CROSSING BOUNDARIES WITH *GEODROMO*:
AN INTERACTIVE CROSS-MEDIA EXPERIENCE

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ABSTRACT

In this paper we present *Geodromo*, a prototype of an educational multimedia system, part of the Portuguese *Ciência Viva* (Live Science) education program, aimed at young people and designed with innovative characteristics. The project is based on a robotic multimedia simulator platform and an online puzzle game aimed at teaching Geology, Climate, Biology and Archeology associated with a Portuguese National Park. The development of the prototype was challenging as it was intended to uphold the interweaving of multimedia events with online resources, based on research that promotes the design of emotional and cognitive factors in educational communications. One of the main concerns was the analysis and study of some pedagogical issues in order to make the project sustainable. Whatever the scientific relevance of the topics and the inherent techno-cultural appeal of the project, the aim was to bring students closer to an "undercover" reality, as authentic as it gets with digital media, and allow for them to convey emotions naturally. We found these to be major success factors in the establishment of an effective relationship between the technology and the pedagogy required to study those particular science topics.

KEYWORDS

Educational multimedia, exploratory learning, robotic simulator platform, educational games.

1. INTRODUCTION

This is a first account of project *Geodromo* after its completion and is based on qualitative data collected last year. In this project we took on the challenge of involving students (up to K-12) in a holistic sensorial experience that goes beyond the usual point-click-watch through the computer interface. Instead of just creating a virtual world accessible on a limited screen with a limited interface, always a viable task with the technology available at this time, the idea was to connect the real environment of nature with the virtual environment of a multimedia simulator and an online game. On the other hand, as techno-cultures become pervasive and create new challenges for educators there was a need for exploring new ways of engaging with the world and with others in an educational context (Gredler 2004).

The *Geodromo* multimedia project became fully operational last year. It deals with science themes relevant to the Natural Park of Aire and Candeeiros Mountain Range located in the center of Portugal. *Geodromo* is housed in the building of *Ciência Viva* (Live Science) in the park and has the technology that makes possible a (virtual) journey of 175 Million years, to the origins of the Alviela spring. It covers a large part of our planet's history, backed up by computer technology of the last generation, simulating cosmic phenomena, geologic events and climatic change. This project is an initiative of the City of Alcanena, in partnership with the Natural Park of Aire and Candeeiros Mountain Range, the School of Technology and Management of the Leiria Polytechnic, the Portuguese Open University (Universidade Aberta), and with the collaboration of the Center of Geology and the Museum of Natural History (Lisbon). The main goal of *Geodromo*, as a multimedia experience, is to launch the visitor on a virtual journey, to discover historical and scientific knowledge, and participate in an educational online game, as well as other activities available (see trailer here: http://www.youtube.com/watch?v=rxa_OwrIaUA).

The *Geodromo* platform is basically a mechanical simulator with 16 seating places controlled by a computer and moving in synch with a video projection. The simulator "carries" the visitor on a trip to the origins of the Alviela spring, showing the formation of the planes where herds of dinosaurs roamed, taking the explorers to the edges of the mountain range with its watercourses, flying high over rims and abysses and diving in caves with the reassuring company of speleologist-divers (fig. 1).

***Figure 1**. Mechanical simulator with 16 seating places.*

The video and the movements of the robotic platform are capable of bringing up the emotions and engage visitors in science themes such as fundamental geologic phenomena, the drift of the continents, the impact of a meteorite or the rise of the limestone mountain range. These 3D images (fig. 2) are computer generated and integrated with real images in a specially designed video narrative. They supply all the clues for tackling online game quests and are complemented by educational materials available in the project website (http://www.alviela.cienciaviva.pt/home/). This robotic platform is an immersive environment if we consider that in a virtual reality simulation the participant is immersed in a virtual world that fully replicates at least three sensory inputs - vision, hearing, and the kinesthetic system - which allows for a complete physical interaction with the world. However, in *Geodromo*, direct user interaction is not viable with the "heavy duty" robotic platform and multimedia system, but can be later accomplished online with educational resources.

