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The Digital Diorama project: the design

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Abstract

Digital technologies can become important tools to enrich learning and provide longer-lasting effects. We have digitalized some of the Natural History Museum's dioramas and created multimedia interfaces accessible through an interactive whiteboard (IWB) to promote collaborative learning. Our aim is to enhance some biological and ecological knowledge, an essential basis for sustainability education. Thus we have developed *Digital Dioramas* which can be used for different levels of exploration. The users can use respectively: feelings that they can imagine, information about living things, cross-cutting themes on important biological issues with links to different aspects of everyday life. The results of the initial testing phase, carried out with teachers represent an opportunity for their professional development and show a high level of communication.

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1. Introduction

The *Digital Diorama* is a research project founded by the Ministry of Education, University and Research managed by the learning biology research team of the University of Milano-Bicocca †. This group of researchers has been working for some time on the realization of learning environments and teaching devices (online courses, learning objects, multimedia objects and so on) using new technologies (Gambini, Pezzotti, & Samek Lodovici, 2005; Pezzotti & Gambini, 2012; Pezzotti, Broglia, & Gambini 2014). The aim of the group's research is to go beyond the traditional approach for teaching life sciences, an approach which has proven to be inadequate in

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† Law 26 June 2012 no. 369 - Promotion of agreements with other government bodies, Universities and other public and private bodies. The project involves these partners: Politecnico of Milan – Indaco Department; University of Rome “Tor Vergata” - Department of Science and Technology of Education; Copernico Comprehensive Institute; Parco Nord Milano.

producing meaningful and lasting learning. Memorizing classifications and definitions is not effective: what matters is acquiring tools and skills to process the information that comes from somewhere else (media, newspapers, Internet...) and to be able to integrate it with existing knowledge. Nowadays, in fact, school is no longer the only place for information and learning. Various disciplines can be explored in different ways, using many constantly changing resources. Therefore, school should be a place that is able “to create a network among the complexity of new ways of learning through daily guidance that is attentive to methods, the new media and multi-dimensional searching”[‡].

Digital technologies provide a great opportunity for schools. These respond to the need for knowledge in society - including lifelong learning – and in increasing young people's interest in order to achieve learning outcomes that are useful in everyday life has been widely recognized[§]. If properly exploited and used according to socio-constructivist teaching methods, technology becomes an important amplifier of communication and interpersonal cooperation, a genuine intellectual partner that can help bridge the gap between information and learning (Ghislandi, 2012). 2.0 web technologies encourage participation, sharing and collaboration. Thus, virtual learning environments become places for experiences through actions, teaching practices, relationships with the objects of study etc., and social places thanks to interpersonal relationships, discussion and sharing. In learning environments, everyone is an active member of a community, everyone is entirely involved and helps complete a task or a shared project, offering their own experiences, knowledge and skills to build collective knowledge, thanks to the chance to discuss and learn through interacting with others (Herrington, Reeves, & Oliver, 2014).

The *Digital Diorama* project intends to implement the teaching and learning of certain subjects in biology, creating innovative learning environments that are accessible through PCs, tablets and interactive whiteboards (IWB). In Italy, interactive whiteboards are available in schools (see Figure 1), although the implications of its use on teaching methods has not been widely investigated.

Nomenclature In Italy, as in many other European and American countries, the use of IWB is long-standing. It is estimated that in 2011 5,300,000 were installed worldwide. In Italy, as early as 1997, the Ministry and the Lombardy Region embarked on a number of projects. IWBs are used in schools in two main ways. The first focuses on form at the expense of content and makes extensive use of images, video and sound. The second use reflects on the integrated linguistic codes that characterize instruments and digital products and the effects that these can generate (Calvani, 2007). We are talking about: multimedia, the term for the union of different media; visualization, thanks to different applications to represent an image in multiple dimensions; tactility involves using the fingers instead of a mouse; cooperation, the many possibilities of being part of a community and working with others to reach a common goal or realize a shared project.

