Evaluating the Effectiveness of m-learning in the Teaching of Multi-media to First Year University Students

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***Abstract*— This paper describes an experiment in which we attempt to gauge the effectiveness of m-learning. This is achieved by comparing the teaching of introductory multimedia concepts to first year computer studies students by using, on the one hand, traditional teaching methods, and on the other, a teaching situation that incorporates m-learning. An m-learning based instructional system was developed and used to present a number of multimedia topics to a group of first year students. A second group was taught the same topics in parallel by traditional methods. The two groups were matched for similar pre-knowledge of the subject matter. Post testing revealed that the m-learning group scored significantly higher than the group taught via the traditional method. Further testing also demonstrated that the retention of specific subject knowledge was better in the m-learning group.**

***Index Terms*— instructional design principles, learning theories, mobile device, mobile learning**

I. Introduction

Mobile technologies are a familiar part of every day life. Ever increasing numbers of the population carry a mobile phone, own a computer or have access to the internet at home. These technologies provide location independent and immediate communication between people, and instant access to the vast library of information available on-line. Furthermore, these technologies are available 24 hours a day, 7 days a week. For example, a student no longer has to wait until the Library at his or her University opens in order to find the answer to a particular question; the student can search the WWW for the required information at a time that is convenient to him or her.

However, this same student will also be expected to participate in the traditional classroom based delivery of learning by attending lectures and tutorials at a fixed time and place. Therefore, to also be able to learn at any time and any place would be a fundamental paradigmatic shift from the way learning is conventionally delivered today in the teacher centred classroom based scenario. [6] in the article 'Mobile Learning for Kids' gives some examples of other significant paradigm shifts, one of which was when people moved from listening to the radio to watching television programs. It is therefore no surprise that mobile technology is causing yet another paradigm shift.

Learning at-the-time-and-place it is needed allows for learning that has far greater context and relevance. For example, a student studying the environmental features of sand dunes could access pertinent information on a mobile device while on a field trip, and develop annotated notes for later use. Surely this is a learning approach that involves the student more fully and directly with the identified subject matter. Research has shown that learning takes place when the information being given can be contextualized and as such, will acquire personal meaning and relevance to the learner.

The m-learning organisation, an EU funded project, defines m-learning as -

> *Using mobile technologies (such as mobile phones and hand-held computers) to enhance the learning process*
>
> http://www.m-learning.org/which.shtml

Mobile devices are excellent interpersonal communication tools bringing the opportunity for students to interact with each other in order to resolve problems and to develop research skills. In addition to acting as an aid to teaching and learning, there are many other potential advantages of using mobile devices in the organization and administration of educational activities. The disadvantages of using mobile devices are limited to issues concerning the loss of the mobile device and ad hoc connectivity problems.

[3] identified m-learning as 'just in time' learning where the student is using a mobile device to access only the 'chunks' of information required to complete a task. The limited screen size of some mobile devices make the reading of large sections of text impractical and therefore this 'chunking' of relevant information becomes even more important. The design and presentation of these 'chunks' of information and its ease of accessibility on a mobile device will be very different from the text based information that is provided to students in a traditional classroom based environment.

The design of m-learning environments must therefore make use of alternative methods of presenting information; the use of multimedia tools and techniques are very effective for this purpose. Therefore, the m-learning environment will focus less on content and more on process and it will use techniques that are difficult to use in a traditional classroom environment (for example, simulation) [5].

II. M-LEARNING SYSTEM – IMPLEMENTATION OVERVIEW

The key objective of this investigation was to support mobile learners, in particular those who have a mobile phone at their disposal. The aim was for learners to be able to continue learning on the move, using the developed m-learning system and assess the effectiveness of this approach to learning, comparing students' performance from a traditional situation to performance of students whose learning was supplemented with an m-learning element.

