

# A new m-learning application designed for self-assessment

## Nueva aplicación m-learning diseñada para la autoevaluación

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### Abstract

This paper presents a new mobile application designed for use as a self-assessment tool. Learners are able to perform computerised tests using their mobile phones wherever and whenever they want. The tool also includes a Web interface. Impact on the learners' performance is measured using quantitative tools. Three experimental groups of learners were selected, aged 14-15, 17-18 and 20-21, in order to measure the impact on their academic achievement.

### Keywords:

e-Learning, mobile learning (m-learning), secondary education, tertiary education, self-assessment.

### Resumen

Este artículo presenta una nueva aplicación para móviles diseñada para usar como una herramienta de autoevaluación. Los estudiantes pueden realizar los tests usando sus teléfonos móviles en cualquier lugar y momento que deseen. La herramienta incluye también una web. El impacto sobre los resultados de los estudiantes se ha medido usando una herramienta cuantitativa. Se han seleccionado tres grupos experimentales de estudiantes de edades entre 14 y 15, 17 y 18 y 20 y 21 con el fin de medir el impacto de la experiencia en sus logros académicos.

### Palabras clave:

e-learning, m-learning, educación secundaria, educación universitaria, autoevaluación.

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## 1. Introduction

With the new «anytime, anywhere computing» paradigm (ubiquitous computing), a shift from «electronic» to «mobile» services has begun. Just as e-commerce has extended to m-commerce, e-learning now includes m-learning (mobile-learning) (Lehner and Nösekabel, 2002). In the field of teaching and learning, the expected benefits of this new mobility include, among others, a more efficient instruction along with an improvement in the learning outcome. Within this framework it is crucial to create new tools that add value to the teaching-learning process, but it is also important to assess its performance with tools that allow us to exert some control over the expected learning action achievement. Within this context, this paper presents a new mobile application designed for self-assessment. It allows students to test their knowledge and expertise in a specific topic using questionnaires designed by their teachers. Young students use mobile phones as an integral part of their daily lives and consider them a crucial element in their communication activities. So it is important to provide them with learning tools that work in this mobile environment because this may increase their motivation to learning. However, it is not enough to have new tools, they must be integrated into learning actions and their usefulness must also be measured. For these reasons, this paper also describes the actions undertaken to test the new application in three different environments. Three groups, of different ages and levels, were chosen for experimentation and analysis. In section 2, the mobile application and the system that provides the appropriate support to the learning action are presented. In Section 3, we describe the experiments that were carried out; and finally, Section 4 includes the results, analysis and conclusions.

## 2. The System

A web based system was designed and built to support mobile self-assessment in traditional class-based learning. The architecture (figure 1) comprises three different systems: (1) A web server to store, deliver and evaluate online tests. (2) The mobile application that students employ to connect to the server, download questionnaires and complete them. And (3), a web based front-end that offers different functionalities to each kind of user. The later may be used by students to complete their tests. Teachers may use it to configure questionnaires and to review the students' achievement. An administrator's role also exists and his/her responsibilities are related to user (students, teachers and other administrators) management.

The system was developed using Java technology (JME for the mobile application) and XSLT transformation sheets. This latter technology makes it easy to adapt the output

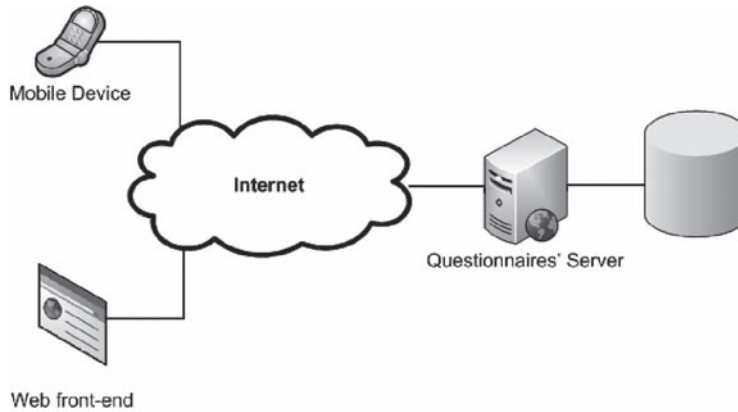


Figure 1. System Architecture

that the web and mobile system require. The mobile application was tested on a number of devices in an attempt to cover as much of the available spectrum as possible. Mobile devices must be java-enabled to run the applications, and they must also provide some form of Internet connection technology (e.g. GPRS or UMTS).

