LEARNING OF ALGORITHMS ON MOBILE DEVICES THROUGH BLUETOOTH, SMS AND MMS TECHNOLOGY

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Abstract: Teaching Institutions are up against challenges of an advanced technology of learning with the objective of improving the efficiency of the teaching-learning process. Joining the students' learning style to the technologies is important to improve the educational process. This work presents the advantages of using mobile devices, associated with the students' learning styles. The learning which is carried out with the use of mobile devices makes it possible for users to learn at anytime and anywhere.

1 INTRODUCTION

The use of ICTs in the teaching of algorithms was made possible through the supervision of the teaching-learning process of this subject at Instituto Federal Fluminense, in Campos dos Goytacazes, when it was able to verify the huge difficulty experienced by the students. The creation of environments which support this learning is of great interest, since the knowledge construction process necessary to the production of algorithms for programming constitutes an arduous task to the student, as (Bercht et al., 2005) emphasizes.

There is consensus, among the teachers of the area, that it is not enough to present an algorithm in an explanatory way on the board in order to be able for the student to comprehend it completely, and to create similar or derived algorithms from that, neither to become capable of resolving problems with these instruments (Barcelos and Tarouco, 2009). This work presents the use of mobile devices to the teaching-learning process of algorithms.

The use of mobile devices as an educational resource is not trivial because the features of the pieces of equipment differ substantially from the ones which are normally used at home and in labs at schools, chiefly by the size of the presentation area of the visual pieces of information. Another factor to consider is the process of transference of the educational content in a thriftier way, because the cost of access to the Internet, via cell phone network, is still very high in Brazil. In this work, it is related an experience in which it was explored another way to transfer learning material to students' mobile device, using the wireless technology called Bluetooth and SMS.

(Caudill, 2007) states that mlearning can be defined as learning through the use of devices and the wireless technology. According to (Boyinbode et al., 2008), this learning through mobile devices (Mobile learning) is observed due to the fact it is without the permanent physical presence within the educational process.

To make explicit mobile learning is to define the use and possibilities about the way how the mobile technologies will be inserted into the educational process. (Valentim, 2009) points to the potential that these technologies enable in terms of learning strategies such as constructivism, interaction, curiosity, complexity, collaboration, challenge.

In a learning context for mobile learning, even if the mobility is one of the pillars, various other factors must be considered like: i) learning along the time; ii) the informality and iii) the appropriation of knowledge by the student.

The use of mobile devices within the learning process has been performed as a support to the presential learning, though, the purpose of this work is to make observed the formal learning of the school environment, that is, the students have got the possibility to "download" the learning objects onto mobile devices for, from then on, these to be accessed for learning at the moment when the users consider it to be more appropriate.

This work investigated the use of the Bluetooth connection that is faster, of easy access for the

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student to share data among the various mobile devices, like: from cell phones to cell phones, laptop to PDAs, laptop to cell phones, laptop to smatphones. The SMS technology was also used, which is the transmission of text messages – maximum of 160 characters for the sending of solution of problems, incentive messages, notices of tasks already performed. The MMS technology makes it possible the sending of educational objects with formats besides texts and videos.

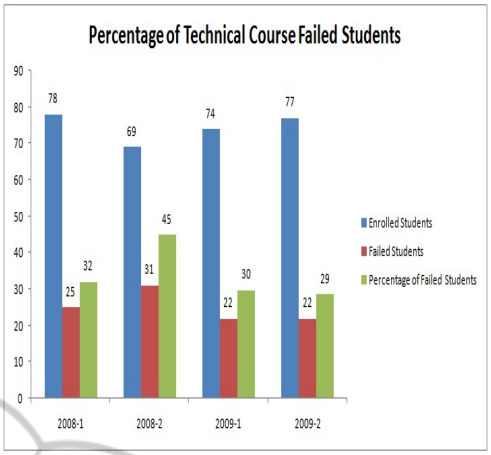
According to (Sharples, 2007), the future educational applications and services will need resources to make it easier its use, like: to download materials in different types of format, text, voice and video, to "run" without the use of adaptations, as well as to make feasible the reduction of the cost of access to the Internet because the characteristics of the functionality of the devices differ from manufacturers.

