Case Studies Of Mobile Applications In Scientific Field Studies

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Abstract

This paper reports research and development focused on two aspects of mLearning. The first involved the design and development of software to facilitate the development of a fully mobile server capable of managing a Local Area Network (LAN). The research component focused on the use of PDAs and smart phones (small mobile devices (SMEs)) for data collection during a geography field trip. The LAN and mobile server provided wireless access to PDAs, smart phones and student notebook computers that enabled seamless uploading and downloading of field data captured by the SMEs. The results indicate that a self-contained mobile server that can provide wireless access to SMEs and notebook computers has a significant impact on student learning. The results of the research also indicate that students with access to such tools make fuller use of mobile devices for both data collection and post-processing of data more efficiently than with traditional pen-and-paper.

***Index Terms*—mobility, field studies, mobile network, mLearning, eLearning, software**

INTRODUCTION

Mobile devices may well define the next era in computing as such devices create a new paradigm between anytime/anyplace availability (ubiquity) and computing capabilities (functionality). Initial mobile technology infancy problems including memory, battery life, connectivity, and CPU speed are being overcome (Kennedy & Vogel, 2007; Rist & Brandmeirer, 2004). Mobile devices also present a different user interface (e.g., stylus-driven rather than more traditional keyboard-mouse), although this is changing rapidly with the advent of 'touch' mobile telephone controlled by gestures with fingers and thumb (e.g., iPhone from Apple Inc. and iTouch from HTC). The growth of computing power in such devices enables many opportunities for learning, notwithstanding screen size limitations. Already such devices are endowed with features and facilities that were in the realm of science fiction just a few years ago, capable of high level multimedia functionality with storage capacity in the multi-gigabyte realm. Connection speeds and CPU processing power have risen dramatically in the last two years. Following these trends, this study focuses on the use of smart phones and notebook computers in a geography field study in a remote location (far north Thailand) by final year high school students undertaking Baccalaureate studies.

Background: mLearning and field studies
This research adopted the conception that mobility is an intrinsic property of learning, encompassing the spatial (university, workplace, home), temporal (days, evenings, weekends) and developmental components (the learning needs/ life skills of individuals which change depending upon age, interest or employment) (Sharples, Taylor & Vavoula, 2005; Vavoula & Sharples,). Student expectations on how and when they learn are creating increasingly heavier demands upon all aspects of their learning, however, the impact of mobile devices in the normal settings of field studies has been limited until recently (Scanlon, Jones & Waycott, 2005). This study focused on two aspects of mLearning. The first was the use of smart phones and PDAs by students to use collecting field data on a geography field study. The second was the use of an innovative Moodle Block that enabled the students using small mobile devices (SMDs) to upload and download files to a central (notebook) server.

THE STUDY GROUP

The study was undertaken with the help of 67 final year students and five of their teachers from a large independent college in Hong Kong. The field trip was intended to facilitate the major assignment to be undertaken by students in the completion of their International Baccalaureate (IB).

The geography field trip was an annual event travelling to Chang Rai in northern Thailand. In initial conversations with the teachers it was established that on prior trips, the three key problems or issues hampering more successful learning outcomes were:

- problems with the student groups sharing data prior to post-processing, particularly the time it required for students to share data from the SMDs in their groups;
- the minimal amount of post-processing of the data collected due issues of data sharing (interviews with the information and communication technology (ICT) coordinator for the field trip indicated that in the previous year, a great deal of time was wasted in moving data from one computer to another by the means of small flash drives); and
- the loss or inadequate data collected by students. (students often didn't realize data was missing or inadequate until arriving back in Hong Kong because so little effective postprocessing had actually been done insitu in Thailand).

The teachers (dot point three above) were obliged to keep a set of 'universal' data for the students who had either not collected the correct data, lost data, or simply had not realized they did not collect sufficient data points until too late. Teachers indentified that the significant part of the problem was the lack of time for students to undertake significant amounts of post-processing.

METHODOLOGY AND DATA ANALYSIS

Given that the research questions in this study are concerned primarily with issues of pedagogy and practice, specifically, the impact of smart phones and access to a Local Area Network (LAN) on the learning outcomes and learning activities of high school students, a mixed-mode case study approach has been adopted where quantitative and qualitative data were collected. A case study approach assumes that students are :

- part of a natural group with common interests (achieving a high grade in the IB);
- all of a similar age and experience; and
- all go to the same college and therefore have shared values and learning expectations.

The research questions were:

1. Does the availability of a LAN have a significant impact on learning during a remote field trip? And
2. Does the use of small mobile devices enhance data acquisition in the field?

The methodology is based upon the generation of a rich set of qualitative and quantitative data to better inform the development of pedagogical and technical frameworks. The multi-modal approach adopted is intended to strengthen the recommendations and generalisations that arise from the project by triangulation of the data generated (Denzin, 1990). The specific types of triangulation to be used in this study are triangulation of the:

- data collection - involving interaction with different groups of students for collection of similar data; and
- methodology - using more than one method to collect the data (the data generating methods used were student interviews, participant observations and log data from the server).

