are well-known not only because this type of learning enables self-regulated and collaborative learning activities between learners at anytime and anywhere (Attewell & Savill-Smith, 2004), but because it facilitates paradigm shifts in education, such as spatial shift (from campus-based to home-based learning), curricular shift (from national/fixed curricula to personal curricula), and shift in teacher’s role (from knowledge-provider to facilitator of learning) (Ally, Grimus, & Ebner, 2014; Alrasheedi, Capretz, & Raza, 2015; Desai, Hart, & Richards, 2008).

In 2014, the Hong Kong government announced a policy (with the release of a new policy document for consultation on the fourth strategy on information technology in education) to broadly implement e-learning in schools through a more pervasive use of mobile devices and electronic textbooks to support classroom teaching and students’ self-regulated learning. However, many local schools and their teachers are not yet ready and confident enough (in terms of teaching methods, strategies, and approaches) to adopt mobile devices in classroom activities. From a review of literature on mobile learning, it emerges that past teaching methods and educational research (Brown & Mbati, 2015; Grant et al., 2015; Seppala & Alamaki, 2003; Tessier, 2014) have focused on the elementary use of mobile devices for communication and reading purposes (discussion, sharing of photos or other materials, short-message service, substitution for textbook, etc.), while there were very few examples of innovative or advanced applications, such as the development of an augmented reality-based mobile learning system for scientific inquiry activities (Chiang, Yang, & Hwang, 2014).

On the other hand, the implementation of mobile learning is in fact coupled with many challenges and barriers, such as fragmentation of learning time, high cost of mobile devices and connectivity service, and the abuse of the devices (causing disturbance of lessons) for personal calls and other non-educational purposes (Denk, Weber, & Belfin, 2007), which need to be identified for further research and development, before the potentials of mobile learning can be fully utilized for educational purposes. Using Google Scholar for a search of academic journals up to August 2014, Baran (2014) identified 329 articles on mobile learning and teacher education. He carried out a detailed analysis of 37 selected reliable articles and found that (a) teacher educators were the subject of only four studies, (b) six papers were directly related to science education and (c) design-based research was used in four papers only. The technology used in all those studies was limited to well-known mobile devices, such as mobile phones, tablets, smartphones, laptops, iPods, iPads, PDAs, and handheld PCs, but did not involve micro-controllers, such as *Arduino* (http://arduino.cc) for conducting on-site or remote-controlled experiments. Furthermore, there was not much prior in-depth research done on teachers’ views, perceptions, and attitudes towards mobile learning. In a limited study on pre-service teachers’ perceptions of the use of mobile phones and laptops in education, Nihat Sad and Goktas (2014) administered a survey to 1087 participants and revealed that mobile phones were perceived to have weaker potential than laptops as mobile learning tools. To bridge the aforementioned educational gap, from September 2014, in the largest teacher education institution in Hong Kong, a group of science teacher educators started to incorporate in some teacher training programmes an array of different teaching and learning activities, which were designed for the use of innovative mobile learning activities. Four instances of these new approaches are reported below, together with the evaluation of perceived learning effectiveness from the point of view of the students and these students' prior experiences, attitudes, and views on mobile learning.

2. METHODOLOGY

For present case study purposes, more demanding mobile learning or e-learning activities were newly developed and separately adopted in five undergraduate courses (each for a 3-hour lesson): A, B, C, D and E, by three lecturing staff X, Y and Z with expertise in Chemistry, Physics, and Physics, respectively (see Table 1). The course A was taught by staff X and was aimed at developing student-teachers' teaching methods or pedagogies in which participants were first assigned to play some applications on simulation experiments in typical school science topics, e.g. photosynthesis in biology and water rocket in physics (force and motion). Free mobile apps used as scientific tools, such as Smart Tool, were introduced to design inquiry experiments. Later, the students were taught how to develop apps by themselves using an online app-building tool called *App Inventor 2*, provided by the Massachusetts Institute of Technology (MIT, http://ai2.appinventor.mit.edu/). The objective of the tool was to equip participants with the capability to develop apps (or to modify open-source apps) for some simple simulation experiments or activities for their future pupils at school. During the lesson, students whose major was neither ICT nor computer science, and who, therefore, had never written any codes for computer programming before, learnt how to create an interactive BMI app with the App Inventor 2, which is user-friendly and contains built-in blocks, instead of abstract programming languages. Though this was the first time they used the MIT *App Inventor 2*, most students could create their first mobile app successfully. As far as we know, this kind of approach, which requires the students to develop their own apps, is rarely found in any teacher education programmes or courses which are not directly related to computer science or ICT. This is because most teacher educators are themselves unable to develop apps, unless they are ICT experts. On the contrary, staff X had received an hour of formal training on app development just before the lesson.