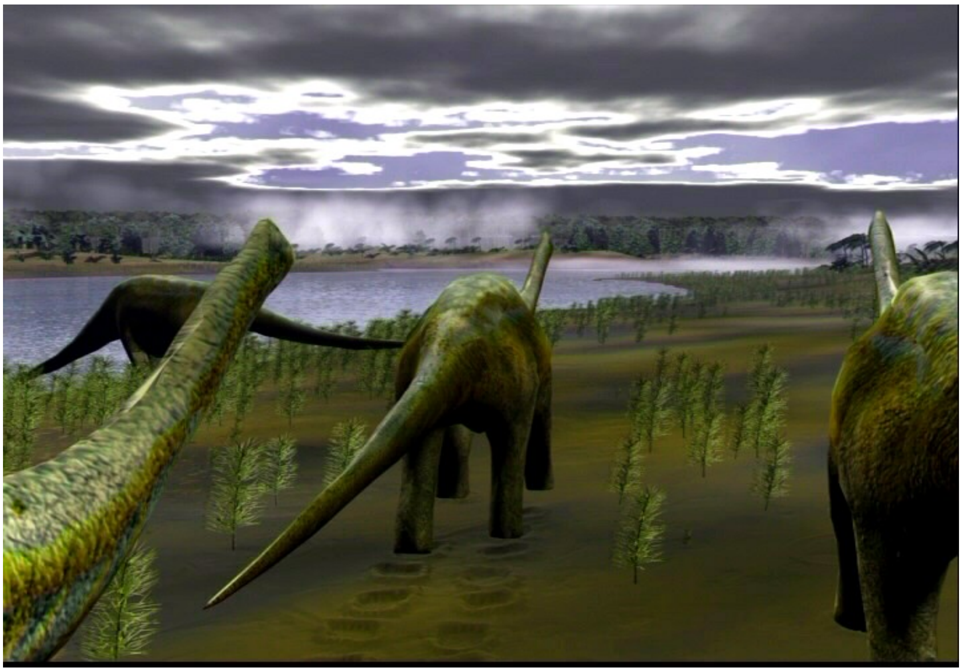

***Figure 2**. Computer generated image of dinosaurs roaming in the Natural Park.*

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2. TECHNOLOGY AND PEDAGOGY

In *Geodromo*, the technologies used are simultaneously “figure and ground” as they embody the virtual environment created but also become instruments to study a historical reality long gone. Because technology has an impact on human cognition and therefore on human learning, the emphasis was first put on learner engagement and on the capacity for visualization, namely, the presentation of 3D structures (such as dinosaurs or geologic strata) in ways that maximize learning. Interaction was also carefully studied; considering that a computer screen-based simulator only provides a limited interface to the human sensory system, certainly very far from physical reality, the robotic simulator was the smarter choice to establish a bridge with the real world. Of course, an ideal virtual reality simulator would replicate all our senses but the introduction of motion in this case definitely becomes an added value to the multimedia experience.

Behind all this technological apparatus there was much work involved. It is essential to point out the role of the different scientific consultants who collaborated in the production of texts, graphics and images to give scientific credibility to this project. In all, this venture involved a wide variety of human and technical resources, including authors for the multimedia content and a large video production team. Prominence had to be given to the engineers that created the robotic platform and the designers who developed the animated computer graphics, as these were critical factors in the project. The production of all the multimedia components took more than three years of intense labor and involved an iterative and creative process that occupied a great deal of the project time. Advanced technical resources were used in the production of the video material to obtain:

- Images of inaccessible spots in the Natural Park;
- Images of caves and speleological activity;
- Images of diving in the underground ducts of the Alviela river;
- Aerial images (by helicopter) over the mountain range;
- 3D graphics to illustrate 175 million years of earth history.

Pedagogy considerations dictated that the video narrative shouldn't be a kind of scientific fiction piece. Everything was narrated with current scientific knowledge in mind and set out as if the user was part of the computer generated images, immersed in a theater environment with 3D sound and comfortably riding a moving platform. Digital image technology was able to show the alterations in continents' morphology and the global climate changes that converged in the formation of the actual limestone mountain range, while, at the same time, the infrastructures of underground water draining were slowly evolving. All this was clearly and accurately shown by means of computer animation. In certain episodes, ambiguous situations were exposed to provoke curiosity and boost attention. In the *Geodromo* video, the intention of the director and the authors was to avoid a traditional didactical approach, as used in many documentaries and educational programs, and to follow a pedagogical approach closer to videogames: very basic information is first given, a timeline to follow is always present and the flow of emotions is deliberately motivated.