To date, the IWB has been introduced in schools without appropriate reflections concerning individual and/or collective use, stylistic and/or linguistic use. Its tactile properties have not yet been completely investigated, nor has the quality of the educational software for IWBs been systematically evaluated. The educational application features of other innovative IWB content has not yet been analyzed. Many questions are still unanswered and the first studies on training teachers to use the IWB and teaching with the IWB have not yet been thoroughly investigated. The *Digital Diorama* project has created new opportunities to study and analyze teaching and learning with digital technologies still to be explored.

Fig. 1. Data regarding the spread and use of the IWB in Italy.

The IWB can be an excellent opportunity for education: it permits organizing resources, preserving and distributing writing, which can be edited and integrated with other multimedia materials, as well as building and sharing knowledge and skills, promoting participation, leading to the creation collaborative learning (Gagliardi,

[‡] 4 settembre 2012: *Indicazioni per il curricolo della scuola dell'infanzia e del primo ciclo d'istruzione*.
http://hubmiur.pubblica.istruzione.it/web/istruzione/prot5559_12.

[§] European Commission, DG Education and Culture (2004). Study on Innovative Learning Environments in School Education. Final Report.

Gabbari, & Gaetano, 2010). The full educational potential of the IWB is expressed when it is used as a “cognitive space” where students construct their own learning through research, cooperation and problem solving (Esposito, 2012). The proposal presented here aims to increase the use of IWB in this sense.

2. Aims

The acquisition of some aspects of scientific disciplines can be stimulated, enriched and facilitated by exploiting resources found in museums, which can be transformed into real learning environments. Among these are dioramas: ecologically and paleontologically based setting-models which act as "windows to look in on." The *Digital Diorama* project involves the digitization of dioramas and transforms them into multimedia learning objects that can be used in schools, museums and other venues.

This project promotes the use of digital technologies as a tool for presenting some biology and ecology contents in an original way and to innovate teaching practices currently implemented in schools. *Digital Dioramas* are also technological devices that can encourage the process of collaboration and the sharing of knowledge and skills in order to disseminate what was learned.

3. Technological tools

We carefully chose the multimedia interface developer to realize the *Digital Diorama*. This expert not only focused on the graphic realization of the different levels of use for this multimedia object, but also on developed and created specific links between the different parts of the diorama. We also found an expert photographer to photograph the entire diorama and its details (required for navigating among the different elements).

The multimedia interface was realized using the software Articulate and the images were prepared using Adobe Photoshop.

The *Digital Diorama* is an intuitive interface built on a model of exploratory user-friendly interaction. The exploration takes place through touchscreen usability developed using a process designed according to formal ISO 9241** standards.

As is well known, usability is one of the most important requirements for realizing a high-quality interface (which allows for faster learning and easier access to the media contents and structure), as well as ergonomics and consistency (Bagnara & Marti, 1999).

Usability, meaning the quality of use, is determined by the ease with which the user is able to familiarize himself with a subject in general. The aim, for an interactive multimedia product, is to reach the goal (effectiveness) with minimal attention effort (efficiency). Of course, every design choice was considered in terms of functionality to the user's perceptual and cognitive dimensions.

User-friendly design based on user-centered design (Andreoni, 2012) allows the user to select a learning path ergonomically suited to his/her needs. The degree of usability of an interface plays a key role in developing a good user experience. The interface, according to Bonsiepe (1999), is not an object but a space in which the human body interacts with a device to perform an action and to achieve a goal. It must be well designed to offer new possibilities for action to a certain number of users (Bonsiepe & Poli, 2001).

Norman (1988) wrote that people invent, design, build and use tools to learn about the environment and act on it; to strengthen his/her individual actions he/she uses technological and cognitive artifacts that incorporate, enhance and integrate their own cognitive and artificial systems that store and process information and support human cognitive activity.