An m-learning system which can be accessed by mobile devices has been developed incorporating proper learning theories and instructional design principles as presented by [8] and [1]. The m-learning system was implemented using the latest Macromedia Flash and Rich Internet Application (RIA) Technologies using a traditional client/server side configuration (see Fig. 1). The system is compatible with most mobile devices capable of supporting playback of the Shockwave Movie file format. This allows the m-content to be accessed by various mobile devices (from a typical 3G mobile phone and palm sized computers to tablets and laptop computers) utilizing a range of wireless technologies (e.g. Bluetooth, Wi-fi, GPRS and 3G). For the purpose of this paper the design and implementation has been targeted to a limited number of mobile devices.

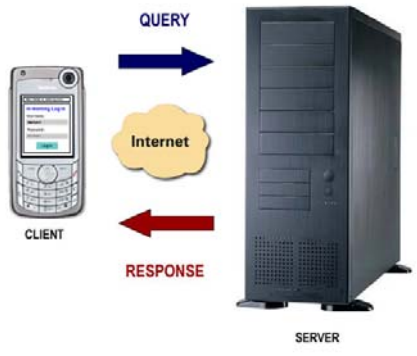

Figure 1. Client/Server architecture model

In developing the m-learning system within a Flash based environment this offers a number of key features and benefits which include:

- Easy to use graphical user interface
- Fast and efficient to access
- Compact m-learning environment for economical delivery
- Compatible with a large number of mobile devices and browsers
- Feature rich combining text, graphics, audio and video content
- Interactive allowing the user to respond to events and feedback.

Another advantage of developing an m-learning system from within a Flash based environment is the relatively small output file sizes. This is important for the fast delivery and low cost of transferring data to a mobile device since the time taken to download content remotely is still restricted by current wireless communication benchmarks e.g. 3G and General Packet Radio Service (GPRS).

For the purpose of this research the mobile hardware and data call charges were met by the Mobile Computing group within the faculty which has a dedicated 3G network.

The system is hosted on a web-server running Apache which serves an RIA to the clients mobile device made accessible through a URL location. User log-in and authentication is handled via a MySQL database connection which is administered externally using PhPMyAdmin.

III. OPERATIONAL OVERVIEW

An overview of the operational procedures of the system is shown in Fig.2.

The m-learning system is accessed using the standard 'http' protocol by pointing the mobile device's web browser at a specified URL location (a). Once a user logs into the system, making use of the devices input method, they are presented with a navigational menu that provides a link to the subject's course material, access to a quiz, and finally a link that provides statistical feedback on a student's performance (b). The course material sections (c & d) provide the student with a feature rich environment containing minimal text [4] and simple navigational features with audio and video content. Once a student has finished studying a section of course content they can then proceed to attempt the quiz (e) and undergo formal assessment (f). The results are then stored within the MySQL database, which can then be accessed via the feedback page on the mobile device (g).

IV. INVESTIGATION

The study involved a class of first year Computer Studies degree students within the faculty at the University of Glamorgan. The study was carried out over a 6 week period. The aim of this investigation was to attempt to assess the effectiveness of m-learning when used to