THE TECHNICAL INFRASTRUCTURE

The technical infrastructure consisted of one Apple notebook computer running Apache, MySQL, an open source learning management system (Moodle), and a special purpose-build Moodle block that enabled wireless mobile devices to connect directly to the server and the Moodle environment. The Moodle database provided the Single Sign On (SSO) for students and allowed them to be grouped into their specific groups (as assigned by the teachers prior to leaving Hong Kong).

The design of the technical system is shown in Figure 1 below. In addition, based upon a request from the ICT coordinator one very specific application was developed for one of the required social geography tasks. Students were required to map the flow of traffic and pedestrians around the central business district of the city. This required a considerable amount of coordination and data sharing between the groups. Individual groups would be assigned a particularly street corner and time. The students would then count the numbers and types of vehicles and pedestrians in a given

time period. An application was developed for the SMDs called iCount. Figure 2 below shows the interface of the iCount, while Figure 3 shows the students collecting data on a street corner. The method used was generally for two students in the group to call the pedestrians and vehicle type and number while the third student recorded the data. The iCount simply allowed students to count by tapping the screen next to the object being counted. The saved file was exported as a .cvs file and could then be downloaded from their SMDs to their group areas on the Moodle system for further analysis with MS Excel on notebook computers.

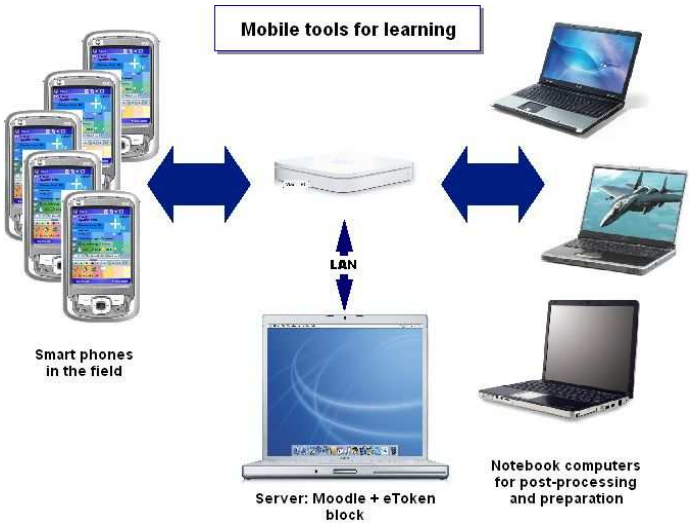

Figure 1: Infrastructure of the LAN system and server

Figure 2: The iCount application

As can be seen in Figure 1, the server provided the link between the SMDs and their notebook computers.

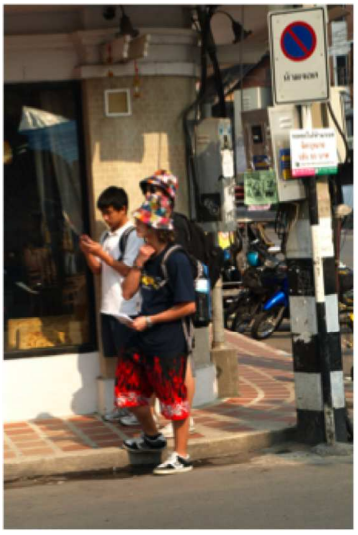

Figure 3: Students using the iCount

The final specific assigned use of the smart phones was an Excel file into which students were required to input data about river flow volumes as they measured depth and flow rates. See Figure 4 for an example of students using the devices for collecting data.

Figure 4: Students collecting data using small mobile devices.

In addition students voluntarily used the voice notes application, took short videos of processes and occasionally used the smart phone for photography (but this was less common because of the proliferation of digital cameras the students brought with them to the field trip, see Figure 4).

THE STUDY GROUP

Students used notebook computers and smart phones to undertake a range of activities during their field trip. In the field smart phones were used. Once back at the campsite data was transferred quickly to their notebook computers. The use of the smart phones for data collection purposes was driven by a myriad of factors, including:

- teacher perceptions of the use of using the SMDs (was it encouraged or discouraged by individual teachers?);
- students attitudes and confidence in using technology for non-social activities (in this case, collecting data); and
- availability of the devices (only 1 between 4 students was possible or one per group).

It was expected that the students would need minimal exposure and training to the use technology. However, it was observed there is a gap in the students' knowledge. Specifically, the technical knowledge to configure a mobile device in order to communicate with a wireless network. For example, during one evening on the third day one of the students said when interviewed about using the LAN:

'I didn't really know how to connect in the first place. I didn't realize that the connecting machine was in this room.'