Every student is provided with a login and password to use both the mobile and web application. First they must connect to the server and then a list of all available subjects and tests is displayed. They can complete any of the available tests, get their results and review their answers (figure 2). The Web application includes the same features. The only difference is that all the questions are presented in a row (figure 3).

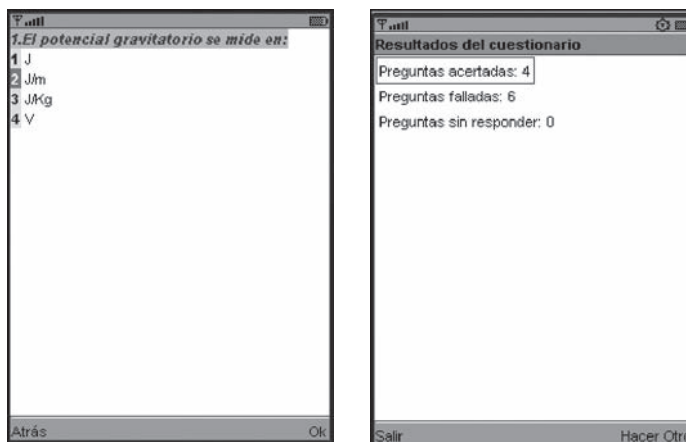


Figure 2. Mobile Application Screenshots (in Spanish). Left-A question, Right-Post-test results.

Teachers can upload and configure tests. One important feature of the system is that it supports IMS Question and Test Interoperability (QTI) specification (IMS, 2006): internally the system stores and manages all tests and questions in that format. QTI is a widely adopted specification that ensures interoperability between systems. In this way created tests that conform to that specification can be moved to any other compliant system. The QTI specification supports a wide range of question types including multiple-choice, gap fill, order, association and open answer among others. At present, the mobile application only supports multiple-choice questions. So teachers must design questionnaires comprising only this kind of questions. The number of answers per question may vary depending on the number the teacher deems necessary. Teachers can also review the students' achievement: the personal scores of each student are stored.

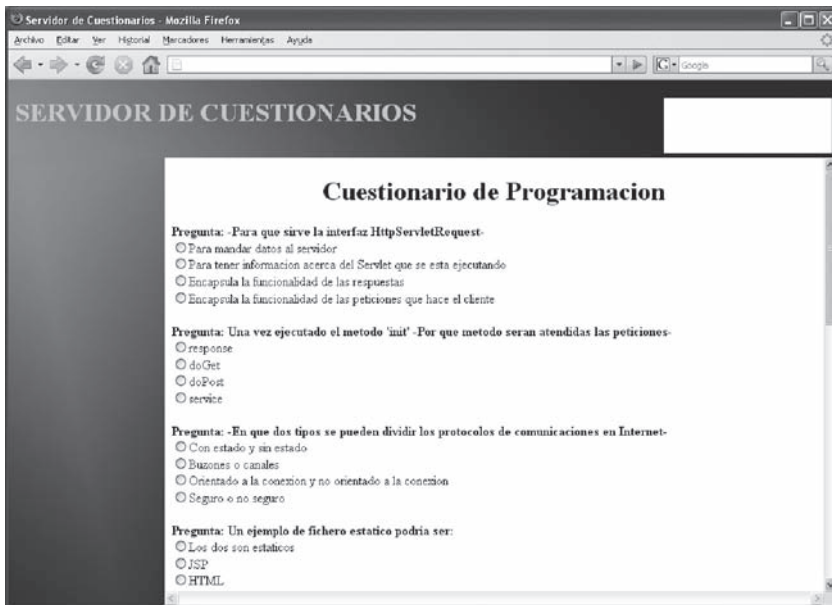


Figure 3. Web application for the students (in Spanish).