Figure 1: The convergence Technology and Education.

Figure 1 shows the investigations of this work, which embody the programming subjects, in particular in the learning of algorithm, the learning styles, in particular the students' ways of learning, as well as the mobile devices technology, besides the insertion of the mobile technologies for the learning refinement. The intersection of these areas is investigated in the teaching of algorithm and corresponds to the way how the students learn by using technologies.

The learning of algorithm has been presenting at IFF one of the largest indexes of failing. A survey carried out by the author, at IFF-Campos-RJ, in the technical course and higher education courses, points out the presented results in Graphic 1, encompassing the four late semesters between the first semester of 2008-1 and the second semester of 2009-2.

Graphic 1 shows, in the semesters 2008-1 to 2009-2, the percentages of failing in the Computer Science Technical Course, from 2008-1 to 2009-2, the average of 34% of the failing of algorithm students. This has become a motivation for an investigation work aiming at the improvement in students' learning. This work investigated the use



Graphic 1: Failed ones in Algorithms.

of new technologies in groups of this universe for the improvement of the teaching-learning process.

The reasons for this high level of lack of success are not specific ones of the area. In general, (Valentim, 2009) and (Jenkins, 2002) observe that the students do not present self-assurance in the organization of reasoning, elaboration of strategies for solving problems, attention, concentration, stimulus to the process of mental calculation. Thereby, the skills involved in this process, such as trying, observing, conjecturing, deducing, and that constitute what we call logical reasoning, not being appropriately developed, they interfere in the learning of practically all cognitive areas, but, especially, they affect this area of knowledge.

On the other hand, the students show a unique self-assurance concerning the use of technological resources. To nullify this difficulty, taking advantage of the students' motivation and vocation for the use of technology, new strategies have been investigated regarding the use of computer science resources in education, in order to enhance skills which aim at the development of the reasoning, according to (Grabe et al., 2009).

2 OBJECTIVE

The objective of this work is to make it available, through the Bluetooth technology, the pedagogic materials of algorithms to the mobile devices. In parallel, the students are registered by their cell phone number so that they receive short texts and messages through the SMS. Texts are sent to absent students from presential classes, informing them about the topics taught in presential lesson and assignments to be developed. Also it was used the

sending of educational objects by MMS.

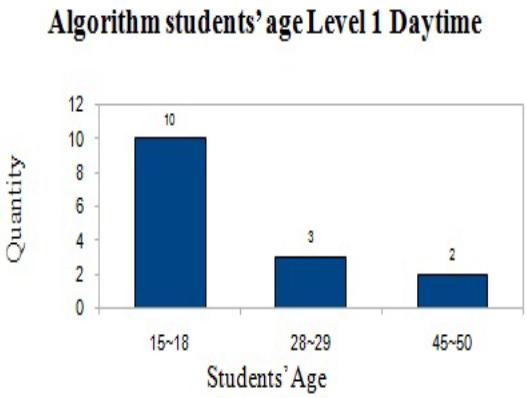
The use of this learning way is considered, in this work, as being a support to the classroom lesson. According to Azubel (Azubel, 2002), this resource is indicated to the improvement of learning in two moments essentially different: (1) right after the initial learning, when part of the forgetting of the content can occur, in order to consolidate the content learned in a more efficient way and, also, to originate the learning of gradations and subtle implications, not learned in the first presentation; (2) after a certain time, when a considerable forgetting can occur, making it possible for the student an opportunity to take advantage of (to avoid posterior presentations) his/her own awareness of negative factors (such as ambiguity or confusion with similar ideas) responsible for the possible forgetting.

