Using Tablet PCs for the Design of Web Educational Environments

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Abstract. Learning models based on competences facilitate the integration of students into the professional world, allowing further integration into the society, where learning is a necessity. The final aim deals with the topic "learning to learn", as essential step for continuous learning (lifelong learning). In the project introduced in this work we have used the Problem Based Learning (PBL) methodology applied to the subject Human Computer Interaction (HCI). Students have designed, evaluated and implemented, computing interactive systems to be used by humans. To perform it, students have used Tablet PCs that contribute to do important changes at the classroom, reducing some of the problems associated with the traditional models of education centred on the teacher. Taking into account the enormous penetration rate of devices having touch-sensitive interfaces (smart phones, tablet PCs, home automation systems, remote control, etc ...), and the big perspectives of growth in the short and medium term the development of interfaces by means of touch devices, the use of Tablet PC have let students develop transversal competences using PBL methodology. The study has been centred on the analysis of Virtual educational environments.

1 Introduction

The great technological advances produced in the last years, especially in the sector of information and communications technologies (ICTs), make it necessary to update professional's knowledge in a continuous way.

Learning models based on competences will facilitate the integration of students into the professional world, allowing further integration into the society, where learning is a necessity. In this scenario, a change in teaching methods will be necessary; new methods of work must not be based on teaching (focusing on the lecturer) but in learning (student-centered). The final aim will be learning to learn, as essential step for continuous learning (lifelong learning). This goal is clearly expressed in the declarations of Bologna [4].

In the field of engineering, the number of work areas will be very extensive and somewhat not much predictable. Engineers are able to work in lots of different designs and projects, management issues, operations, development, sales, etc. For this

Lacuesta R., Palacios G., Albiol S., Azuara G. and Catalán C..
Using Tablet PCs for the Design of Web Educational Environments.
DOI: 10.5220/0004088300140025
In *Proceedings of the 1st International Workshop on Interaction Design in Educational Environments* (IDEE-2012), pages 14-25
ISBN: 978-989-8565-17-4

reason, it will be essential to identify the competences necessary for the forthcoming broad and changing employment context.

Broadly speaking, competences can be regarded as skills or abilities to understand and use knowledge, solve problems, use tools or technologies, learn in an autonomous way, research and think with initiative and creativity, communicate, cooperate, and so on.

The design of the university curriculum in terms of skills generates the need to design educational goals beyond a disciplinary content. These goals are linked to intellectual, social and professional demands according to the labor market. Two competences level can be established: degree generic competences (regarding to transferable skills) to be used on a high number of functions and tasks and specific degree competences, directly related to the occupation.

Different studies demonstrate that ICTs can contribute important changes at the classroom, reducing some of the problems associated with the traditional models of education centred on the teacher [7],[24]. There is no doubt that the possibilities of a personal computer are multiple, these ones increase significantly when we incorporate technologies such as tablet PCs, digital blackboards or user interface elements like special pen producing digital ink, giving name to the so called "Pen-based Technologies" or “Digital Ink Technologies”[6],[8],[11],[23].

These devices allow to improve the interaction among students-computer-lecturer. Some of the most prestigious universities in the world have stationed for a few years for the above mentioned technologies.

In the project introduced in the current work we have used the Problem Based Learning (PBL) methodology applied to the subject Human Computer Interaction (HCI). Students have been asked to work centred in the design of interfaces within Virtual Learning environments, complex and little intuitive. In this project the use of tablet PCs has allowed the development of the prototypes of the above mentioned environments designed by the students and their heuristic valuation.

2 Human-Computer Interaction

2.1 Introduction

The human-computer interaction is a discipline related to the design, evaluation and implementation of computing interactive systems to be used by human beings and the study of the most important phenomena that is related to.

In the case of the human-computer interaction, the interface is the point in which human beings and computers make contact with each other, transmitting information, orders and data as sensations, intuitions and new ways to see things. On the other hand, the interface is also a limit to the communication in many cases, since those things which are not possible to express through it, will remain out of our mutual relationship.