The developed architecture and systems are easy to install, deploy and maintain. This ensures that the costs of using them are affordable to many institutions. On the other hand, the features offered are limited. This will make it difficult to employ our system as the sole or central part of a learning action. Indeed it is designed to be used as a complementary system that may be included within new or currently running learning actions. But, in any case the fundamental architecture and technologies that have been used also ensure that it may be extended quickly at low cost. We are going to give just

one example. QTI questions and tests are stored and delivered using an XML dialect. The use of XSLT technology means it is easy to transform XML data to any output (user-readable) format, such as that used by the mobile and web applications (please note that from a technological point of view the two latter formats are rather different).

## 3. The Experiment

### 3.1 Learning Actions and Experimental Groups

Our aim was to test the improvement that mobile assessment produces in the achievement of students at different levels, so we decided to choose three different experimental groups; two of them were at secondary school level and the third was at university. The first group was taken from the Technology course during the third year of compulsory secondary education (learners aged 14-15). The second experimental group was drawn from a Physics course from the sixth (and last) year of secondary education (scientific branch). The learners were aged between 17 and 18. And the third group were taken from a Nursery course in the third year of a Life Sciences degree (learners aged 20-21).

The next step was to arrange the subjects being assessed in each course into a set of learning objectives. The group of teachers designed a self-assessment test with ten questions for each learning objective. Single choice questions with 4-5 options were employed. Questionnaires were later adapted to conform to QTI specification and uploaded to the web server. Teachers and students were finally provided with their login and password.

### 3.2 Realisation of the Experiments

The mobile learning tool is designed for self-assessment, so the obvious way to distribute it is to make it available to every student so they can install the application on their mobile phone. Each group of teachers was also temporarily provided with a set of five pre-configured mobile phones so that they could schedule different sessions in which the students were able to use the devices to perform their self-assessment. Two sessions (50 minutes per session) were scheduled for each class group. During these sessions the students had assistance from their own teacher and also from technicians that specifically attended these sessions. Finally, students could also use the web front-end to access the questionnaires from any computer with an Internet connection and a Web browser if they preferred this method.

Students were graded using the method that each teacher traditionally employed according to their personal preferences and experience, but also to the requirements imposed by his/her own institution or any other public regulations. Examination methods include papers and exams in all cases, and practical tests on the nursery course. Final grades were also provided by the teachers; in their computation every module was assumed to carry the same weight. Experiments and grading were carried out during the 2008/2009 spring term, and all the aforementioned learning objectives were part of the course syllabuses taught during that semester. It is also important to mention that control groups were selected from the same institutions, taking care to choose those that had demonstrated a similar achievement (so far) to the experimental group. This selection was an easy task because all the teachers had performance data from the previous semester.

## 4. Results

The students' achievements were compiled into sets of defined learning objectives for each experimental and control group. They were also normalised to a 0-1 range. It