Various peculiarities are important in the learning process of algorithms as it follows: i) coherence with the fundamental objectives of algorithms and that the teacher must build in the operationalization of this learning for the students: i.1) to express in an objective way the ideas, the concepts and the techniques to the students because if the teacher presents the algorithms in a confusing way (confusing ones) in the presential class or by using transparencies, the students do not understand the resolution of problems involving this learning and the expected results of the proposed algorithms are not clear in students' responses; i.2) to highlight the importance of the theoretical results and show formal rigor in the situations, even in the simpler ones; and i.3) to valorize the use of techniques in the resolution of problems; ii) to highlight the critical thinking, a care to be observed, because the students own little experience in the resolution of problems involving mathematics and tend to believe any demonstration. This kind of behavior must not be stimulated. It is essential that the students have critical thinking on any resolution of problems and are stimulated to obtain new solutions for the same problem. It will be from healthful doubts and of a new resolution and perception that the importance of the theoretical work will be presented. Still in that sense, a valuable resource is the set of exercises which make it possible for the students to identify argumentation failures, errors in algorithms or algorithms that would be made better; iii) the theory put into practice. The experience shows that the students, in general, do not feel themselves motivated as they consider the learning of algorithms to be extremely abstract, then, it is believed that it is important to use real examples as a didactic resource.

That group of factors is the one that makes it possible the improvement or the lack of success of the learning. First of all, it is essential to comprehend what an algorithm is. Its definition becomes, thus, important to have a perfect comprehension of these peculiarities, because the algorithm is a sequence of instructions in order, without ambiguities, presented in a logical way for the resolution of a determined task or problem. The algorithm is a mathematics formulation, a piece of code, and finds itself located between the input and output to transform the first into the second. It is the way for the solution of a problem and, in general, through these ways several solutions can be obtained.

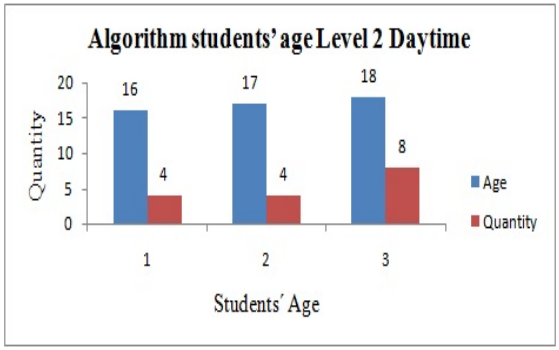
3 CHARACTERIZING THE TARGET PUBLIC

Initially, it was investigated the students' age of two Computer Science Technical Course class groups Level 1 – Morning and Level 2 – Afternoon at Instituto Federal Fluminense. The students' age, according to Graphic 2, presents four eighteen-year-old students, six students of the 16-17 age group and three of the 28-29 age group. In this case, there is a heterogeneity with regard to the group of students, because whereas the 15-19 age group can be regarded as being digital natives, the 45-50 age group, according to (Prensky, 2001), is characterized as digital immigrants.



Graphic 2: Algorithm students' age Level 1 Daytime.

In Graphic 3, with the Level 2 students, this discrepancy of age does not take place, because all students can be characterized as digital natives since the age is between sixteen and eighteen years old.



Graphic 3 - Algorithm students' age Level 2 Daytime.

4 METHODOLOGY

Using MLE, Bluetooth and SMS – In stage 1, the construction of a quiz (questions) about algorithms with images and sounds using the MLE (Mobile Learning Engine) was the solution presented in this work. This system is open source (code free font); free of charge and with capacity of personalization, and the access to MLE by cell phone is done through Bluetooth technology. The MLE is available in two languages, German and English and offers various tools, as it is shown by following the items: i) Didactic Material: It constitutes of a set of pages, ending with a question with answer alternatives. ii) Quiz: It is a multiple choice test, true or false, and questions of short answers. Each attempt is automatically checked and the teacher can choose by which way the interaction with the student will occur, i.e. the answers will be sent, or to present the right responses to the immediate student's correction.

Through the MLE, a special learning object is constructed called Mobile Learning Objects (MLOs) that can be stored into the cell phone and subsequently used, without any connection to the Internet. This way is considered as off-line. The learning through the MLOs implements all the MLE functionalities, including: interactivity among instantaneous questions with automatic correction, answer to quizzes, simple and multiple choice questionnaires.