Table 1. Undergraduate courses, lecturing staff, and distribution of students participating in the trial lessons.

Course Code	**Nature of undergraduate course**	**Lecturing staff (expertise)**	**No. of students**	**No. of questionnaires returned**
A	teaching methods or pedagogies	X (Chemistry)	72	60
B	science and technology, and their link with society	Y (Physics)	98	80
C			80	55
D	a general-education course on daily-life applications of chemistry	X (Chemistry)	54	39
E	scientific and socioeconomic aspects of information	Z (Physics)	60	35

Courses B and C were related to subject knowledge in science and technology, and their link with society, as taught by staff Y, and there were two separate classes of students who mostly had no senior secondary school background knowledge in science. The aim of the newly incorporated lesson was to facilitate the students' in-depth understanding of the mechanism and principles underlying computer-automated systems, as well as the link between hardware and software. During the lesson, students were organized in groups of three to four members and asked to build a simple automated traffic light system. A manual was provided to them as a guide on how to wire simple circuits consisting of basic electronic components including LEDs and resistors, and on how to code simple computer programmes for *Arduino* micro-controllers to control the time in which the colored LEDs were switched on and off. A proper development of hardware and software, i.e. a correct circuit with an appropriate computer program, would result in a system simulating automated traffic lights, as used in daily life. For many of the student-teachers, the lesson was their first experience in computer programming and, yet, most groups were successful in building the traffic light simulator in a 3-hour lesson, following the manual (Figure 1).

Figure 1. Photos of students' performance using the Arduino platform to develop an automated traffic light system: (a) wiring the electronic circuit, (b) coding to programme Arduino for conducting scientific investigation and (c) enjoyment on successful completion of the system.

(a) (b) (c)

In addition to building the automated traffic light systems in one lesson, students were given online quizzes in the other lessons of course B and C. The goal of the quiz was to consolidate the students' knowledge, after a discussion on specific topics of science and technology. Each quiz consisted of 5 to 6 multiple-choice questions and was administered to students via Moodle during class, after the discussion of each specific topic. Students logged in to Moodle via their own mobile devices to access the quiz, they were allowed to refer to their notes and discuss with their classmates to find the correct answers to the questions. After a set period of time, the lecturer closed the quiz and the results were computed by Moodle. Students immediately obtained their own quiz scores, as well as performance statistics for the whole class. For more difficult quiz questions, they had a discussion with the lecturer.

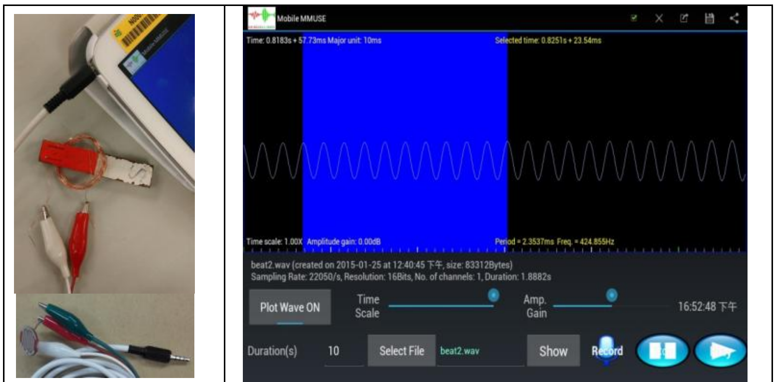
Course D was a general education course taught by staff X and was related to daily-life applications of chemistry, such as wine brewing. The alcoholic contents of homemade wine after fermentation could be determined by the traditional titration method. However, the alcoholic changes during fermentation were not known. The aims of this newly designed mobile learning activity were to (i) find out the alcoholic content in homemade wine using the *Arduino* alcohol gas sensor and (ii) develop a remote experiment using *Arduino* sensors to monitor the fermentation process of wine brewing, so that students could compare the rate of fermentation in different conditions. During the lesson, students calibrated the alcohol sensor using standard alcohol solutions (from 0%-20%, see Figure 2(a)). Later, they prepared wine samples in different conditions, in which the independent variables were: quantity of grapes, mass of yeast, and mass of sugar added. The dependent variables were alcoholic content, pH, and temperature change. A remote-controlled experiment using a newly developed mobile logger (see Figure 2(b)) was set up in the laboratory, in which the data were measured, and recorded automatically and continuously for two weeks. Students could access the data through their own mobile devices at any time and from any place, and the lecturer discussed the experimental results with the students after two weeks.