The idea that technology can provoke radical changes in pedagogical methods and in processes of educational communications reflects a paradigm change that we believe to be decisive. The relationship between technology and pedagogy changed substantially in the last decade and must be considered in the light of the recent developments in digital technology, as these definitely entail a rupture with the tradition of a rigid curriculum based instruction, for example, simulation-based media such as games challenge both *how* we teach and *what* we teach (Squire 2008). Also, given the state of the education today, teaching must become cross-disciplinary and cross-cultural. Through the intersection of multiple perspectives and approaches, new theoretical insights will develop and unexpected practical solutions may emerge. In recent years, the need to reorganize education became a necessity and finally we have the perception that the use of digital media may produce effective and global results. These results are not limited to mere experimental situations as it was done in the past (Bidarra *et al.* 2004), as evidence shows that some progress is under way: control of learning processes shifted from the teacher to the student, book materials are replaced by multimedia materials (mainly, podcasts) and the information is now available online instead of offline. But, perhaps more important, learners cannot continue to be taken as simple users as they are also producers of multimedia materials. This was true in the past (Bidarra & Mason 1998) but today's students not only engage with creative activities such as the production of a videoclip or a blog but also spend their days interacting online with multiple media: exchanging messages, sharing images and playing games.

On the other hand, along with the pedagogical advantages offered by the new digital technologies, it seems there is an exaggerated emphasis on the technical characteristics of the multimedia products and little interest in actual educational communications. This superficial attitude means that multimedia and games are seen by many as high-tech entertainment options but not as education tools, even with the proven failure of more conventional instructional resources. But it also means that, in many e-learning cases (Bidarra & Dias, 2003), advanced multimedia materials and websites full of rich content do not support effective educational communications and are deficient as instruments for instruction. Very often, graphical animations and videos presented have an excess of information that becomes difficult for a student to apprehend the right conceptual framework within the instructional activities and resources. The same is true of many games that fail to deliver the curriculum while involving students in endless (and useless) routines of styling and data manipulation.

3. AN INTERACTIVE CROSS-MEDIA NARRATIVE

Research has shown (Roschelle *et al.* 2000) that learning with games "is most effective when four fundamental characteristics are present: active engagement, participation in groups, frequent interaction and feedback, and connections to real world contexts" (p. 80). At a first glance this is true of *Geodromo*, as there is a great potential for students to learn through gaming that extends and builds on tacit knowledge, but perhaps there is some difficulty in classifying this mix of mechanical simulator with online game. A recent trend has been the so called "augmented reality games", the kind of games that are usually location-based and have a context-sensitive dimension related to a precise physical space (Squire & Klopfer, 2007). Also known as "enhanced reality", it usually refers to virtual experiences being played out in real-world spaces. In general, contextualized clues can only be discovered via the digital interface when a player with a mobile device arrives at the right location. In the case of *Geodromo* we can say things are turned around, the (first) physical part of the game is on location, takes the form of a video projection synchronized with a robotic platform engineered to create the right "virtual context" for the game to take place. *Geodromo* comes closer to the concept of an alternate reality game, i.e. an interactive, cross-media narrative that evolves based on knowledge associated with a real world setting. In this case the high emotional impact of the physical experience - people seat on a robotic platform that moves and jumps in synch with a video that is being projected – is an important feature to engage the players in further gaming/learning activities. Of course, this experience takes place in a physical space but it's also a "virtual journey" in the sense that the content presented is a 3D digital reconstruction of ancient times, featuring extinct dinosaurs, prehistoric landscapes and the first men hunting for food, compressing 175 million years in a 10 minute video presentation.

How does the game work? A kind of scientific detective story was created online. For example, a player of the game has to find a clue in the 3D representation of the Alviela river and this triggers a further investigation process. The player follows up the clue, locates a particular information online, has to answer specific questions and inputs the right information within the game environment. Players may also negotiate meaning through the social context of game play that promotes collaboration. They do this through the co-construction of knowledge as each player may use specific information, bridging physical and digital game space with support on messaging. Usually most students (K-12) do it on their own while the younger ones need assistance and guidance (usually by teachers or parents). Information has been layered to address a wide public but this is a feature we are still evaluating.