Learning objects – shaped like videos – were sent and made available to the students with the following topics and time duration: i) introduction, time – a minute and six seconds; ii) types of data, time – two minutes and thirty-six seconds; iii) sequence, time – two minutes and fifty seconds; iv) repetition, time – two minutes and sixteen seconds; v) decision or selection, time – three minutes and six seconds; vi) refinement, time – two minutes.

The use of SMS technology in this project was used in various categories. Three categories of themes to send SMS messages by cell phone were selected.

1. Administrative Messages: They are content messages specifically about the operational and administrative part of the course. For instance, messages informing the availability of the contents, activity hand-in deadline, and the contents taught at the presential lesson etc. Example of messages sent: i) Two days left to hand in the assignment about If…Then…Otherwise; ii) The content of the August 04th presential activity was the construction If…Then...Otherwise; iii) Today, August 11th, we are starting the If…Then…Otherwise.

2. Pedagogic Messages: Content messages related to the subject of the course. For example, tip about sites with related content, reading suggestions etc. Example of messages: i) Send a message to a classmate about which questions of the assignment you have already done; ii) Ask another classmate which questions of the assignment he/she has done; iii) Do you have any difficulty about the problems to be solved?

3. Motivational Messages: They are messages that enable the motivation for the learning and the resolution of proposed problems and the individual objectives: i) messages which rouse students' interest in the learning of algorithm. ii) messages that are usually out of the context of the course like, for instance, "have a good holiday" or "U had a good performance in the activities grade 8,5" iii) Are you going to solve problems this holiday?; iv) When you are to solve problem 5, try If…Then; i) Have a good weekend!; Enjoy the holiday!.

The work had as a return text messages sent by SMS, by phone-call or by e-mail. Example of messages of replies sent by students: i) Thanks for the Information; ii) Nice holiday! 4U2.

The learning object constructed to be used on mobile devices demanded a series of observations like: size of characters, colors, sounds, among others. The sequence of Figures 2, 3, 4, 5 presents the contents on the mobile device.

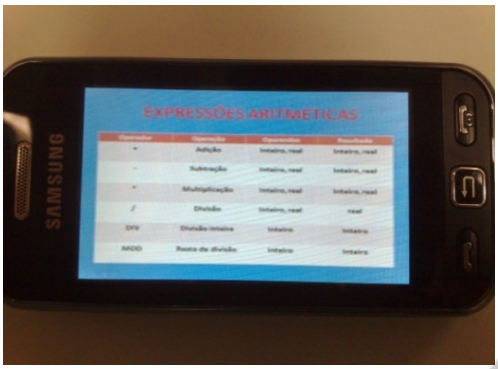


Figure 2: Representation of data types.

Figure 3: Example of algorithm using logical expressions.

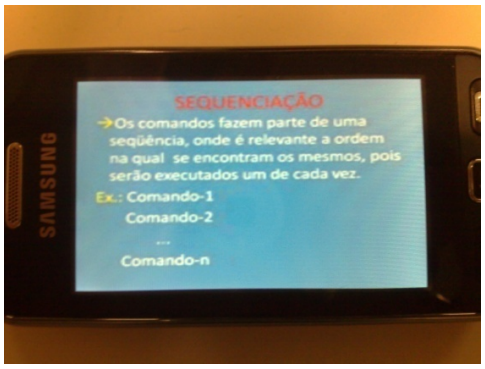


Figure 4: Example of sequencing algorithm.

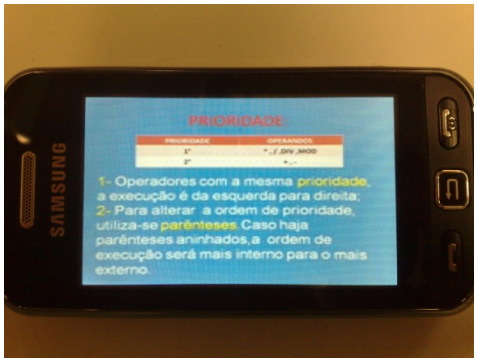


Figure 5: Example of algorithm using priority.