Course E was taught by staff Z and dealt with the scientific and socioeconomic aspects of information. Most of the students lacked science-education training in their senior secondary schools. One of the authors of this chapter, Y. Y. Yeung, has developed an app called mobile MMUSE (MultiMedia Utility for Science Education), which enables an Android-based mobile device to record, display, and analyse sound, as well as light, and electrical signals with the use of a modified audio cable (connected to the microphone input of the mobile device) plus a light-dependent resistor, or a copper coil (see Figure 3). There are some experimental worksheets designed for guiding students on how to use this app in a tablet or smartphone to (a) collect, (b) visualize (the waveform and amplitude) and (c) measure the duration, period, or frequency of different sound sources (including tuning forks, musical instruments, or animal/insect voices), of light signals (from infrared remote control or fiber-optic communication), and of electrical signals generated by an electrical generator or by a copper coil when a bar magnet moves across, or passes through, it.

Figure 2. (a) Setup for calibration of alcohol gas sensor and (b) setup for online monitoring of the fermentation process in wine brewing.

(a) (b)

Figure 3. (a) Connection of a copper coil (upper photo), or a light-dependent resistor (lower photo), to the microphone input of a tablet via a modified audio cable and (b) screen capture of the signal displayed in the app called mobile MMUSE.



(a) (b)

After the lesson, a self-developed and validated questionnaire was administered to all the class participants (364 in total), on a voluntary basis. Apart from requesting some background information, the questionnaire (see Tables 1 and 2) consisted of four parts, namely (1) ten questions on the respondents' prior learning experience with mobile devices, (2) seven questions on the respondents' attitudes and views on mobile learning, (3) seven questions on the evaluation of the respondents' e-learning experience in the lesson, and (4) four open-ended questions to collect the respondents' opinions and feedback on the issues of using mobile devices for e-learning, the reasons why they thought some activities were more interesting, suggestions for improvement, and other comments.

3. Results and Discussion

The survey was administered to students in five courses and 269 questionnaires were returned, with an overall return rate of around 74% (see Table 1). The mean score and standard deviation (SD) of all items in each section is provided in Table 2, while the qualitative data collected from the open-ended questions are summarized in Table 3. While the overall mean of the students' prior learning experience with mobile devices is fairly high (2.9±0.8 in a 4-point Likert scale), there are distinctions on the type of experiences. They had much more experience (with mean being 3.31 to 3.38) on searching web information, using a dictionary, encyclopedia or translator, and tools, such as calculator, map, or other educational apps; but less experience (with mean being 2.48 to 2.58) on learning new science concepts through simulation or virtual experiments, or conducting scientific investigations or experiments using the built-in sensor of mobile devices.