4. EMOTION AND COGNITION ISSUES

The current model of pedagogy in schools (and universities) is essentially teacher focused and one-way communication. It tends to isolate the student in the learning process. Evidence shows that students learn more by collaborating with their teacher and with each other in the context of educational narratives (Pachler & Daly 2009). Also, there is evidence that a new model of education is emerging, one that is student-centered, networked, customized and collaborative, leading to the creation of mechanisms through which infusion experiences and other rich learning contexts may support activity in novel situations (Shaffer 2004). In addition, it is now recognized that student emotional expressions are a part of the learning process and also an essential component of basic education, but these continue to be so far a minor concern in schools and higher education. There is a growing body of evidence from the neurosciences and the cognitive sciences that stresses the importance of emotions in cognitive processes and memory operations. The Portuguese born neuroscientist António Damásio developed a theory of emotion that has evolved from his first book, *Descartes' Error: Emotion, Reason and the Human Brain* (1994), which explains how feelings are entangled in the cogitations of the brain and the circumstances of the body. In his second book, *The Feeling of What Happens: Body and Emotion in the Making of Consciousness* (1999), Damásio explores the role of emotion; he attempts to connect the neurology of emotion to the neurology of consciousness and extends this to the existence of a sense of self. Essentially, Damásio states that mind and body are inseparable and integrated via mutually interactive biochemical and neural components, such as the endochrine, immune, and autonomic neural constituents, which produce chemical and electrical transmitters. Let's imagine a young student riding the *Geodromo* platform in full motion, he is emotionally satisfied and fully engaged in the experience. Suddenly there is a strong thump and a dinosaur appears in close up. The sensory input sends the brain the image of the dinosaur. The brain sends signals using neurotransmitters telling the body to react: the heart speeds up, the muscles tighten, blood rushes to certain parts of the body. Simultaneously, the image of the dinosaur is sent to other parts of the brain for analysis. This analysis accesses stored knowledge and memories. These working regions of the brain continue to process further information to the brain hub which then sends another message to tell the body to relax. The heart slows, the muscles relax, the blood flow returns to normal. Why? The robotic platform has slowed down and the images suggest that the dinosaur is walking away (relief sigh). Later on, while playing online, that situation has left a mark and the student definitely remembers the dinosaur and its specific features.

We argue that any project developing a game or multimedia environment must acknowledge the value of emotions as a tool to be used in the cognitive dimension, particularly when the education and training of young students is involved. There is also a need to shift curriculum focus from knowledge about things to knowledge significant to each learner, and this must include emotional play. Changing the focus of education in this way is not an easy task as the current school environment and its operation are very distant from the world of today's digital natives. In this context, *Geodromo* tried to break away from the mainstream didactics of Geology, Biology or Archeology, but also tried to shift the educator's view on emotions, by giving it new status, as a dimension that co-exists with the intellect, taking students to do something new: ride on a robotic simulator platform and later interact with an game online environment.

Ideally the *Geodromo* game should have been more complex and based on simulation, with several levels of varying degrees of difficulty through which the players could move and learn new skills, however, because of financing constraints, the first instance of the game became more like a puzzle falling within the detective genre. Nevertheless, the success of the project is evident and has been reassuring to see some thousands of students (and general public) use the simulator platform. Furthermore, teachers have been using both the platform and the online materials to engage students and deliver part of the curriculum.

With the *Geodromo* project we also found that it is pedagogically more effective for teachers and young students to be able to graphically see and discuss abstract concepts, for example, in areas such as Geology, Climate, Biology and Archeology (fig. 3). We feel that instructional design and scientific representation today converge in the creation of digital 3D models that can show a "new" reality (even if long gone or difficult to apprehend). No matter if some scientific representations are just educated guesses based on the data available (e.g. dinosaur bones), we think it is worthwhile to promote student's engagement and facilitate access to some curriculum subjects by means of digital technology.

