Effectiveness of Multimedia Systems in Children's Education

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Abstract. Presently multimedia has become part of youngsters' daily life, although the quality is not always satisfactory. Sadly, many multimedia resources are not used as tools for socializing, transmitting knowledge and know-how for improving society. This paper presents methodological features for the development of a multimedia tool that combines Participative Design and User Centred Design methodologies, to improve knowledge in the Ergonomics and Occupational Safety and Health for children domain.

Keywords: Multimedia Systems, User Centred Design, Participative Design, Usability.

1 Introduction

Presently, there is a crisis in teaching and in traditional learning processes based on lectures, usually not very stimulating for young people. This problem amplified when dealing with youngsters who are familiar with multimedia systems, that are more interactive and exciting.

We often mention that students do not want to learn and are uninterested in studding theoretical subjects. This is a superficial way of analysing the situation, as there are many examples of students *interact* with theoretical and complex problems and learn, and like to learn. The problem might be – *interaction.* In this context, there are several alternatives connected to information and communication technologies that offer adequate systems for carrying out innovative work in this area. The use of multimedia systems, in particular computer games, has drastically increased in the last years. According to "The New York Times" of 2003/10/23, the investments volume proposed for 2002 for designing multimedia systems in the whole world, either for diversion or training exceeded the investments intended for research in the pharmaceutical industry. This proves the large number of projects developed in this area.

Forwell [2], supports the idea that there are two reasons why Information Systems should be included in to education. The first reason concerns the great capacity of this tool has to adapt to different kinds of education materials. The second, regards to the proved improvement and development of an individual while learning.

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According to Knezek [4], using technological resources for educating primary and secondary grade school children significantly raises their performance levels.

Another author [11], state that there is unquestionable evidence of positive effects when using educational games as an educational tool. According to them, progress is more intense in areas such as mathematics and reading.

Educational games offer an environment in which learning is enhanced by stimulating tasks, and skills are developed as a result of playing the game, [7].

Murray [8], confirm this concept and show how the system can become uninteresting and non-motivating, generating the opposite effect of what is expected. In other words, emphasis on the conceptual aspects, results in low progress for students, who do not find situations in which they can develop the expected skills by using the softwares, or develop them in the right way.

Despite this data, projects for the development of multimedia systems, in most situations, do not involve the users in a systematic way during the systems development process, [10].

Normally, emphasis has been given only in technological aspects, designers' empirical knowledge, experience of successful projects, or formal scientific research, do not take any notice of the potential user during the design phase, [9].

Consequently, in this paper we present a methodology, based on Participative Design (DP) User Centred Design on the (UCD) methodologies, for developing educational information multimedia systems, that involve potential users in all the development stages, proposing the integration of developing teams.

2 Contribution of Participative Design (DP) and User Centered Design (UCD) Methodologies

According to Mandel [5], one of the difficulties in producing good quality educational software seems to be linked to the fact that in the design process there is a significant difference between representations that designers, programmers and teachers have on the teaching and learning processes.

According to Tchounikine [13], the problems with the majority of educational software seems to be the difficulty between the elements designers have at their disposal and the way in which educator specify their ideas. According to the author, interaction between programmers and educators is a problem due to the difficulty of sharing concepts in different areas.

To solve this problem, a set of techniques was developed in Scandinavia intended to manage design with multidisciplinary teams and potential users. The proposed approach named Participative Design, emphasizes the importance of democracy in a work environment, improving work methods, design process efficiency (through users experience and comments), and supporting multidisciplinary teams.

From this point of view, the use of Participative Design has brought the following benefits:

1. The company could follow-up and evaluate the project;
2. Researchers had a greater understanding and power over the elements, as problems were shared between the directly involved participants. With this interaction researchers could carry out their theoretical proposals;

3. Greater possibility of satisfying the company's objectives, as they directly took part in the system's development;
4. Possibility of mutual learning and improving work practices:
5. Greater efficiency and quality.

The involvement of potential users' involvement in the project could not be disregarded in any of the software development phases, even the initial ones, such as the concepts, software architecture and content development. The users' cooperation during the whole design process provided the work group with the necessary information. Besides the DP activities, the result system quality is improved due to a better understanding of the work accomplished by the potential user, combining the participants' different know-how's during the design process [1].

Presently, potential users' involvement only appears in the final development stages of a product, making it impossible to produce meaningful changes. To this fact, we can still add temporal commitments or financial difficulties.

Therefore, by associating the methodologies proposed by the UCD, we are trying to minimise the distances between the user's real needs and the technological and didactical contributions of educational software.