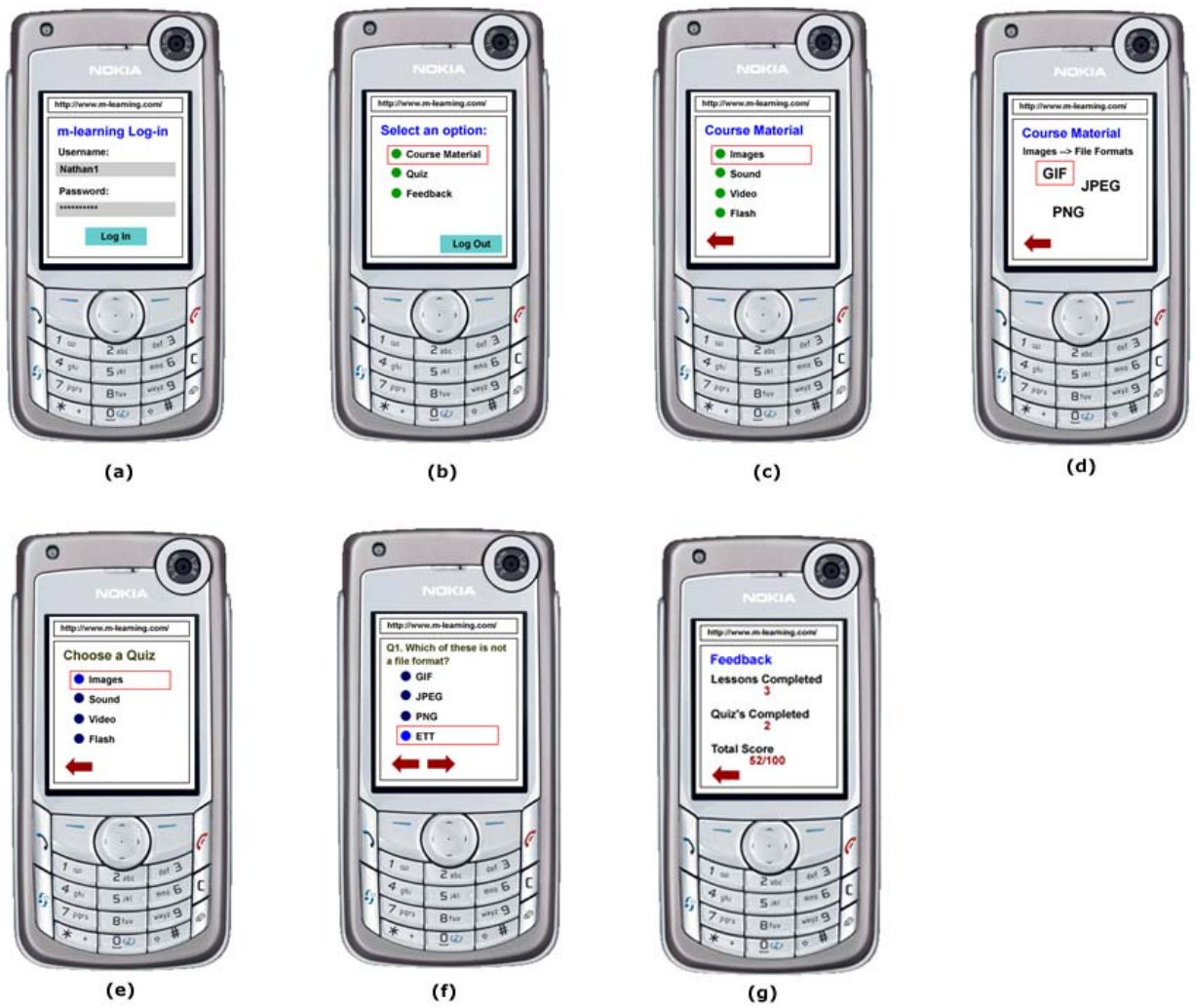

Figure 2. Overview of m-learning application

augment the traditional leaning environment to a so-called "blended learning" structure [9].

This means that the lecturer is no longer the only focus of the learning environment. For the purpose of this study effectiveness was assessed by student performance in pre and subsequent post tests.

Using an m-learning application means that the learner has far more control over their learning experience. Pre-study, the potential advantages held by the m-learning students were thought to be:

- m-learning would be available 24 hours a day
- m-learning would not depended on the location of the learning environment
- m-learning would facilitate learning on the move
- m-learning would provide an additional focus to a traditional learning environment.

V. EXPERIMENTAL DESIGN

A sample of 40 first year degree students studying the module 'Principles of Multi-media' were selected to participate in the study. The student sample was divided into two groups matched on pre-knowledge of the multimedia subject material presented.

One group (the control) was taught via traditional teaching methods only, whilst the other group (test) was taught with the support of the m-leaning application.
The independent variable is the teaching treatment.

A. Hypotheses

An important consideration of this investigation was a comparison of the effectiveness of the m-learning teaching against the traditional learning environment. Furthermore it was hoped that the results justify an extension of the use of mobile technology within the school. For the purposes of this study effectiveness was defined by student performance during the testing procedures.