However, whereas sometimes these limits derive from the current condition of our knowledge about any of the implied parts, in many cases the interface turns into a barrier due to a poor design and a little attention to the details of the task to be

fulfilled.

In the project, students have centred their efforts in determining what a usable surface is, who the protagonists located on both sides are and which the human factors involved in such a project are. The interface is part of a cultural, physical and social environment and therefore we will have a series of factors that we have to bear in mind in the moment when designing them.

2.2 Human Factors

Human beings are subject to losses of concentration, changes in the character, motivation and emotions. We also have prejudices and fears, committing mistakes and having a lack of common sense. At the same time, we can lead remarkable facts, perceive and answer rapidly to stimuli, solve complex problems, create masterpieces and coordinate actions with others in an orchestra, fly planes or film movies.

In days gone by information technologies system designers had not given importance to the human element because it was supposed that without a lot of effort, users could learn and use the systems and the developed applications. Nevertheless, experience tells us that the use of systems is often difficult, complex and frustrating.

It is very important to understand the human aspects of the computer science and inside them, the cognitive system, because it may be very useful to define models of interfaces with a better adaptation to the cognitive models of the human being. At the same time, the different levels in which the human behaviour in the interaction can be analyzed should be framed. This frame will serve us to focus the sensorial and perceptual aspects. Furthermore, it will be convenient to treat some conceptual aspects such us 'Cognition' and the distinction between 'Individual Cognition' and 'Distributed Cognition'[1].

3 Human-Computer Interaction: Practical Design

3.1 Problem to be Resolved

The problem presented to students in the Human-Computer subject (Computing Engineering degree) was the following:

Alfredo Martin, teacher of a formative academy has decided that current platforms supporting education (Virtual educational environments and systems of management of courses), which help educators to create communities of learning on line do not follow the appropriated criteria of usability taking into account their methodological orientation. This kind of technological platforms is also known as LMS (Learning Management System). He has his sights set on another type of users who do not know the use of these environments, those that, for example would want to have assistants in the education. Alfredo is aware of that not all the people master Internet and its multiple applications. Advised by his friend Sara, expert on this subject, he has understood that the success or failure of his application is going to depend on multiple factors: functionality, added value in comparison with other web sites, customization and others. Nevertheless he has remained worrying about a possible solution, since he

does not have a clear idea. He wants that all the users (with knowledge or not about computer science) are capable of following a on-line course in his web site.

Alfredo has arrived to Improved Developments PLC (where you all work), expressing his problematic to the chief of group. He has the need of development of an application to be able to give on-line courses, being able to extend his business in this way.

Alfredo said: “I would like (from my company) to manage the application and see the state in which we are: users, evaluations and so on. As you already know every time people need training in the most varied things that one could imagine. For this reason, it would be ideal the creation of all kinds of courses. In addition, I would like that my oldest relative is able to follow a course”, said smiling and remembering his 80-year-old grandfather. “I do not imagine everything what should be born in mind, looking at my current business. It is necessary to control payments, results, evaluations, etc. It is also very difficult for me to imagine how my business and its current running can be reflected in a web application. So, you will have to give me some help”.

Alfredo has thought that the application might have a part of a social network, to increase the number of accesses to the page. Even it might happen that a person creates a questionnaire of evaluation or a course, informing friends of the network in order that they do the above mentioned questionnaires in a private among them.

Our client (by the moment) only wants to have an idea of how the application is going to work. He does not want code, only to see how the interface works, buttons, colours, the arrangement of the menus, etc. This will be evaluated with a strict criterion, because his business depends on it.