According to ISO 13407, the UCD is a move towards developing interactive systems with the purpose of developing usable products. This should be a multidisciplinary activity that combines human factors, knowledge and Ergonomic methodologies.

Applying Ergonomics in the design of interactive systems improves efficacy and efficiency, improves conditions of use, and avoids possible adverse effects on health, safety and performance.

Systems centred on users support and encourage their learning. Benefits can include:

1. Increased productivity;
2. Improved users' performance quality;
3. Decreased costs for support and training;
4. Increased satisfaction of user.

According to Rieman [12], the most important role of educational software goes beyond the promotion of learning. Therefore, it is not only a question of learning how TO DO something with an interface, but of learning how to deal with an interface to LEARN a new concept. In this context, educational interfaces hinder the cognitive development of users, with an impact on the learning of certain concept areas, [14].

To access data about users' cognitive activities, either related to learning domain or to the teaching context (activity), it is necessary to guide the adequate cognitive models to the subject's approach. Consequently, we propose divulging the concept applied to this project in studies that either involve, or do not involve, multidisciplinary teams. Applying this method helps people in charge of design, hardware or software processes, to identify and plan user centred design activities, in an efficient and punctual way, complementing the existing design approaches and methods.

3 ErgoShow Development Methodology

The Ergoshow project was based on a methodology developed in three phases:

1. System definition concept;
2. Preliminary and detailed studies;
3. Final validation;

These phases intersected in time, and a symbiosis became visible, this helped Ergoshow's development process using the Design Centred on the User and the guidance of the whole team through Participative Design.

3.1 Defining Concept System

Analyzing Reference Situations. We started this project by analyzing educational computing programs with similar characteristics to those planned for ErgoShow. By educational software we mean, the class of educational interfaces or the ensemble of artifacts designed to function whilst being mediators, in training activities in specific areas of Human knowledge.

This activity served two purposes: the first one was to present the different kinds of views regarding these information systems. Accordingly, designers, ergonomists and pedagogues described and presented their viewpoint about certain software to the whole team. The second was, identifying positive and negative aspects of the analyzed programs. This process can be carried out by analysis with pre-defined heuristics or by usability tests with potential users.

Only after securing this information is it possible to establish strategies aimed to work when improving or innovating an information system.

Defining Types of Contents. Defining types of contents was developed in *brainstorming* meetings with ergonomists, pedagogues and Occupational Health specialists. Defining and categorizing types of contents was carried out to inspire the public targeted for these systems and to prepare them to be, in the future, responsible workers in relation to Ergonomic and Occupational Health matters.

The topics concerning these contents were presented to a sample of potential users, who gave their opinion and pertinence about it.

Developing Contents. The selected contents were developed and adapted into a simple and direct language, understandable for the prospective users' age group. Therefore, the technical terms were replaced by simple explanations, or when this was not possible, they were put into context with images and other elements such as navigation interaction.

Part of the contents was shown to a potential user list, who expressed their opinion on the way these were developed.

The same contents were shown to teachers, who expressed their agreement or disagreement on the way they were developed. The final contents emerged from a negotiation process, a mixture of casual speech and a more colloquial language used by teachers.

Defining Metaphors. During the definition and development process we defined the metaphors for the multimedia system and its contents. This process was developed during the *brainstorming* meetings with the multidisciplinary groups of ergonomists, teachers and potential users.

Visual metaphors were defined for the characters and physical contexts in which the organizational contents and metaphors unrolled.

3.2 Preliminary and Detailed Studies

After defining the Ergoshow concept, we advanced to the development phase, initially with simple mock-ups, drawn on paper and in the following phases, with increasingly complex semi-functional prototypes.

All along the development process, usability tests were carried out, using samples of five potential users. Their opinions and interaction difficulties, allowed us to modify several system mock-ups in order to improve usability.

Focus Group meetings and *walkthrough* type interactions were carried out, were potential users were called upon to verbalize all they were thinking during their interaction with the software. At the end of each test, they were subjected to a semi-structured interview and a questionnaire that evaluated a number of aspects, such as a person's reaction or memorizing contents.

3.3 Final Validation

The first DEMO version was submitted to a sample of 30 possible users in order to obtain varied and critical opinions that should be considered for reformulating the software. For this analysis we had meetings with the Focus Group and *walkthrough* type interactions, where users were asked to verbalise everything they were thinking while interacting with the software. At the end of each test, the users were submitted to a semi-structured interview, that evaluated different aspects that went from a person's reactions to memorising contents.

While interacting with the *walkthrough* technique, we registered user reactions and verbalisations. The objective was to gather information about the difficulties of interacting with the system, regarding committed errors and communications.

