USING HYPERMEDIA AS A SUPPORT FOR COMPUTER SCIENCE COURSES IN PRIMARY SCHOOL

Design and Evaluation of a Web Based Multimedia Framework for Primary School

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Abstract: Teaching children is a very critical task due to several factors. Attention in children is limited in time, very often the kind of information they face at school is conveyed in abstract and formal way and, most of all, it is not playful. Moreover, they have to deal with devices normally designed for adults (i.e. mouse and keyboard among all) and could have psychomotor difficulties to their firs use. For these reasons, the learning-by-doing approach, together with the edutainment philosophy, are ideal learning methods in courses designed for children. In this work we present a teaching framework based on the learning-by-doing approach to support several subjects in primary school curricula, especially computer science courses preparation, but also used successfully in foreign language courses preparation.

1 INTRODUCTION

One of the major issues in recent years' debate about learning and education is the role of multimedia as both tools and subjects present in the teaching environment. Technology becomes at the same time the tool to study traditional subjects and is itself a subject, because the new literacy challenge will be centered on the ability to deal with information technology. Concerning the first point, obviously, the introduction of computers as tools in the classroom will not set aside the teacher, because her presence still remain the crucial factor in education. To accomplish this, psychology can be helpful, as we will see later. The second issue concerning information technology is its role as a new subject; this is far truer today when we face with the capillarity of informatics in every aspect of citizens' life. The challenge of today's school is not to give students data to collect and retain, stuff that will be obsolete when they will be adults, rather it is important to teach them how to learn new things, how to reason about their reasoning, how to find new connections among old and new information. Computers and multimedia can be a useful tool in this direction, but as happens for every tool, the solution is not inside it, but in the way we use it. The power of computer graphics may hide the vacuity of some products, but finally the student has only a sort of entertainment, with any education (Norbert M. et al, 2003). The capacity to grab the attention of a child is a necessary requisite of a multimedia edutainment tool, but it is not sufficient.

Concerning this trade-off between attention-grabbing learning environments and education, we considered as target of our applications, children of the primary school (5-10 age).

Attention of children is limited in time and in capacity, for this reason it is a very critical factor in primary education and we have developed multimedia framework and learning applications based on it to support attention in the learning task. To achieve this objective, we used different combination of components: narrative elements, graphic elements and music. Our aim was to support

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learning with an attractive tool to be integrated with traditional learning styles.

The challenge for every edutainment tool is to be a useful method to improve learning, and understanding some basic subjects in the primary school curriculum requires skills that we tried to trigger in our application: learning-by-doing and metacognition. With the former we mean the experiential aspect of a concrete activity that gives a new knowledge to the child, a process of continuous enrichment directly achieved with actions (Cadamuro, A., 2004),(Marton, F. et al, 1976),(Kolb, D.A., 1974),(Honey, P. et al, 1986),(Norman, D.A. et al, 1993). With the latter, metacognition, we see the higher level of understanding, where the children can think about their learning styles and can manage abstract concepts about knowledge (Sternberg, R.J., 1985).

2 TEACHING COMPUTER SCIENCE TO CHILDREN

Computer science teaching has been one of the most challenging applications, due to the double nature of computers, both tools and topics to be learned.

The first interesting experiences in teaching of computer science appear in the early 60s and are focused on programming language (George Lukas et al, 1972). In the last years, the world registered a disruptive social phenomenon called "Personal Computer" based on graphical and multimedia. The role of computers changes from "calculator machine" to "everyday tasks support machine". The objective of research on ubiquitous computing is a world where interaction with computer is natural and easy and electronic in invisible (Mark Weiser, 1991),(Norman, D.A., 1998). But nowadays computer electronic has not yet disappeared and computers are difficult to use though they are much pervasive in our life. The teaching of computer science from the early years of the school aims to bridge these gap.

2.1 How?

In this context, a new paradigm of computer science course preparation aims to integrate the use of computers into the cultural curricula of each citizen. Programming language is only one aspect of computer science teaching and it is very useful to develop logical faculties related to the use of computers. In fact it is not important teaching the computer as a calculator machine, but it is important to teach how this machine can be exploited and used in everyday information based tasks (Kirk, M. et al, 2004).

2.2 When?

The ideal moment to begin teaching computer science to children is not well defined. It depends from several factors as children's age, their psycho-motor skills, the pre-school environment where they had their first experiences.