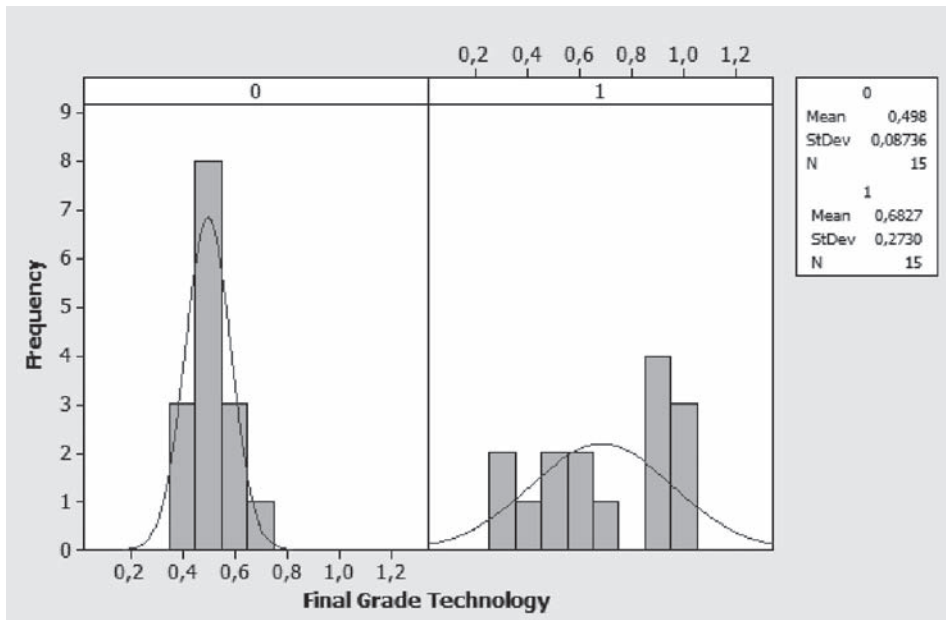


Figure 4. Histogram of the Final Scores for the Technology Group (N=15)  
0-Control Group, 1-Experimental Group

should be noted that, in accordance with our national system and after this normalisation, a final qualification of 0.5 or greater is a successful grade. Figure 4 includes a histogram with a visual representation of the students' final grade for the *Technology* course along with a summary of the descriptive statistics. The mean value of the experimental group returns an important improvement in the final grade (18.5%). Variability shown by SD is below 1/2 the overall mean (around 1/4 of the maximum possible score) and it remains constant for both groups: 41.8% of the overall mean for the control group and 40% for the experimental group (for the final score in both cases).

Results for the *Physics* course are summarised in Figure 5. In this case an improvement in the mean is also observable, but it is more moderate. The variability is low, since SD is little more than 1/3 above the mean in the worst case, which is about 1/5 of the maximum possible score. For the global score SD represents a 33.68% increase above the mean for the control group and 27.46% for the experimental group.

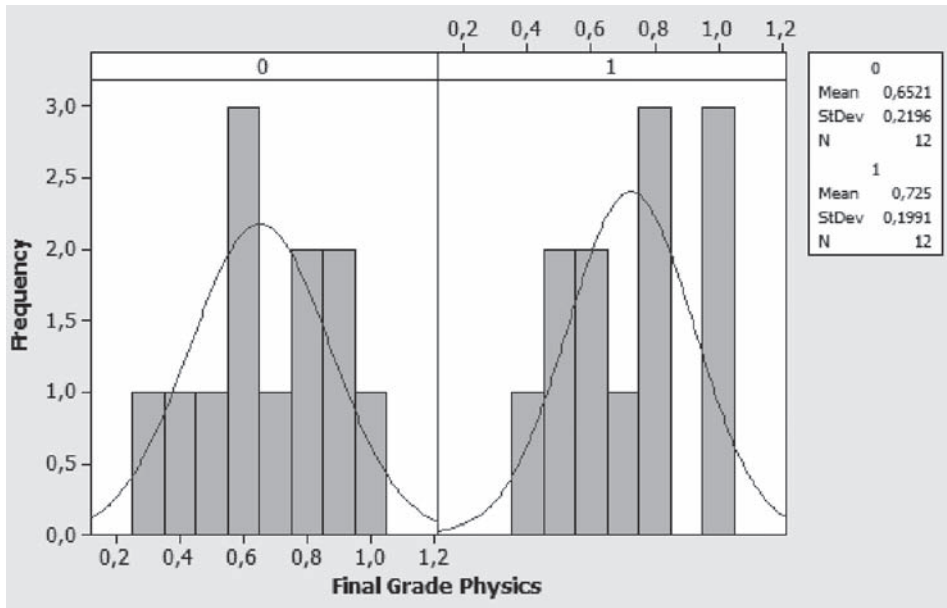


Figure 5. Histogram of the Final Scores for the Physics Group (N=12)  
0-Control Group, 1-Experimental Group

As for the *Nursery* course, results are shown in Figure 6. The final mean score is increased to 7.11%, while the variability remains low: SD is 29.69% above the mean for the control group and 23.66% for the experimental group. The variability observed for

each learning objective is also low since the SD is around 1/4 of the maximum possible score for the control group and around 1/5 for the experimental group.