Three null hypotheses were tested, H_{0A}, H_{0B}, H_{0C}.

H_{0A} – There will be no initial difference between the Control and Test groups prior to post testing.
H_{0B} – There will be no difference between the Control and Test groups after Post Test 1.

H_{0C} – There will be no difference between Control and Test group after Post Test 2 (retention).

B. *Testing procedures*

The testing consisted of three phases. An initial test was given to assess the subject knowledge of the subject matter to be presented. The purpose of this test was to allow for the division of the sample into two groups, a control group and a test group, both matched for pre-knowledge of the multimedia subject material. A post test was administered at the end of the investigation period in order ascertain the extent of knowledge acquisition of the presented material. A second post test was given to both groups in order to assess retention of the subject material. The control group was taught in a traditional lecture situation, supported by a one hour tutorial and teaching materials available on the University VLE. The test group was also given this standard teaching and support, but their teaching was supplemented via an online m-learning system that was available on a number of specified mobile devices. The m-learning system was password protected to restrict access to the m-learning group only.

C. *Learning Flow*

A simplified view of the learning process presented by the traditional teaching strategy is that the student acquires knowledge regarding the presented subject matter by receiving learning information from his/her lecturer supported by teaching material and the academic environment. These facets constitute the learning environment. The learner may collect, classify and stores the learning material for later recall. The lecturer provides a human focus for the learning process controlling, to a certain extent the progression and quality by providing guidance and responding to student feedback to modify the teaching process. The m-learning system provides an addition focus of a two way flow of learning information between the student and the learning environment. It was also perceived that the use of mobile devices for learning purposes would increase interest in the learning process and hence increase the effectiveness of the mobile involvement.

VI. RESULTS

This section presents the statistical results obtained from the investigation. The data collected was concerned with making:

(i) an assessment of the effectiveness of the two teaching treatment.
(ii) an comparison of the effectiveness of two teaching treatments .

For effectiveness, the performances of students in the pre and post tests are presented below.

A. *Pre-testing*

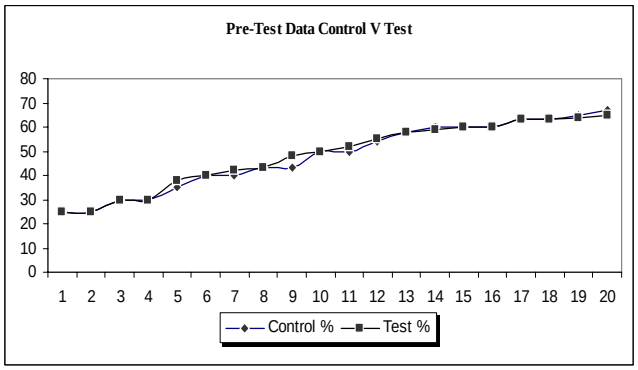

Figure 3. Pre-test Control vs. Test Group

TABLE 1.
Pre-Test Control vs. Test Group Results

Group	Mean	Standard Deviation
Control - traditional environment	48.05	14.01
Test - using m-learning application	48.50	13.57

TABLE 2.
Paired t-test Results

Paired t-test	-1.99
Probability value	0.061

The above results show that hypotheses H_{0A} can be accepted (t=-1.99, p=0.061) showing that there is no difference in composition between the control and test group base on initial student performance. Students performance issues determined by pre and post test score are illustrated by the calculated means of user scores along with the relevant standard calculations in the tables below.