Besides this technique of videos with contents of algorithms, demonstrative videos of functioning were produced using one of the techniques called Table Test, presented by (Szwarcfiter and Markenson, 1994) and (Medeiros and Dazzi, 2002), that consists of following instructions of the algorithm in a sequential and accurate way, storing the possible values of the variables to verify the procedures used in the designing of the algorithm.

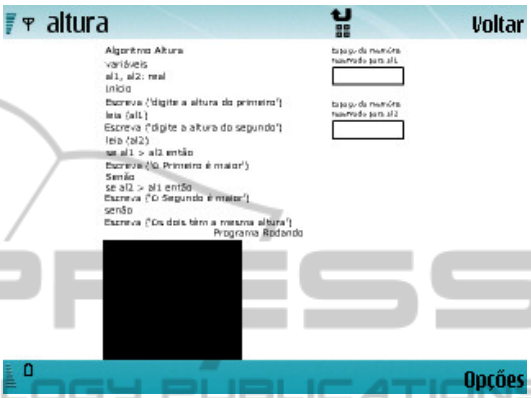


Figure 6: Table test on the mobile device.

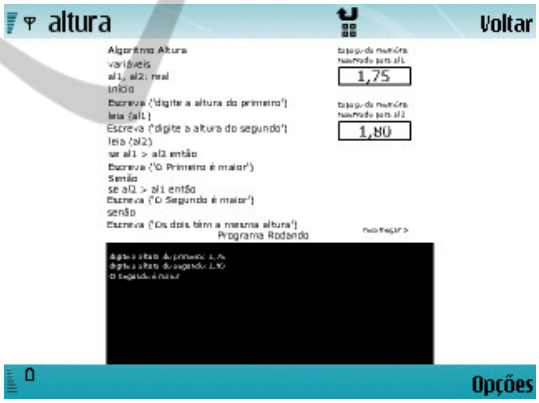


Figure 7: Table test on the mobile device.

Figures 6 and 7 show the construction sequence of the table test. This test makes it possible to compare the results to the objective of the algorithm and the possible errors during the execution. The teachers also use them in learning environments through the web. It is a technique which prioritizes the visual perception.

5 DIFFICULTIES AND DISCUSSION

As soon as the students were informed about the cell phone use as an educational device, the reaction was

very reticent because they do not "believe" and also do not understand how the cellular could be used in educational activities. In so far as they acquired knowledge about the methodology to be used, it was observed that the learning with the use of technological resources and the attitude changed.

The results appeared from individual interviews with the students, taking into consideration punctual questions like the use of the student's cell phone (access, didactic-pedagogical perspectives, interface, cooperation, synchronous and asynchronous tools, adequacy and usability. It was observed that only one of the students did not have a cell phone with the Bluetooth function. Initially, the students were apprehensive with regard to learning by using the mobile devices for the learning and also how the pieces of information about this content, that is, how to learn using these devices, not only with theory, but also to resolve problems. Miscellaneous students' accounts were important in this work: Student F1: "I did not have a hard time using my cellular, but how are we going to learn?". Student M1: "The activity was very interesting, because the classes are always the same". Student M2: "I was convicted of not having a flowchart of algorithm in the cell phone".

The results obtained showed that students own a developed technological view, and the relations of them with the videos were the best ones because they manifested the desire to access and watch the video related to the content to be taught in the presential lesson of the day.

We can state that the students identified themselves with the format of the objects, mainly when they had entire knowledge of their learning styles. Thus, they requested the materials that would better provide them with learning; however they also accessed other format of objects.

Under the aspect of the used technology, the students presented difficulty in the transmission of videos notebook/cell phone. In this methodology, they pointed out the delay to "download" the files into the devices. In the execution of the system, problems appeared due to the low memory of the cell phones regarding the size of the file to be sent.