Regarding the registration of verbalisations, the prime objective was to register spontaneous verbalizations made by the users while interacting with the system, as well as the moment they occurred.

Interviews were carried out immediately after interaction with the system and were based on an ensemble of pre-established questions. This method allowed greater flexibility and richness in gathering information, and also, because it was a more expedite and easy method to use.

The interview objective was to assess the *difficulties* felt during interacting with the program and to get to know the users' *opinions* and *suggestions*.

4 Introducing an Example – Ergoshow 1

Ergoshow 1 was developed for youngsters from 8 to 14 years old and deals with subjects related to transports, load's manipulation and seated work. We started by

assuming that the consolidation of the teaching-learning process happens when a youngster understands the "reason of things", as opposed to being confronted with an ensemble of "prescriptions". Therefore in Ergoshow 1, no prescription is given for manipulating loads or to be well seated. The youngster is confronted with the vertebral column, muscle-skeletal and the circulatory systems' behaviour, in order to understand why one should not assume some postural behaviour on a daily basis.

To present the text contents, we decided to create an animated mascot (BONE) that is the host in all the software's stages and phases. "BONE" is an adolescent skeleton, was designed in live colours and with a *hip-hop* appearance that makes the contents in an easy way and uses adolescent lingo (Figure 1).

After selecting the text contents, language was adapted to an informal speech presented by the "BONE" character. To organize and hierarchize the contents, we proceeded to separate the software into two distinct modules, each one subdivided into three levels. These texts were used as a source for a guide book prepared to aid in the film's animation and interaction sequences.

Ultimately, spoken itineraries and some suggestions of content animations were structured, and use as a starting point for developing each one of the system's final animations.

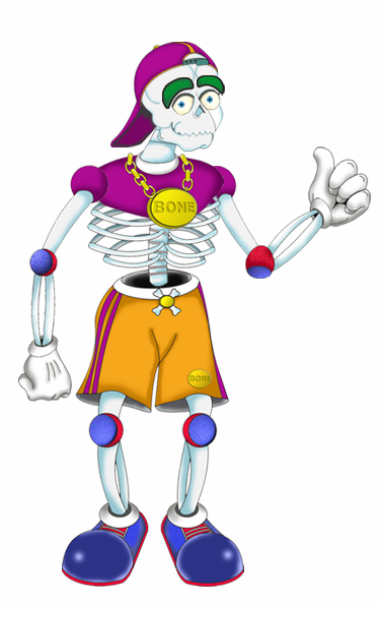

Fig. 1. BONE, mascot designed for contents describing

At the end of this stage we defined the whole program *layout*, by pinpointing interaction elements that were grouped according to its importance, easy to use and/or setting into motion. According to these concepts, the items were grouped in one of the following 4 functional areas:

a) *Top Toolbar:* On this toolbar we can find the software's control elements, as well as the system user's situation and reference indicators.
b) *Host Area:* On the left side there is an area set apart for the host. In this area the mascot performs several movements without interfering with the *Animation Table's* elements.
c) *Animation Table:* This area characterized by a white board, in which animations described by "BONE" are posted and where all the animations, films and also questionnaires appear. On the top of the animation table we can always see a text about the subject being viewed.
d) *Lower Toolbar:* Directly below the animation Table is a bar designed exclusively for subtitling. The prime objective of this area was to make the contents accessible to hearing impaired people, thus broadening the number of possible users of this program.