B. *Post-test 1 – Control vs. Test Group*

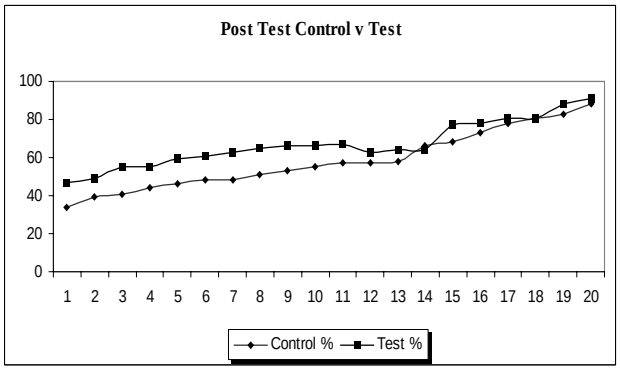

Figure 4. Post-Test Control vs. Test Group

TABLE 3.
Post-Test 1 Control vs. Test Group Results

Group	Mean	Standard Deviation
Control - traditional environment	58.40	15.71
Test - using m- learning application	64.50	9.29

TABLE 4.
Paired t-test Results

Paired t-test	-6.33
Probability value	0.001

The results (t=-6.33, p=0.001) show that hypothesis H_{0B} can be rejected (p<0.05) showing there is a significant difference in the performance of the two groups. This result it can be accepted to be due to the teaching method.

C. Control Group, Before and After

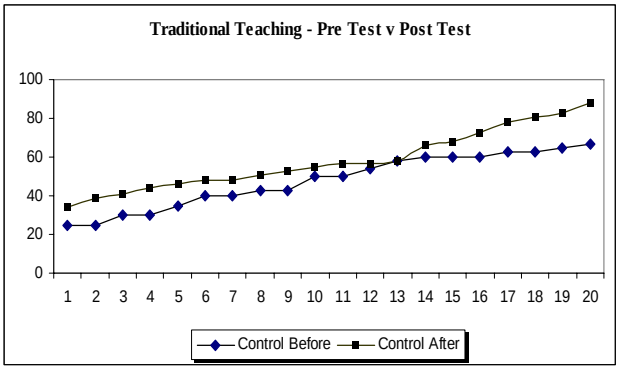

Figure 5. Post-Test Control vs. Test Group

TABLE 5.
Traditional Teaching Results

Traditional Teaching	Mean	Standard Deviation
Control group - Pre-test	48.05	14.01
Control group – Post-test	58.40	15.71

D. Test Group Before and After

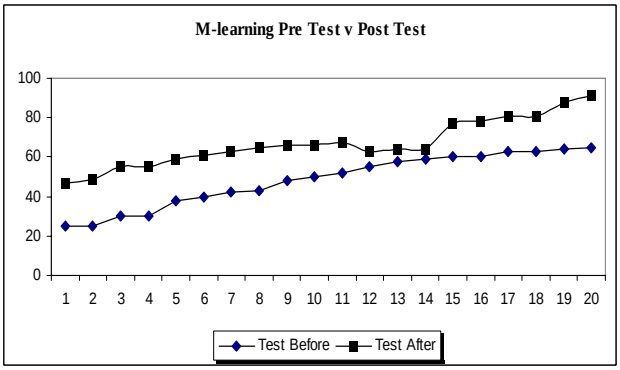

Figure 6. Test Group vs. Post Test Results

TABLE 6.
m-learning Results

m-learning	Mean	Standard Deviation
Test group - Pre-test	48.50	13.57
Test group – Post-test	64.50	9.29

E. Retention Test

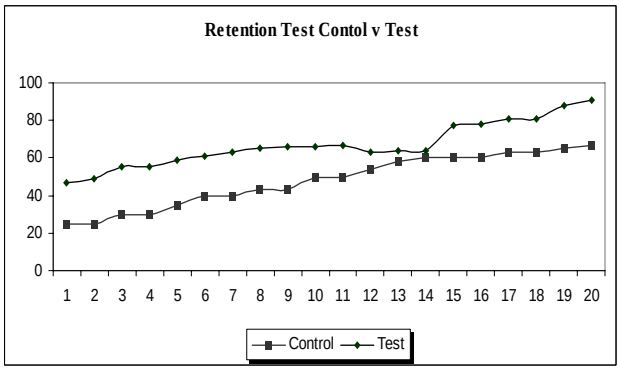

Figure 7. Retention Test Results

TABLE 7.
Retention Test Results

	Mean	Standard Deviation
Control group - Retention test	50.22	12.30
Test group – Retention test	64.50	9.77

TABLE 8.
Paired t-test Results

Paired t-test	-10.9
Probability value	0.0001

The results (t =-10.9, p=0.0001) show that hypothesis H_{0C} can be rejected (p<0.05) showing there is a significant difference in the performance of the two groups. This result it can be accepted to be due to the teaching method.

