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EXPERIENCES IN THE USE OF MOBILE GAMES TO IMPROVE PROGRAMMING SKILLS IN COMPUTER ENGINEERING

Roberto Barchino*, José M. Gutiérrez, Luis De-Marcos, José J. Martínez
Lourdes Jiménez, Salvador Otón, José A. Gutiérrez and José R. Hilera

Computer Science Department
University of Alcalá
28871 Alcalá de Henares, Spain
{ josem.gutierrez; luis.demarcos; josej.martinez; lou.jimenez }@uah.es
{ salvador.oton; jantonio.gutierrez; jose.hilera }@uah.es
*Corresponding author: roberto.barchino@uah.es

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Abstract. *This paper presents an experience in the use of technologies and mobile games to improve programming skills. Improvement of students' achievement is evaluated to check how this kind of experiences can help them to pass their programming-related courses in information engineering degrees. MobiGame contest is the central point of students' work. In this event, they show a game or application that runs on a mobile device (cell phone or PDA). Before the main event, different technical seminars are arranged to guide students on the development environments and the suitable technologies. The Java programming language and JME technology are the most used, but it is not the only technology that seminars cover. The point is taking the Java programming Language learning process to different learning environments, not just the academics ones. This way, we promote the creation of a collaborative learning environment, among the group components and all the event contestants. After examining the results, it can be concluded that the students have acquired new skills and obtained very good academics results.*

Keywords: Mobile games, Learning, Java

1. **Introduction.** Historically, programming subjects represent a problem for students, who, in most of the cases, are not used for programming languages. Because of this, we have found that, specially in the first years, many students fail in these kinds of subjects; but as they keep practicing on afterwards semesters, they usually get better scores and have no problems passing programming subjects. As a result of this, we started looking for solutions, and finally we found a reasonable one: to organize an event which encourages students to use programming languages. However, the idea was that, at the same time when the students were practicing, they should have fun doing it. It is usually accepted that learning experiences associated with enjoyable activities are more likely to success. So, starting from the idea of a programming contest, we decided to guide it towards an enjoyable activity. And which activity can be more enjoyable than playing games?

On the other hand, young generations show a strong attraction towards mobile phones and the kind of communications that they enable. Within this scope, we have been organizing, since 2001, a yearly public contest in which students are required to develop a mobile game. This event, named MobiGame [1], has different categories and has grown during its live to include, in each new editions, new partners, sponsors, technologies (both programming and communication) and devices.

Java is one of the programming languages that are used to develop games and applications for the event. Java has achieved an enormous popularity since it appeared. As stated in Java language white paper by Sun Microsystems: "*Java is a simple, object-oriented, distributed, interpreted, robust, secure, architecture neutral, portable, multithreaded and dynamic.*" [2]. We consider that the Java programming language is one of the most important in use. It is widely used in a great range of stages, such as portable devices and Web servers. It is a language that students will probably have to face when they will start to work in the real world. That is why it was the chosen programming language for the subjects.

Different initiatives to improve the learning of the Java programming languages using new architectures and learning environments have been presented so far [3,4]. There also exists a field of study, called Game Based Learning, which exploits the advantages of using games to get different competencies [5]. The current research is focused primarily on the use of mobile technology through new tools and systems to support learning [6-9]. Have also been taken into account other experiences and works, incorporating other fields of research [10-13].

Within this environment, we propose a completely new way to develop programming skills through the study and implementation of games for mobile devices, and not just from its use. Our approach has also been validated through the academic results comparison among the students who attended and those who did not attend to the event. The rest of the paper is organized as follows: Section 2 presents the learning goals of the programming subjects; the next section introduces the used methodology; Section 4 presents the basic results and Section 5 introduces the impact of the experience in the teaching-learning process; finally, Section 6 presents the conclusions and future work.

2. **Teaching – Learning Objectives.** Almost every student that participates in MobiGame event is a student of the Information Engineering degree of the University of Alcalá. The rest of students usually take courses that belong to Industrial Engineering or Communication Engineering degrees. Table 1 presents the subjects (courses) related with programming skills that the Information Engineering degree curricula actually comprises during the first academic year.

Table 1. Programming subjects

Subject	**Semester**	**Type**
Programming I	Autumn	Core
Data Structures	Spring	Core
Programming II	Spring	Core

The learning objectives, which the study guide for each of these subjects presents, are now briefly stated:

Programming I. This subject introduces to students the basic techniques to solve generic problems using structured types and programs that implement suitable algorithms.