3.2 Assessment Criteria

3.2.1 General Guidelines

The following guidelines should be followed by all the students:

- On a fortnightly basis the workgroup will meet lecturer Raquel Lacuesta at the office 3.14, who will act as the "client".
- In every meeting they have (with the lecturer and among the group components), students will have to take notes of the meeting, writing down the hours of dedication, taken responsibilities, performed actions and advance of the project. These notes will be also presented in the fortnightly meeting. Notes will be taken by the secretary of the group, position which also will rotate along the 7 weeks.
- A report will be done along the four-month period about the development of work where different phases will have to be reflected, together with design, development and evaluation. The report will have 30 pages, maximum.
- Every student will be responsible for a part of the work and will be evaluated as coordinator for it.
- Every student will work as project manager throughout 2 weeks approximately. This fact will have to be reflecting in the minutes. It will imply the organization of meetings, revision of notes, revision of the progress of the project and distribution of work.

- Last day the work should be presented (about 10 minutes) to the rest of the companions showing functionality, design and evaluation of the proposed solution.
- Work groups will consist of three people.

3.2.2 Final Goal

Design of a Web for the management of on-line and on-site courses, visual prototype (without any code) and evaluation. Tools for the development of the prototype: free software, to be chosen by the group.

3.2.3 Evaluation

The final mark will be fundamentally global to the three components of the group. Except the part of "Follow-up of the project" and "Individual responsibility". Every project manager will be evaluated independently as regard notes, conducted meetings, advance of the project and follow-up carried out in three weeks in which the above mentioned project manager acts as such. The responsibility for the tasks will also be evaluated individually, depending on the level of achievement and results obtained in the project regarding this task. This does not mean that the above mentioned person should perform them, but he or she has to make sure of its achievement.

Group weightings

- Group organization: 15%.
- Report: 15%. Plan, design, development and evaluation.
- Final result: 30%.
- Presentation: 10%.

Individual weightings

- Individual responsibility: 10%. Associated to the responsible for that task.
- Project monitoring: 10%. Associated to the project head.
- Generic competences development follow-up: 10%. Done on a fortnightly basis. Input address for test filling: 155.210.68.27.

3.2.4 Work Schedule

Table 1 shows the weeks of work in Alfredo's project.

4 Heuristic Evaluation

We might define Usability concept as the facility of finding, dealing and using the information showed in a web site [13]. According to Nielsen [22] the main problems as far as usability are concerned come are included in three factors: occurrence of mistakes, degree of difficulty to solve problems and the persistence strictly speaking.

Nowadays, the use of the engineering of usability allows to generate a quality product aimed at obtaining friendly tools for the final user. To achieve it, it is necessary to structure the term usability in two categories: usability focused on the user and usability focused on the designer.

Table 1: Work schedule on Alfredo's project.

Date Meetings	Groups and tasks
February 23th	Work presentation
March 6th	10:00-10:30- Group 1 Multipurpose classroom 10:30-11:00- Group 2 Multipurpose classroom 11:00-11:30- Group 3 3.14 office 11:30-12:00- Group 4 3.14 office
March 13th	Group 1and Group 2
March 20th	Group 3 and Group 4
March 27th	Group 1and Group 2
April 17th	Group 3 and Group 4
April 24th	Group 1 and Group 2 Final handing
May 1st	Group 3 and Group 4 Final handing
May 8st	Final presentation

Within the category of usability focused on the user, the tests most commonly used are: System Usability Scale (SUS) [5] and Software Usability Measurement Inventory (SUMI) [14]. The SUS test consists of a questionnaire elaborated with the Likert techique, with 10 items having five response levels, obtaining a global evaluation of the usability of our product. The SUMI test evaluates new products, establishes similarities among versions and fixes aims in future lines. This test is characterized by its subjectivity, being capable of storing subjective opinions, and sensations of the final users about the product to be evaluated. SUMI consists of 50 items with three different response levels (in agreement, undecided, in disagreement). Mainly, the application of these tests is carried out in the final stages, in particular, when the user has already analyzed the tool, but the appropriate discussions have not been done to solve detected errors.

Concerning categories focused on the designer, three methodologies exist:

1. The method of the heuristic evaluation developed by Nielsen [17],[19] does a classification of the usability problems in the interface design. The method is classified under nine categories, extended later to ten:

- Simple and natural dialogue.
- Speak the user's language.
- Minimize user memory load.
- Be consistent.
- Provide feedback.
- Provide clearly marked exits.
- Provide shortcuts.
- Good error messages.
- Prevent errors.