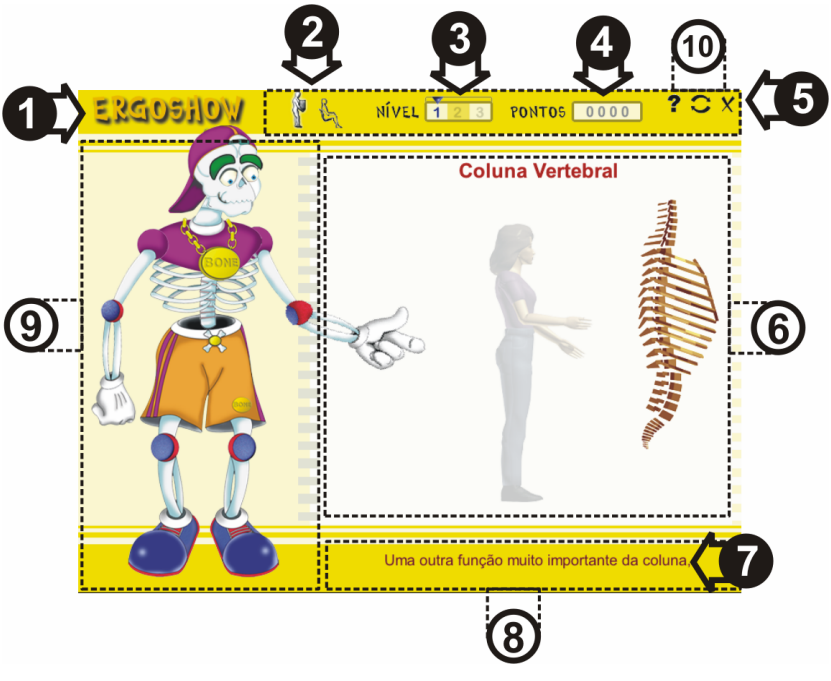

Fig. 2. *layout* items 1- program name; 2 - module indicator showing where the user is; 3 – indicator of the level at which the user is; 4 – indicator of the score obtained by the player; 5 – help button; 6 – return to previous page and leave the program; 6 – animation table; 7 – area reserved for locution subtitling; 8 – lower toolbar; 9 – host's area; 10 – top toolbar

In order to memorize the contents, a little game of multiple choice questions and answers was developed, shown at the end of each level, in which, the player is confronted with a string of questions concerning the contents shown on the previous Level. Each question was awarded 100 points, therefore, it was necessary to answer at least 60% of the questions correctly in order to allow the user to advance to the next

Level. The user had the possibility of skipping the question or reviewing the contents. These resources could be used to help the user answer the question correctly.

As an incentive for improving performance, the question game had an evaluation system for the player's performance, where a collection of expressions (*smiles*), placed next to the scores, showed four levels of satisfaction Satisfied – Serious – Sad and Bombastic

5 Conclusions

Understanding potential users' difficulties, needs and expectations and the main negative and positive aspects that could complicate or optimize the relationship with the system or the learning, made the system become more adjusted to users, as well as, avoiding the great number of surveys proposed for usability analysis after product completion.

Thus, the methodology presented in this work had the merit of involving potential users along the whole development process of an information system. We contextualized this methodology in the design of an educational software ensemble, in game format, for adolescents from 8 to 14 years old.

The main conclusions allowed us to:

- Evaluate the characters' concept from the beginning, although in the beginning there was some doubt about the success of some of them.
- Make small adjustments in the characters, allowing to better identify adolescents' expectations.
- Evaluate the success of transmitting contents in a game format, with difficulty levels and scoring.
- Verify if the presented examples comply with the future users' everyday realities.
- Identify and correct the first graphic and navigational environment proposal's small problems.
- Evaluate the used language, introducing some expressions used by adolescents, without damaging the transmitted information's thoroughness.

Systematizing the potential users' involvement in the various development phases of this information system allowed to:

- Better adjust of this system to the users' mental model, their needs and expectations.
- Identify mistakes that would be difficult to correct at the end of the project.
- Reduce the expenses for development, as corrections at the end of the project would mean added costs.

Regarding the use of PD, we became aware that applying these kind of techniques and others, originating from organizational psychology and management areas, are extremely important for managing the development of educational products, for controlling each one of the development stages and reinforcing individual competencies of each one of the involved persons.

The UCD has brought enormous benefits to the project. Only by frequent enquiries in each of the product's development phases, is it possible to adjust, in the best

possible way, what designers think of the project regarding imagination and expectations of the target population. Mainly because imagination varies regarding to [6]:

- Culture of the analysed people;
- Age group of the target population;
- And gender.

It was surprising to observe that the system attracted the attention of individuals out site the proposed age group, mainly adults, with different kinds of profiles and cultural levels. Therefore, this product generated the interest of some companies that requested them for training their staff in Safety and Health at Work.

Information technologies have been used in school environments for over twenty years, with most of its development taking place in the eighties, when personal computers emerged [3]. It spread through different kinds of social interest areas, and teaching was no exception, and the advantage these systems offer, being well-known. An important reason that justifies applying information technologies in this environment is the capacity to improve student's learning, due to the fact that it gives the student an opportunity to develop different kinds of competencies, continuously increasing in today's information society.

The making of this project proves as it was show, to be a welcome tool capable of transmitting important issues.

Through tests done by future users and from opinions collected from people of different age groups, is it possible to conclude that Ergoshow conveys the intended know-how a whole, viewers were generally satisfied. Regarding developments from the first version to the second version, these were significant concerned to graphic quality, increasing empathy with the final user and decreasing the distance with similar software. Contents are more dynamic and interaction with the player was increased.

The developed tools confirm, through the first tests done with users, an enormous potential for transmitting contents to different age groups. The product was enthusiastically approved. All students referred they liked the characters, the colours and were, also, able to understand and assimilate all the transmitted contents.

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