Data Structures. This subject studies data structures under a conceptual perspective considering their representation forms and structures. Students will get the skills to specify abstract data types and simple applications, and to implement them using a structured programming language. To achieve this goal, the following objectives will be progressively attained.

- Learning objective 1: To learn the concepts of abstraction, abstract data type and data structure. To get acquainted with the abstraction and occultation techniques.

- Learning objective 2: To understand the necessity of data structures and their developing.
- Learning objective 3: To identify and understand the complexity, efficiency and representatively of each data structure.
- Learning objective 4: To use abstraction as a mean to solve complex problems.

Programming II. This subject presents to students the body of knowledge necessary to develop efficient algorithms employing the most suitable set of techniques for each problem.

The main contribution of MobiGame is moving the Java programming learning process to a different environment, not strictly academic; in which the mixture of developing a videogame and the collaborative/competitive environment fosters learning of programming skills. This way, it is promoted the creation of a collaborative learning environment, among the group of components and all the event contestants. In order to do that, and firstly, different documentation about the languages and development environments is offered to students. Examples that students can use to start their training in developing mobile applications are also included. All this contents and practices are presented in what we call technical seminars, which are described in the next section.

3. **Methodology.** Students are asked to complete three stages. The first stage comprises to attend the technological seminars, where students first get in contact with this experience and where they get the basic technical training related with the programming languages used to develop mobile applications. Attendance to these technical seminars and thus the completion of the first stage is not compulsory but it is highly encouraged. The second stage comprises to devise and present a proposal of the game or application that they plan to develop. The final stage is the contest, where students present their games and compete to win a prize in a two-round competition.

3.1. **Technical seminars.** Two months before to the contest, four technical seminars are programmed. Each seminar is bound to one technology in particular. The first seminar is titled JME and it covers the following theoretical contents:

1. Introduction to Midlets.[1]
2. Introduction to the JME high level interface.
3. Introduction to the JME low level interface.

Students are also offered with a set of JME manuals along with a set of examples, so that they can start to work on their own after the seminar. The seminar lasts 10 hours.

The second seminar is built over the first one. It offers advanced information about the JME technology. The contents of the seminar are:

1. Persistency in Applications: Record Management Storage – RMS[2].
2. LWUIT[3] graphic library.
3. Communication: Bluetooth, Wifi and HTTP.

This second seminar lasts for 15 hours and it includes, as the previous one, a set of related stuff (manuals and examples). The third seminar introduces the Microsoft .NET technology to students. The contents covered in the 8 hours that the seminar lasts can be summarized as follows:

1. Introduction.

[1] A Midlet is a Java program that runs on embedded devices; specifically on the Java Micro-Edition (JME) virtual machine.

[2] RMS is a small and simple database system, but it permits to store information in the not volatile memory of the device.

[3] LWUIT is a graphic library that extends the functionalities of many standard JME controls.

2. Developing Windows games and applications.
3. Web applications, Web services and communication.

The fourth and final seminar presents Adobe Flash Lite technology. This software is a powerful multiplatform engine for mobile as well as for other electronic devices. It offers several advantages to developers and device sellers because of its strong emphasis on the graphical interface. This last 5 hours seminar includes the following contents:

1. Introduction to Flash.
2. Flash support for mobile handsets.
3. Development and emulation environment.

With the seminars we try to cover the wider set of technologies and platforms available. Students are free to choose and to attend to the seminars that they prefer. Java is the most preferred option and about the 80% of the games and applications that are finally presented to the contest are developed using Java. The rest is usually distributed between the other two technologies.

3.2. **Game proposals.** Before completing the technical seminars students are ready to start to work. The next activity in the program, a couple of weeks before, is the game proposal. Students can create groups up to three students. Each group must present to the MobiGame contest committee a proposal describing the game or application that they plan to develop. Then the committee reviews every proposal trying to address any weak point that, at this stage, can be easily fixed. Reviews focus on trying to identify potential lacks concerning connectivity. Students are specially compelled to include in their games functionalities that make use communication capabilities, because, such functions leverage the real potential of mobile devices.

3.3. **MobiGame.** The main event is the MobiGame contest, which spans over three days. The first one, a committee composed by department members evaluates all the proposals. A first selection of applications is made; otherwise there would not be enough time for all of them in the remaining days. Moreover, this also ensures that all the applications that get into the second day have a minimum quality level. Students who have passed the first selection are headed into the second day, held in one of the assembly halls of the school, and where they must present their work in front of a real audience, composed by students and department members.