2.3 What?

Teaching computer science implies the definition of contents and methods that should be included in a computer science course for children. In this section we report the three fundamental skills:

Use of mouse and keyboard. Keyboard and mouse are the two well-known data input methods for modern computers. In particular, the mouse is the pointer device used for moving on the graphical interface and give commands, the keyboard is the input method for words. At present these devices are considered the best in term of usability, for these reason it is important to learn first the use of them. Nevertheless, learning to use keyboard and mouse is a critical task in computer science teaching. Children have both reduced psychomotor abilities and they must interact with devices that are not designed for children, and performance between children and adults using mouse is different (Hourcade J. P. et al, 2004),(Inkpend K. M., 2001).

Basic knowledge of the computer principles. Nowadays, a basic knowledge of computer is fundamental for its correct use. Actually this deeper knowledge of the internal mechanisms let to a better understanding of the higher level abstraction, such us the copy of files into a folder stored on hard disk. Another aspect is the programming of the computer which is very useful to understand computer philosophy. Programming visual worlds or digital games, children can learn the logical aspects and the mechanisms of programming (Smith, D.C. et al, 1994),(Myers B., 2002).

Use of the programs to solve everyday problems. It is not important to explain the functions of a program, but it is important to relate the use of a program with the everyday problems the computer can solve, For example, how can I use a computer to

classify, to send a letter, to combine text and images?

3 THE COMPUTER SCIENCE COURSE FRAMEWORK

We implemented a multimedia framework to support teaching of computer science in the five classes of primary school. The framework has been designed taking into account all the skills necessary to prepare children, and the methodology approach to it was user participation design (Carroll, J. M. 1997),(Beck, A., 1993) Our challenge has been the design and integration of the entire modules necessary to accomplish these objectives, in an articulated but homogeneous and interactive application. For this reason, we designed the novel framework combining a large number of multimedia solutions and didactic strategies.

3.1 Didactic Strategies Integration

The overall framework implementation approach is primary based on the combination of two didactic strategies: (i) the application of learning-by-doing methodologies: over 30 articulated modules based on this philosophy have been realized; (ii) the use of narrative moments: the course is based on a trip into the computer world.
According to the didactic objectives, we accurately applied these strategies in the preparation of a multimedia framework and computer science course. In particular, we used dialogues and narration as glue (Weller, 2000) between other moments such as games, simulations or training

3.2 Multimedia Elements Integration

The multimedia framework is an articulated combination of the following elements:
Virtual characters: two children, a girl and a boy, and a fantasy character drive schoolchild in the magic world of the computer. We choose to use two real characters of both sexes, in order to let the children identify themselves with the actors of the story, and a fantasy character, as a funny and friendly information provider, a kind of omniscient guide.
Narrative dialogues: the virtual characters make observations and questions. In this dialogue the schoolchild is involved and her attention is grabbed by the fast rate of questions and answers.
Games: we divided and balanced games into action games and reflection games. Both uses the playful element to achieve the objectives. This division mirrors the two main aspects of the ideal learning outlined before: reflective and experiential activities. Moreover, games have the added value of scores, a crucial feedback of children's performance and a solution to involve them in the educational experience.
Trainings: similar to games but without the playful elements. For example a training may come before the "bubble game" to learn the use of the keyboard. In this phase children can acquire the best mastery of main actions without the frustration of initial failures.
Simulations: environment in which the schoolchild can freely try different solutions to understand a concept.
Music: according to the type of game, we composed and tested different typologies of rhythms and music. For example: we inserted a dynamic music in action games and a reflective music in simulations.
Creation of paper material: the paper versions of the modules were found very useful to reach the didactic objectives and are used in traditional laboratories moments.

The framework is modular and the teacher may select his/her teaching path as prefers. In fact, the courses inspired by such framework are nor stand-alone or support material. With respect to other experiences, our effort has been to provide children with an involving and immersive application with a clear story and path to follow and with the goal to be a support to the didactics and not a self-centred application, our framework aims at developing a fruitful interaction between schoolchild and teachers.

We implemented the framework using Macromedia Flash 8.0, a high performance technology for animation with a high penetration in computer connected to internet (98%).

The table 2 describes some of the didactic elements we designed and included in a computer science course based on our framework.

4 FRAMEWORK EVALUATION

After a first phase of laboratory tests with a focus group formed by teachers, we developed a wide set of data collection procedures in order to have a reliable feedback about the real usefulness of our framework, ranging from reports filled in by teachers to tests on children to check if the new

Table 1: Some of the 30 multimedia didactic modules of computer science course.