VII. DISCUSSION

The results of the analysis show that whilst there was initially no difference in the performance of the two groups at the pre testing phase of the investigation; subsequent testing revealed differences regarding the performance of the students for both phases of post testing. Thus illustrating that the addition of the m-learning application to the learning environment improved knowledge of the subject material presented. It can be also seen from Table 6 and 7 that when the teaching process is considered, the percentage improved in student's mean score were greater when the m-learning component was added.

The second post test was applied to determine whether the m-learning had any effect on the retention of the subject material after a time lapse of two weeks. This is where the greatest difference between the groups was observed (Table 7).

If time had allow it would have been interesting to keep applying the post test to see if this effect persisted are if it would drop off with time. The traditional teaching model concentrates on presenting learning material and therefore there is limited tutor time available outside

timetable periods to consider issues related to understand the material. M-learning is not restricted to time or location and therefore students can access a learning environment on the move and review the learning material at any opportunity and use this environment to test both their knowledge and understanding of the learning material.

VIII. CONCLUSION

The m-learning project conducted by the Learning and Skills Development Agency reported that -

Mobile learning can make a useful contribution to attracting young people to learning, maintaining their interest and supporting their learning and development [2]

The report also identified that the learners were more focused for longer periods of time and that m-learning removed some of the formality of traditional learning. M-learning also helped to raise the learners self confidence in their ability to approach tasks and to discuss issues with others in their group.

This was a small scale study over a short period of time and detractors could argue a Hawthorne Effect. However, the results of the study are encouraging and show m-learning components are worthy of further consideration in the Higher Education Curriculum as students need to develop effective study skills very quickly. Students also have to cope with an increasing variety of teaching methods including lectures, practical sessions, distance learning [8]. This increasingly flexible approach to study means that students in higher education have to manage a significant set of learning resources, teaching and assessment methods. The results of the study show that m-learning can help students to become more effective in managing their time and to develop study habits that result in improved learning.

REFERENCES

[1] Ahonen M, Joyce B, Leino M and Turunen H, (2003). Mobile learning: a different viewpoint. In H Kynäslahti and P Seppälä (eds) Professional, mobile learning. Helsinki: IT–Press, 29–39.

[2] Attewell J. (2005). A technology update and m-learning project summary. Technology Enhanced Learning Research Centre Report, www.LDSA.org.uk

[3] Freyson J (2004). M-learning: an educational perspective. M-learn 2004 Conference, Rome, Italy.

[4] Miller GA (1956). The magical number seven, plus or minus two: some limits on our capacity for processing information. Psychological Review, 63, 81–97.

[5] Oblinger D, Resmer M and Mingle J. (1998). Student Mobile Computing taken from The Future Compatible Campus: Planning, designing & Implementing Information Technology in the Academy. Bolton, MA, USA.

[6] Sanreget Bob, Mobile Learning for Kids, Last accessed: Jan 2006 http://hotlavasoftware.com/newsdesk_info.php?newsdesk_id=100

[7] Sharples M (2002). Disruptive devices: mobile technology for conversational learning, International Journal of Continuing Engineering, Education and Lifelong Learning, 12(5/6), 504–520.

[8] Sharples M, Chan A, Rudman P Bull S (2003). Evaluation of a Mobile Learning Organiser and Concept-mapping tools. Learning with Mobile Devices – a Book of Papers 2003, Learning Skills & Development Agency.

[9] Stockley D. (2003). Blended learning or training - definition and explanation, Last accessed: Feb 2006 http:/www.derekstockley.com.au/blended-Learning.html

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