2. In the method of Weinschenk and Barker (Sauro) a new usability lines were designed, dealing with aspects such as the modal integrity, human limitations, interpretation, accuracy or flexibility among other items, grouping twenty types of questions altogether.

3. In the cognitive engineering principles developed by Gerhardt-Powals [10] a set of items similar to the heuristic evaluation enunciated by Nielsen were described, but more focused on the cognitive principles.

In the current experimental design, in order to evaluate correctly our product, we

used one of the most commonly used usability methods focused on the designer: the method of the Heuristic Evaluation. This method was first enunciated by Nielsen [20], being one of the best error recognition methods in the design of User Interfaces.

The heuristic method of Nielsen is characterized for being a simple method, capable of being applied in early stages of the product design and being necessary only the existence of an expert for the accomplishment of evaluations. Concerning heuristic evaluation, Nielsen [21] states that “is a way of finding usability problems design by contrasting it with a list of established usability principles". Thanks to it, our product would have resolved a high percentage of error in the design stage in a simple but rapid way, reducing global errors in the final phases.

For the heuristic evaluation of the current interfaces and those of the appropriate design the following criteria were born in mind:

a) Clarity in the presentation of the web site, goals and functions.

- The aims of our product should be well outlined and structured, fulfilling a series of premises such us: supposing the existence of several aims, these ones should be coherent among them totally integrated with the global aim.
- Easiness of remembering the URL of the product, being intimately related to the raised aims.

b) Visibility of the information.

- Our product should show and inform the user at any time about the actions that are being carried out, establishing an identical feedback according to the raised aims.
- Relevant areas of the web site will be clearly outlined (site title, page title, section(s)) as well as path indications associated with the actions performed by the user. On the other hand, when the action that is being carried out is a process, the product will be capable of indicating the current stage as well as the number of necessary stages to finish.
- The web site must provide a series of supplementary functionalities such us: clear identification of the links, visualization of all the carried out actions in our product, existence an internal seeker and a correct feedback in actions that are being carried out and/or successfully completion or not.

c) Consistency of our product with the world, adequacy of the mental objects of the user and the logic of the information.

- With regard to the logic of the information, a series of coherent premises intimately related to the raised aims should be fulfilled: existence of a understandable and effective presentation logic, correct and coherent structure of each of the actions to be carried out by the user, clear, concise and appropriate interrelationship to the icons and the actions of our site, easily understandable, group of actions with a high degree of consistency among them.
- With regard to the format of the information, criteria to be fulfilled will be the following familiarity, clarity and a correct structure of the language, to reach a narrow relation between the adopted language and the user. Furthermore, correct structure and arrangement of the information, nonexistence of supplementary information for the web site global comprehension, icons labelling associated to the actions according to their functionality, use of a direct language.

d) Recognition more than memory.

The nonexistence of a mental model when selecting categories can generate difficulties at the moment of interaction with the web site. For that reason, a series of criteria must be fulfilled such us: the system must be capable of offering actions related to the aims without any need of remembering information of previous pages, facility in the search of information previously showed, visualization and selection of the most common actions, familiar organization for the user with a recognized logic, range of blocks showed in the web site varying among 7 ± 2, conformity of the icons and actions raised in the aims.

e) User control and freedom

The tool will have to allow the user a set of functionalities: the user record will be done at the ending of a process, being unnecessary to perform any type of action; the tool will allow to undo the most important actions of the system (logout or to cancel), neither automatic actions nor non-user controlled animations will be run in the system, possibility of web site auto-save, possibility of printing without any type of loss of information, increase of letter size showing our application perfectly no matter the resolution, nonexistence of software requiring any type of update or external plugins, generic consistency, actions, labelling and organization of information, obtaining identical results, use of standards (HTML, XHTML, CSS) as well as use of colours, links and areas of navigation correctly.

f) Error Prevention.