The respondents generally (less than 10% of them responded with disagreement or strong disagreement) held very positive attitudes and favorable views on different aspects of mobile learning (with overall mean of 3.6±0.9 in a 5-point Likert scale), except the campus support of their e-learning (mean of 3.16±1.0), which was substantially lower. Regarding the evaluation of the students' e-learning experience in the lessons concerned, the respondents provided a fairly high mean score of 3.5±0.7 (in a 5-point Likert scale and in fact less than 8% of them responded with disagreement or strong disagreement), and responded very similarly across the seven questions (with mean being 3.43 to 3.59) on the attitude-related aspects of learning (interest, stimulation, and motivation to learn), their ability to carry out the activities, their preference for more e-learning activities in other courses, and adoption of e-learning approach in their future teaching in schools. Table 3 summarizes the key feedback provided by the respondents, as collected from the four open-ended questions, on the main reasons for interest, the problems encountered in different types of e-learning activities, and the suggestions for improvement. This information will form a very important reference for future large-scale implementation of mobile learning in this or other teacher education institutions.

Table 2. Consolidated results of the Likert items in the questionnaire survey.

Part	**Content/Aspect**	**No. of questions and Scale**	**Distribution of responses**	**Overall Mean (SD)**	**Cronbach's Reliability α**
1	Prior learning experience with mobile devices	10 questions with 4-point Likert scale	Rarely =1: 5.8% 2: 20.0% 3: 48.8% Frequently =4: 25.4%	2.9(0.8)	0.84
2	Attitudes and views on mobile learning	7 questions with 5-point Likert scale: Strongly disagree (SD), Disagree (D), Neutral (N), Agree (A) and Strong agree (SA)	SD=1: 2.1% D=2: 7.1% N=3: 31.3% A=4: 47.7% SA=5: 11.7%	3.6(0.9)	0.82
3	Evaluation of e-learning experience in the lesson		SD=1: 1.4% D=2: 6.4% N=3: 37.2% A=4: 50.1% SA=5: 4.9%	3.5(0.7)	0.90

Table 3. Consolidated results of the open-ended questions in the survey.

Question Aspect	Category	Opinions or feedback
Reasons for most interesting activities	Programming	Excited with first-time experience in programming. Useful aid for teaching purpose.
	Online quiz	Interaction with teachers and classmates. Can realize the extent of understanding immediately.
	Remote experiment	Can access the process everywhere. Amazing to build such an equipment. The result was interesting.
	Playing simulation apps	Can link up the scientific principle with technological product. Simulation was well illustrated. Step-by-step demonstration.
Problems on e-learning	Instruction	Limited time. Students cannot follow the pace. Limited teaching aids/equipment (e.g. tablets). Not every student can participate. Learning objectives unclear to students.
	Programming	Not experienced users. Unable to connect the Arduino board with the computer.
	Online quiz	Connection to Moodle is difficult sometimes. Mobile devices ran out of power.
	Remote experiment	Require both mathematics and science knowledge.
	Hardware	Unfamiliar with the tablet Android-based operating system and interface. Malfunctioning of the circuit board and of the electronic components.
Improvement or solution to problems	Instruction	Give enough time for students to try. Ask helpers/teaching assistants to provide support and follow the progress of each group of students. Provide more equipment. Make students responsible for specific tasks. Clearly state the learning objective before starting the activities.
	Programming	Provide relevant background materials to students for self-learning prior to the lesson. Provide a clear list of troubleshooting for the problems which may occur in connecting the Arduino board with the computer.
	Online quiz	Tablets provided in-class to students who have problems with connection to Moodle or their own devices.
	Hardware	Adapt the teaching materials or apps to mobile devices of other brands.

Although various difficulties were encountered during the activities, many students enjoyed the lesson. For the activities developed in course A, students were excited because it was their first-time experience in creating apps. Unfortunately, students did not have enough time to further develop their own apps. From their responses in open-ended questionnaire, they enjoyed the MIT app inventor activity, while they found it difficult to imagine adopting it in their future teaching. This might be due to the fact that most of them were not familiar with computer programming. They preferred using scientific simulations or free apps they might develop in their future teaching career, because of ease of handling and infusion of different scientific inquiry processes, such as manipulating variables. For instance, although students in courses B and C had to learn from scratch basic computer programming skills during the construction of traffic light systems, they collaborated to tackle the difficulties encountered. After completing the task, many groups took pictures of their completed traffic light systems to celebrate their accomplishment. Most importantly, through implementing the activities, they developed a better understanding of information technology, as well as its value in teaching and learning. For the remote experiment in course D, for all students this was the first time they performed this kind of experiment and they were happy to use new technology. In the open-ended questions, most of them revealed that it was not very difficult to perform the experiments and they could monitor the process and compare the graphs. Students in Course E considered the activities much more interesting (because of the unexpected findings) than the traditional experiments and they felt it was easier to understand the underlying scientific concepts and principles. Some became very excited in using a mobile device to measure human reaction-time during a game between classmates. However, they also remarked that there was not enough time for so many mobile learning activities.