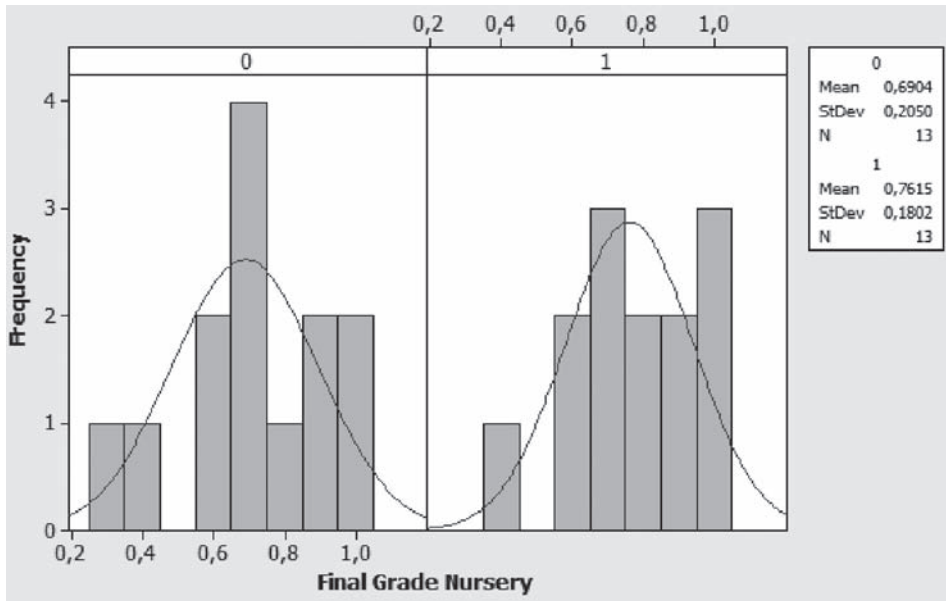


Figure 6. Boxplot of the Final Scores for the Nursery Group (N=13)  
 0-Control Group, 1-Experimental Group

## 5. Conclusions and future work

A new system for m-learning which consists of a mobile application for students' self-assessment, the server side and a web front-end are presented in this paper. Its conformity with current specifications is a remarkable feature of this system, since it ensures that the questionnaires designed for it may later be moved to any other compliant system. Three courses of different education levels have been adapted to include support for this tool, and different sessions were scheduled to test its usability, usefulness and performance. The students' achievement for various learning objectives of these courses was collected for statistical analysis. Results show that there was an improvement in the students' achievement in all cases.

As for future work, 3D applications have demonstrated their learning potential (Chittaro and Ranon, 2007), and the use of 3D technology for mobile devices as a learning tool is fast becoming a reality (Gutierrez et al., 2008). Personalisation is a relevant factor in



connection with the last issue, but it is also a hot topic in its own right. Adaptive tests and systems have been studied thoroughly (Barchino, 2005) and it is also possible to find work on m-learning adaptive tests (Triantafillou et al., 2008). Therefore, the fact that the presented system can be extended to include this kind of tests could play an important role in existing m-learning applications (described in Section 1). Furthermore, if learning content inclusion is later considered, adaptive technologies offer a wide variety of techniques for improving learning.

## 6. Acknowledgements

This research was funded by the educational innovation cooperation programme (grant EM2007-004) of Castilla-La Mancha autonomous community. The authors also acknowledge the support provided by the University of Alcalá FPI research staff education programme.

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