Didactic element	Type	Didactic objectives
Presentation of "Mr. Computer".	Dialogue	Fundamentals of computer elements and useful functions.
Burst the balloons	Game	Use of "mouse motion" action (1st level of mouse learning).
Bubbles explosion (fig. 2b)	Training and game	Correct use of the keyboard with the two hands. Coordination betweer video and keyboard visions (1st level of keyboard learning).
Write the words	Training	Use of the keyboard to write words (2nd level).
Travel inside the desktop	Dialogue	A simple explanation of the desktop metaphor and icons.
Order the files	Game	Order files into folders.
Draw	Simulation	Draw with a typical drawing program.
Game programming	Simulation and gam	Computer programming and logic. Visual programming of a game.

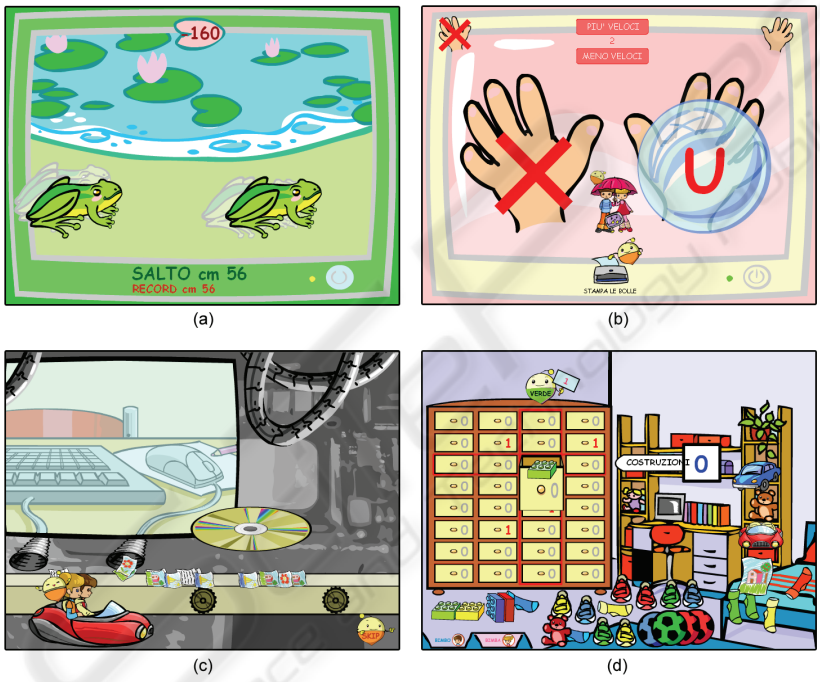

Figure 1: Snapshots from the computer science course for primary school.

learning method was effective and efficient. The questionnaires provided to teachers covered all the aspects characterizing a well-done multimedia edutainment tool.

The simple test on children checked if their learning reaches the required levels and if it is different, qualitatively and quantitatively, from traditional learning.

In particular, we measured users acceptance of application in term of effectiveness, efficiency and user satisfaction (Frokjaer, E. et al, 2000). The target users we considered were teachers and children. We asked one hundred users about pleasantness of interfaces and games. Children found the graphics nice and the games engaging. Teachers found the application useful if integrated to their traditional courses. In particular, they found very useful the training games, such as the three level game to learn the use of keyboard and mouse.

5 CONCLUSIONS

We have developed a web based multimedia framework to teach basic subjects of the primary school curriculum, from computer science to foreign language. We combined together multimodal, multimedia, traditional teaching and narrative

elements. The interesting aspect of this implementation relies in the close adherence to the Italian Ministry of Instruction's guidelines (Italian Ministry of the Instruction, 2004) about the contents of the several subjects teaching for primary school. We tailored each game and activity paying attention both to these rules and to the criteria for a good cognitive design for edutainment, i.e. thinking about our final user: 6 to 10 years-old children. We got the strong feedback from teachers during the planning, the implementation and the distribution in schools of this application, because our tool has to be a support to traditional didactics, not a substitution. In conclusion, our approach aims to be a reliable support in primary school teaching, it is characterized by a playful style and by experiential methods, but it cannot express its potential without the presence of the teacher. Our applications have been designed in order to be tuned on as many learning styles as possible, mixing experience and reflection, action and storytelling, pure play and scored game. But such a flexibility will be lost without the sensitivity of a good teacher.

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