The product will allow to resolve standard and generic errors as well as: support of errors performed by the search engine, clarity in the showed information in each of the errors reporting the type of generated error, aptitude to give suggestions to solve them to be able to return in a coherent way to the event previous to the error.

g) Documentation and help

Help in the coherent actions of insertion of information, clear location of help, context sensitive, adjustment to the needs and aims of users, FAQ's existence, coherent organization and visualization of examples.

h) Flexibility and efficiency of use

Existence of accelerators or short-cuts to perform frequent operations, simplicity of repetition of actions previously generated customization of actions, establishment of different criteria in advanced searches.

i) Aesthetic and minimalist design

The information of the page will have to be light for a rapid and efficient load, containing relevant, concise and precise information, without any type of redundancy, distinction of the informative elements without generating any type of confusion, reading of the pleasant information, legibility of the sources, and use of colour sources with enough background contrast.

5 Using Tablet PCs in the Design Stage

In the design of the interface students have used Tablet PCs.

A tablet (or tablet computer) is a type of portable computer, bigger in size than a Smartphone or a PDA, integrated on a touch-sensitive screen (simple or multi-tactile) one interacts with primarily by using the fingers or a pen (passive or active), without any need of physical keyboard or mouse.

The term can be applied to a variety of formats that differ in the position of the screen with regard to a keyboard. The standard format is called a blackboard (slate) and lacks of integrated keyboard, although it can connect to a wireless one (e. g. Bluetooth) or by means of a USB cable (many operating systems recognize directly keyboards and USB mice). Another format is the convertible laptop, which has a physical keyboard that turns on a hinge or slips under the screen. The third format, named hybrid (like the HP Compaq TC1100), has a physical keyboard, but it can be separated of it to behave as a blackboard. Finally, Booklets include two screens one of them touch-sensitive (at least), showing on it a virtual keyboard.

Recently, Tablet PCs have been widely used on education. As an example, we can mention some experiences based on Tablet PCs: [2],[3],[9],[15],[16],[18],[27],[29]. In the development of the experience, students have used Toshiba Portégé M400-12F Tablet PCs having a 12.1" XGA TFT screen with a 1.024x768 resolution. Figure 1 shows the device.

Fig. 1. Tablet PC used for the experience.

6 Results and Conclusions

The use of active methodologies based on student learning facilitates the development of competences and skills. One of the main methodologies for continuous learning is the Problem-Based Learning (PBL). In this methodology, students play an active role in their own learning. It allows students to get a better understanding of difficult concepts and let them retain the knowledge acquired for a long period of time. In addition, students are able to develop the professional qualities required in the business world, such as critical capacity, communication ability, planning ability, autonomy, capacity of work in group, etc.

In this paper we have introduced the use of classroom teaching techniques to improve the student competences development by using interactive devices (Tablet PCs in this case). Also the students have had the opportunity of use heuristic evaluation to analyze virtual education environments. Final results and the design of a

prototype of a new education virtual environment will be presented on the extended version.

The development of interfaces by means of touch devices has been very useful for students, the creation of a system perfectly tuned having inputs, outputs and feedbacks which let us improve student performance in competences acquisition, using ICT that optimize at the same time efforts in every element of the global process of teaching and learning.

All along the year students have developed the market research (pros and cons of the current platforms from the functional point of view and that of usability), analysis of requirements, analysis of users (experts, non-experts, beginners, administrators) and tasks, design of the web and heuristic evaluation and evaluation of users. The design has been developed using Tablet PCs.

Data gathering (generic competences) has been done on a fortnightly basis and via surveys. Every student has valued the members of his/her group and him/herself (auto-evaluation). The lecturer has valued the progress of the students in the same way.

The results obtained showed that the abilities and skills more developed were: capacity for organization and planning, information management skills (ability to retrieve and analyze information from different sources), leadership, concern for quality and self-learning. These results were predictable, given the characteristics of PBL. The results obtained let us confirm the usefulness of PBL as active learning method based on both team work and self-learning. Furthermore, students value the use of technological tools to improve the evaluation and design of user interfaces.

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