4. CONCLUSIONS

An array of mobile learning activities was implemented in five teacher-education courses by three different teacher educators. The activities were: (a) app development by students, (b) wiring circuits and programming of a traffic light system based on the *Arduino* micro-controller, (c) *Arduino*-based remote-controlled experiment on wine fermentation and (d) low-cost experiments based on the newly developed MMUSE app. These approaches are innovative in that, as far as we know, no similar activities have ever been adopted in training pre-service or in-service teachers who are not majoring in either computer science or ICT.

The use of *Arduino* and the development of computer apps are probably quite common in many other courses or programmes of engineering or computer science, but the underlying educational context is very different from that of student-teachers who lack the basic engineering or programming training prior to the lesson. It should also be noticed that the teaching staff were not trained engineers nor computer programmers in their own academic disciplines and so they needed courage and confidence to implement those innovative teaching and learning activities in their classes, given the high risk of failure. As reported in the case study above, the educational outcomes of the mobile eLearning activities are qualitatively correlated with the ultimate aim of providing some innovative and hands-on mobile learning experiences (especially the newly-developed experiments for scientific investigation) to student-teachers, so that they will be able to develop different ways of using mobile devices in their future classroom teaching and learning activities. The case studies reported some innovative approaches which were in stark contrast with the elementary, or layman, use of mobile technology in teacher education, as recorded in the literature (Seppala & Alamaki, 2003; Montrieux, Vanderlinde, Schellens, & De Marez, 2015).

As shown in Table 2 (with high Cronbach's Reliability $\alpha>0.8$ for the quantitative findings), students had a fairly good prior level of experience and had positive attitudes and views on mobile learning, even though most of them did not have any academic background in information technology or in computer science. The results were strikingly different from those obtained by Nihat Sad and Goktas (2014) whose findings implied: "An urgent need to grow awareness and further positive attitudes among" student-teachers towards mobile learning. The questionnaire used here also collected students' personal information, revealing that nearly all of them possessed a smartphone and nearly a half of them had a tablet. Combining this information with the fact that there is 100% WiFi coverage within the campus, it could be concluded that it is highly feasible to have a widespread adoption of mobile learning in teacher training programmes. These findings will be compared to those of research involving other university students enrolled in other types of undergraduate programmes (Park, Nam, & Cha, 2012) and will undergo further analysis to uncover the underlying factors (Wang, Wu, & Wang, 2009; Abu-Al-Aish, & Love, 2013). Besides, they could be used to redefine or revise the current research priorities in mobile learning as advocated by Yu-Chang, Yu-Hui, and Snelson (2014).

However, the findings from the students' evaluation of a 3-hour e-learning experience should be viewed as tentative, because students normally need to be exposed to new teaching activities for a few lessons before they can reliably assess the learning effectiveness of these activities. Nevertheless, the students' identification of learning problems and their feedback are useful for future refinement and improvement of the mobile learning activities and teaching approaches, and for integration with remote-controlled experiments (Tho & Yeung, 2015) and community-based science learning (Tho, Chan, & Yeung, 2015). In fact, students have shown a greater level of engagement and collaboration in their learning process, as well as of joy and happiness for the successful completion of their tasks. The educational implications of these findings are that they should be viewed as positive and favorable evidence for the widespread incorporation of innovative mobile learning activities in various teacher education programmes. Subsequently, when the student-teachers graduate to become regular teachers in school, they will have acquired the sort of confidence and competence in the effective integration of mobile learning so as to improve access to education of a mobile world (Ally, Grimus, & Ebner, 2014). Mobile devices will then become a good learning companion of young people, instead of being merely a handy tool for entertainment or social networking, as they are nowadays.

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