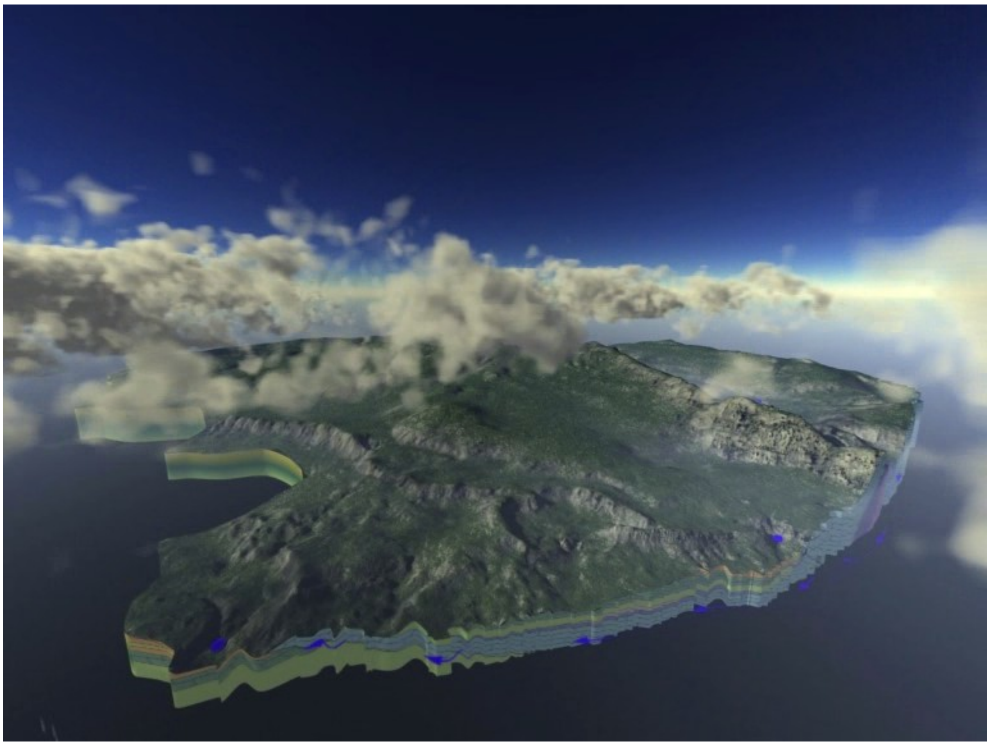

Figure 3. *Geologic model of the mountain range showing rock layers.*

In a project of this kind it's also important to emphasize the imagination factor, often described as the capacity to create mental "images", as a key element of educational communications. When we try to describe imagination, most of the time we mention the capacity to develop images in our mind, frequently images of things that not even exist in the real world. The nature of these images is sometimes difficult to describe, they can be almost-pictorial, or exact images, or even vague impressions. For Egan (1986) imagination is the support of the so called oral cultures. In these cultures the knowledge of the social group has to be preserved and kept alive for future memory. This implies the of use techniques of representation and narration with a recognized social value, for example, words and rhymes or music and rhythm, that are important for the spreading of a culture and the prospect of future memorization. Today this is achieved through digital technology, social networking and games in exciting new ways (Web 2.0, podcasts, MMOGs, etc.), the only difference is that knowledge is not so much stored in people's memories but widely distributed across a network of electronic devices. However, this is another interesting issue for future discussion.

5. CONCLUSION

Geodromo was designed to be an innovative prototype of an educational multimedia infrastructure. The primary goal was to provide young students and general public with knowledge of important concepts in several domains, namely, Geology, Climate, Biology and Archeology, related to the specific context of a National Park. To achieve its goals, *Geodromo* employed a number of techniques closely tied with he improvement of learning quality, including the explicit consideration of emotional and cognitive issues in educational practice. *Geodromo* was a pioneer effort to bring about new ways of involving students in a holistic sensorial experience and exploring beyond the usual keyboard, mouse and screen practice. So far, the thousands of young people attracted by the simulator are a promising indicator. In addition, many teachers have been using both the platform and the online materials to engage students and integrate with formal curriculum and instruction. However, in what concerns the online game setup we sense that a lot of work still has to be done. A future major concern is to improve the integration of the "virtual reality", presented by means of the robotic simulator, with the digital environment accessed online, in such a way that the narrative carries on from one to the other in a more fluid and seamless manner.

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