From the pedagogical point of view, it is more urgent and necessary than ever to rely on a number of detailed studies on how a media object should be properly designed for children and adapted to the times and modes of human learning, especially in light of the most recent research in the field of HCI (Human Computer Interaction) and HCIforKids (Jacko & Sears, 2002).

** International usability standards ISO 9241-10 about *ergonomic requirement*.

Digital Dioramas seek to promote the use of imagination through interactive media that stimulates the development of creativity and the relationships with other knowledge. This technology allows users to navigate between narration and the emotions of exploring science.

4. Methodological issues

Digital Dioramas are not designed as a standard format for the transmission of content, but rather as a tool that promotes the discussion on biological topics, to open "in-depth investigations", to bring out questions and curiosities.

The design of these multimedia objects refers easily to daily life, which is essential to ensure that school activities become reservoirs of knowledge for all areas of life (Arcà, 2009). In addition, connections with the great unifying themes of biology were carefully made while avoiding traditional, linear, predefined learning paths (Gambini, Pezzotti, & Broglia, 2008). Finally, attention was paid to exploiting the emotional aspects in the process of acquiring knowledge. Many studies have been carried out on understanding how emotions and affections come into the learning process (in school and in everyday life) and how, by highlighting these aspects, it is possible to enhance cognitive abilities (Chalufour & Worth, 2004). The methodology suggested for using *Digital Dioramas* promotes a close union between the information learned and the emotional aspects, which are generally marginal in the teaching of science.

5. Results

Museum dioramas, once digitized, become interactive interfaces consisting of a central image (the photograph of the entire Museum diorama), a menu and a number of hotspots activated by fingers or a mouse. Hotspots enable personalized exploration among many multimedia objects such as diagrams, images, videos, audio output and textual traces. *Digital Dioramas* are interactive systems that focus on the user and his/her "cognitive interaction" with the elements of the environment represented.

The *Digital Diorama* home page consists of a high-resolution wide-angle photo of a diorama in the museum. Scrolling over the photo, the user can zoom in to enlarge it. From the home page, a pop-up menu allows the user to choose different levels of exploration. On the first level, a narrator invites the users to enter the diorama using their imagination and creativity to make an "imaginary journey". Access to the *Digital Diorama* begins with the personal involvement of the user: he/she has to imagine the sounds and smells, sensations, etc. Hotspots allow users to continue their "imaginary journey", lingering on some details of the scene.

On the second level, each hotspot offers users access to a sort of identity card of the item represented, containing brief questions and answers (FAQs), easily consultable during exploration of the *Digital Diorama*.

Each hotspot, at the third level, leads to a biology theme that joins different living things (i.e. movement, hunting techniques, reproduction strategies, etc.). Each theme is illustrated by five multimedia contents (diagrams, images, videos) accompanied by brief captions (see Figure 2).

These materials are designed to stimulate thinking and enable group discussions that lead to a better understanding of the theme. Each multimedia content, in addition, refers to certain aspects or objects of everyday life: for example, a fish that filters water to feed is compared to objects used daily, such as a tea bag, a colander, etc.

By clicking on an icon, users can access a guide containing text and images which provide insight on the topic and a brief explanation of the multimedia content.



Fig. 2. Screenshot of the theme regarding the feeding methods. At the top left there is a question that introduces the theme while the strip below shows the detail of the *Digital Diorama* where the hot spots are located. Clicking on the images of the organisms allows users to access multimedia content.

The last level of exploration proposes scientific educational experiences that can be connected to some of the issues addressed.

6. Evaluation and testing

The evaluation of the *Digital Diorama* takes into account the quality of the interface and its interaction with the users and furthermore its effectiveness in improving the learning of some fundamental aspects of biology. The first assessment is quantitative, while the second includes the application of some qualitative research methods such as focus groups, observations, analysis of the products.