During the second day, students are asked to present a small demonstration that resumes the main points of their applications. These points include the reasons that led them to choose a specific platform, how the application is used, or in case of a game, how the game is played, and how they actually developed the work. Finally, they are also asked to show how their work runs on an actual device. Based on those points, the best works are selected to participate in the final contest, which takes place the next day. It is important to mention that while the first and second day, the committee is formed by members of the department and the research group, the final committee is composed by a jury that also includes a group of professionals from the IT field. During all the years the event has been taking place at the University of Alcala, the university has signed agreements with companies related to the mobile communications area, as well as some other important companies. Among these companies we can find Movistar, HP, Microsoft and Pearson Prentice Hall.

To conclude the event, the jury scores all the games and applications and decides the winners. Different awards and honors are given to all the finalists. Prizes that are given include mobile devices (phones and PDAs) and books which usually are bestowed by sponsors. It is also worth mentioning that thanks to this collaboration between the

University and the companies, many students have found a job as a result of the work in the event. This is also a great motivation point for the students. Figure 1 presents a snapshot of the event web page. It includes all the relevant information for contestants as well as attendees.

FIGURE 1. Event web page (In Spanish)

4. **Results.** Table 2 summarizes the achievement indicators for the different courses of the Information Engineering degree in the studied subjects. Data have been collected and distributed by the Institute of Education Sciences [14] of the University of Alcalá since 2004 to 2008.

TABLE 2. Performance indicators

Year	Subject	Enrolled students	% passed
2004/2005		**165**	**66,07%**
	Programming I	168	53,2%
	Data Structures	165	72,2%
	Programming II	187	72,8%
2005/2006		**141**	**52,9%**
	Programming I	148	37,2%
	Data Structures	148	63,3%
	Programming II	141	58,2%
2006/2007		**120**	**66,47%**
	Programming I	129	38,1%
	Data Structures	135	80,3%
	Programming II	120	81%
2007/2008		**110**	**52,1%**
	Programming I	124	34,4%
	Data Structures	110	71,1%
	Programming II	110	50,8%

The first column identifies the academic year. The second column breaks down the studied subjects (Programming I, Data Structures and Programming II). The third column establishes the total number of students registered in the three subjects. It also includes information about the number of students particularly enrolled in each of the studied subjects. The fourth column contains the general percentage of students that passed the subjects. Besides, percentage data is broken down for each subject. The general percentage is the mean of the concrete percentages for every subject.

During the courses 2004/2005 and 2005/2006, around 66% of students passed the subjects. On the other hand, during the courses 2005/2006 and 2007/2008 the percentage was around 52%. Another important piece of information, the number of enrolled students, deserves some attention. This number has decreased from the course 2004/2005 with 165 students to the 110 students enrolled in the course 2007/2008. This is due to the fact that the number of students that gain access to the corresponding Information Engineering degree has fallen down in the last years. When the degree was started, course 2002/2003, 150 new students were registered in the degree while now just around 75 students enroll every year.

After reviewing students' score that participated in the contest – MobiGame – in these three subjects, the following table is obtained.

Table 3. Achievement indicators of students that attend MobiGame

Edition	# students	% passed
MobiGame 2004/2005	**47**	**73,48%**
MobiGame 2005/2006	**56**	**70,01%**
MobiGame 2006/2007	**72**	**68,98%**
MobiGame 2007/2008	**68**	**71,60%**

The first column identifies the edition of the MobiGame event. Second column specifies the number of students that participated in the event and that are also enrolled in the three studied subjects. Third column informs about the percentage of students that passed such subjects. It can be observed that the percentages of passed students that participated in the MobiGame event are better than the global percentages presented in the previous table. Therefore, results suggest that participation in the contest helps students to pass programming subjects. Data also demonstrates that student's participation in the event has increased every year. From around 50 students in the 2004/2005 edition numbers have raised to nearly 70 in the 2007/2008 edition. Besides, the decrease of the number of students, possible contestants, needs consideration. In our opinion, the MobiGame event has acquired an important consistency and it fosters motivation and enthusiasm in the students' side.

5. **Assessment of Experience's Impact on Student's Achievements.** This section shows up a couple of questions related with the impact of the experience in the teaching-learning process. The first proposed question is the pass ratio of students that participated in the MobiGame event (contestants) in relation to those that did not participate in the event (non-Contestants). Figure 2 represents graphically this relation.