This was after two days of observing other students connecting to the LAN and working on the post-processing of their data. While the students were very skilled at using the features of the mobile phones (e.g., voice notes, camera, and games), they were less than confident with configuring the wireless settings necessary to allow the mobile device to communicate with the LAN. This pattern of a lack of in-depth knowledge of how the SMDs actually worked was repeated over the entire three days of the field trip. It was necessary to direct students to small help files on the storage cards of the smart phones (either in the form of Word for Mobile devices or PowerPoint for mobile devices). However, the devices were used very significantly for data collection by students.

THE DATA GENERATED

In total, 20 individual student interviews were carried out during a three day period. The interviews consisted of short discussions with students about the use of (a) the iCount tool for traffic analysis, and (b) the use of the LAN during the evenings for sharing and processing the data collected during the day. In addition, the researcher made a number of videos (with audio) using a digital camera, observing the students during their river and urban geography studies, voice notes on the smart phone when a camera was not appropriate and post-trip interviews (email) and face-to-face with the teachers. In addition the access logs from the server were examined to determine the frequency and student access (who) to the server.

DISCUSSION AND CONCLUSIONS

The interviews with the students produced some unexpected results. They were universally very positive about the access to the Moodle/ LAN system because it was the same environment that they used when at school. It was therefore deemed to be useful, but not fundamentally different and therefore not really worth mentioning or commenting about very much. It just *was*! It has been remarked (Prenski, 2001) that digital natives take being connected for granted and what the students really wanted to know was if the LAN could connect to the internet and if not, why not? One of the most interesting comments made by 40% of the students interviewed was the fact that the LAN in Thailand was 'just as fast as it is at school' so an awareness of bandwidth and wireless speed would seem to be part of their consciousness although students did not describe it in those terms. The logs of the Moodle block were also examined.

In all, there were more than 1300 accesses to the server in just four days from 60 of the 67 students (based upon username access). Accesses included download files (e.g., resources (PowerPoint templates, files for SMDs for use during the day, Excel templates for data processing)) were examined and/or downloaded the sum total in excess of of 540 occasions). Although there were only 35 notebook computers, students shared hardware with each other and 60 individual students actually logged on. The most accesses of resources, reading updates of files or just commenting on the reflective diary by a student involved 88 logged events, but this is most likely to represent the activity of the group (up to four members). What is clear is that the availability of working in ways familiar to the students enhanced data sharing and post-processing (see teacher comments below).

All of the students agreed during the interviews that access to the LAN and the ability to share and exchange files was a very positive support for their learning and subsequent processing the data. Participant observations by the author moving around the two areas used each evening by students showed that students worked very diligently at processing the data using Excel, preparing a Photostory (an assignment for presentation when they returned to school), and engaging with the specific writing tasks assigned by the teachers.

Most teachers were extremely positive after the event, although not all were initially. In initial informal discussions at least two teachers did not see the value in using technology for data gathering, preferring instead to use more traditional pen-and-paper methods (clipboard). However, their perceptions were different in regard to the availability of LAN and Moodle server after the field trip had been completed.

In the initial part of this paper three concerns arising from previous field trips were identified by teachers. Example statements after returning to Hong Kong from teachers included:
From a technology-negative teacher;

> *The sharing of information on fieldtrip is usually very tedious, time consuming and boring. The shared server makes that process much quicker and thus we can actually get down to the analyzing of data!*

From the field trip leader (teacher);

> *Makes a more direct connection between the work and the end result (the coursework) as students can see the direct connection between the collection, collation and analysis of the material.*

From the IT coordinator and teacher;

> *The ability to sideline the paper, for the lower-level/ order tasks has a lot of benefits. To have data in the field that they could analyse to a higher level, than they could previously.*

The evidence suggests that while learning outcomes may not have changed, the perception from the teachers suggests that students were more engaged, processed the data more quickly and accomplished more (on their final report) while still at the field study site than had been previously achieved in the past.

LIMITATIONS

One of the problems identified in the study was the need for an FTP server and more storage space. The students took 1000s of digital photographs to help them present their findings and storage became an issue. The LAN system used in this study did not support the upload of gigabytes of data as requested by students. Additionally, there was no access to final grades achieved by the students for their final IB assessment due to privacy regulations of the school. As such it is difficult to sustain that the use of technology has actually changed the learning outcomes. However, there is evidence that access to technology changed the ways in which students worked during the field trip, allowed many students to complete the processing of key data before returning to Hong Kong, and facilitated better communication within and between the groups.

CONCLUSIONS

The use of mobile tools has been shown, at least at the behavioural level, to change the actions of students engaged in geography field studies. Students exhibited more focused behaviour in collating, analyzing, and presenting the data generated during their daily activities in the field. Interviews with teachers confirmed their view that the behavioural change during the field trip was fundamental and no serious problems (e.g. were experienced when the students returned to Hong Kong. The initial problems identified in the past by the teachers were not present in this study. From the students' perspective, the use of mobile tools for collecting and collating data was just a reflection of the 'normal' way in which they were used to working, as one would expect from digital natives.

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