The evaluation of the interaction quality and the usability of the interface of the *Digital Diorama* is heuristic and will include the use of different methodologies and the involvement of all project stakeholders (researchers and users) to ensure a participatory approach (Nielsen, 1993). This evaluation is based on video observation of actions performed by users while interacting with the *Digital Diorama*. The evaluation is therefore cooperative, according to the methodology designed and developed by Monk and colleagues at the University of York (UK). They developed the "cooperative" technique (Monk, Wright, Haber, & Davenport, 1993). This technique will allow the cooperative research group to gather experimental evidence about the objective and quantitative exploration of the graphic interface of the *Digital Diorama* and the exploratory behavior of those involved. To carry out this evaluation, we will draw on the expertise of the INDACO Department Laboratory of Human Behavior at the Politecnico of Milan, which will provide technological equipment for the detection and analysis of the eye movements of subjects interacting with the graphic interface through an eye-tracking display. Eye movements move towards areas of interest; gaze and attention are closely linked: users can shift their focus without moving their eyes, but not viceversa. Eye-tracking technology is based on these assumptions. It detects eye movements using video oculography that provides information on the direction of gaze with respect to the surrounding environment.

Together with the evaluation of the quality of the interface, we will conduct a qualitative analysis aimed at investigating the educational effectiveness of *Digital Diorama* in improving the learning (at school and throughout life) of some fundamental aspects of biology. This assessment will include the monitoring and observation of classroom work, focus groups with teachers, the collection and analysis of products (maps, drawings, reflections, short tests, research on the Internet, etc.) which will be implemented by students during and after the use of the *Digital Diorama*.

Both evaluation approaches will be utilized during the testing of the *Digital Diorama* prototype involving 10 primary school classes. This experiment will be accompanied by a teacher training program including an initial phase of theoretical study. Teachers, before working with the class, will personally explore the different sections of

the diorama and try to simulate possible discussions with children, highlighting any difficulties. After the training course, teachers will propose exploring the *Digital Diorama* to their classes, both at the Human Behavior Laboratory and in the classroom.

The training program began with a focus group to gather data about the use of the technology in the classroom and the teaching methods of the group. During the focus group, the *Digital Diorama* prototype under construction was shown.

The results of the prototype test will be an important resource in the realization of the other *Digital Dioramas* foreseen as part of the project. The testing of all the *Digital Dioramas* will involve more than 20 classes of various levels distributed throughout Italy and will be conducted using only qualitative research methods.

7. Conclusion

Data collected during the focus group shows how new technologies are already used by the group of teachers, supplemented by more traditional forms of teaching. The IWB is a teaching tool that is predominantly managed by the teachers and used as a tool for research rather than as a tool for cooperation.

The first presentation of the *Digital Diorama* prototype received a positive reaction. It proved to be an educational device for use not only with regard to scientific disciplines. This is a first important return on the possible use of the interdisciplinary *Digital Diorama*, which answers the need to promote well-established connections and relationships between the different fields of knowledge. It is also expected that the proposed methodology can make known the procedural aspects that reflect the mind-set of the researchers, i.e. to build a concrete product to share with others, discuss, reflect on the information exchanged, etc. These same goals regarding the experimentation will be investigated.

After the experimental phase, the *Digital Dioramas* will be used to explore the complexity of ecosystems, in connection with the most urgent environmental issues. An important aspect is the diffusion of basic knowledge regarding the main themes of sustainability which must be directed either to students at different levels as well as to students with different social and cultural backgrounds in today's multiethnic society (Sterling, 2001). The *Digital Diorama's* methodology, intended to explore a broad range of themes, also aims to enhance educational aspects.

The *Digital Dioramas* can be used also outside the school, in public spaces: at museums, universities, and in other suitable public spaces. They will be available to anyone wishing to interactively explore environmental issues linked to everyday life. Applying this awareness to our daily lives will help us to change certain socio-cultural habits and to support sustainability. In addition, the *Digital Diorama* methodology will help to foster individual creativity and a sense of greater responsibility towards carrying out sustainable actions, not based on rules but stemming from individual choice.

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