Students' Academic achievements who participated in the MobiGame contest are notably better than those who did not participate. Analyzing the results for every course it can be observed that for the course 2004/2005, the percentage of students that passed is more than 73% in contrast with the 66% of students that did not participate. The difference is around 7 points. For the course 2005/2006, around 73% of students that participated in the event also passed the programming subjects; but only 53% of non-contestant students passed them. The deviation is then of 17 points. During the 2006/2007 course the percentage of contestants that passed the test was around 69% in contrast with the 66,47% of non-contestants. For this edition the distance was reduced to 2,5%. Finally,

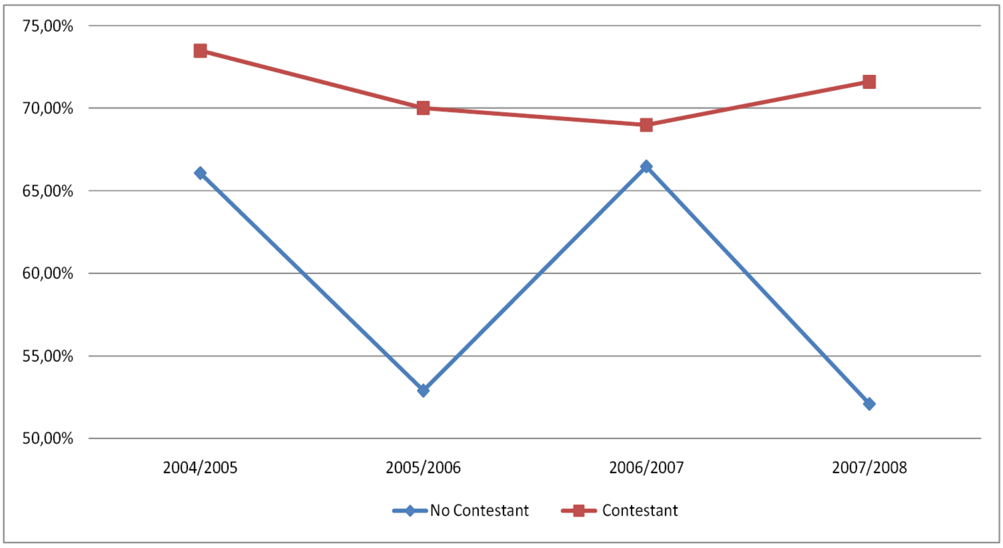

FIGURE 2. Relation of students' achievement

during the 2007/2008 course 71% of contestants passed in contrast to the 50,8% that did not pass. The difference this year was then greater and especially remarkable; the gap was around 20 points.

Data provided demonstrates the participation in the MobiGame contest increases succeed guarantees of students. Contestants have more chances to pass subjects related with programming than students who did not participate in the event.

The second question that deserves attention is the progressive increment of participation. Table 4 displays the percentages of participation of the studied editions. This is an important issue because it reflects the interest and motivation that this kind of experience creates.

TABLE 4. Participation in the contest

Edition	% of student participation
MobiGame 2004/2005	28,48%
MobiGame 2005/2006	39,07%
MobiGame 2006/2007	60,00%
MobiGame 2007/2008	61,81%

We have been moving during the different editions from participation ratios close to 30% to more than 61% in the last edition. Therefore we can assert that the event will probably have a long life because participation, motivation and enthusiasm are guaranteed.

6. **Conclusions and Future Developments.** This paper has presented the positive effect that the MobiGame contest has had in the students of the Information Engineering degree. This effect can be observed in the improvement of students' achievement in the programming-related subjects. Besides that, the number of participants increases continually even when the total number of registered students is decreasing.

In the literature, it is possible to find works related to different proposals; nevertheless, in all cases studied, the results are not to participate in a contest. This is a fundamental element that identifies us compared with other works and from our point of view is a great advantage.

In the near future, we plan to continue with this experience because it motivates students and it is an invaluable help to assist them to pass their programming subjects. We are also developing a platform to share info-educational contents.

This platform aims to be a free and open exchange of educational contents (games, applications, etc.): to develop contents and games applications compatible with the highest possible number of devices, analyzing the characteristics of the devices themselves. It is also being considered the possibility of creating specific contents that make the most of the special characteristics of some devices, for an instance raising the usability or the level of interactivity (e.g., by using pointing devices). To create a technological architecture to promote the access and use of the developed contents which have been mentioned above. To provide the educational contents and games with the required accessibility properties, so they can be used by people with physical limitations.

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