Some of the difficulties in the construction of the educational objects are related as it follows: i) the diversity of cell phone models. In relation to the materials to be consulted by the students, there was the necessity of installing the software Java in two cell phones – program required for the mobile devices, as they did not contain the necessary "plugins" to run the materials, that is, the devices which do not 'run" files with .doc, .pdf. format. The solution found was to convert the files with .txt extension (in text format), though, in a short way, because in this format they do not contain the illustrations of the original material, serving just as fast consultation about the concepts over specific subject.

Another difficulty reported by students was the cost, in the case of the sending of SMS to other students and teachers, impairing the interactivity. Concerning the educational difficulties, the students "would like to have more consultation material during the learning out of the classroom", more didactic material, i.e. videos with other contents of algorithms.

In a general way, the students understood that the use of this technology for the learning was of great importance and they expect that its use converts itself into positive results in their performances in the learning. The fifteen students answered the questions on a Saturday and Sunday and on their way work/school and, mainly, when they did not have access to the computer.

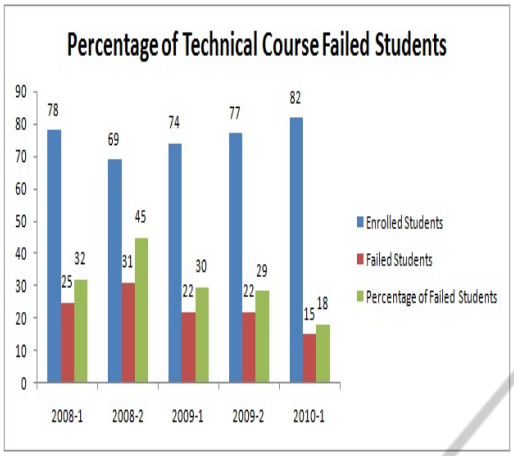
6 RESULTS

With regard to the male students' learning styles, only one with visual and kinesthetic learning style as well as male student with preference to the auditory learning style did not obtain approval.

Concerning the female students' learning styles, only one with visual and kinesthetic learning style as well as male student with preference to the auditory learning style did not obtain any approval.

The failed students were interviewed and reported that the experience regarding the knowledge of their own learning styles was beneficial to the learning and attributed the weak performance to extra-class problems, because they missed the examination. Though, they even reported that would like to keep on in the process and be re-evaluated based on the support with educational objects.

Graphic 4 shows the result in the subject of Algorithms of the students of the Computer Science Course in the year 2010-1 that the performance was satisfactory, because in the year 2009-2 the index of failing was of (29%) and in the year 2010-1 this index was of 13%.



Graphic 4: Performance and algorithms 2010-1.

Through accounts, the students attributed to the satisfactory performance in this subject several factors, as it follows: i) the use of mobile devices making it available the access to the course content, what enhances the motivation and learning opportunity, as the performance shows. Practically by just one click, contents are found which permits students to learn wherever they are, despite the limitations of the home responsibilities, work hours, trips etc. Besides, since the students achieved the success and progress through exercises, they state that they have being motivated to learn more by the use of pieces of technology; ii) Another factor was the strategy of learning of algorithms in an individual way made possible by the convergence of information and communication technology with the strategy used; iii) the learning of algorithms through the opportunity of interaction among the students. The availability of the learning objects must include the opportunity for the students to interact with other students and with the teacher in order to report the difficulties and the solutions found in the resolution of the proposed problems. The students understand that the mobile devices are becoming integral part of the teaching.

7 CONCLUSIONS

The use of mobile learning in the teaching of algorithms led to a significant improvement on the students' performance, because it made possible the collaboration, giving a good opportunity for the support of multimedia such as videos, graphics. The learning through the mobile devices in consonance with the students' learning styles, as well as their motivation with the insertion of this technology made the teaching of algorithms more attractive and, consequently, made it possible to improve the learning.

Regarding the fifteen level 1 students, fourteen students participated actively of the assignments and thirteen obtained approval without need of a third exam to be retaken. It can be, therefore, stated that the experience contributed to the development of the logical thinking and made it easier the supervision of the academic trajectory. It was verified in these students the improvement of the abstraction, of the logical reasoning and of their learning performance, confirming a differential with regard to the ones who did not take part into the project, even though, evidently, other factors can also have interfered into the learning.

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