

3D for Cultural Heritage and Education: Evaluating the Impact

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Abstract

Since the year 2002, Politecnico di Milano has been developing several educational projects aimed at schools, based on advanced technology (3D virtual worlds, shared over the Internet). The two most recent projects are about history: Learning@Europe (www.learningateurope.net) deals with the formation of European nation-states, and Stori@Lombardia (www.storialombardia.it) with medieval history in Northern Italy. Both projects underwent massive testing in spring 2005, thanks to the support of Accenture Foundation and the regional Government of Lombardy. L@E involved almost 1000 students and 60 teachers from 6 different European countries (Belgium, France, Italy, Poland, Norway, Spain); Stori@Lombardia involved 800 students and 40 teachers from Lombardy region (Italy). A huge amount of data was collected in order to verify the cultural impact of the project. The projects were very successful – beyond our expectations – both in terms of pedagogical impact and of customer satisfaction. The paper will present the most relevant data and the most salient aspects of the qualitative analysis. It will also argue a generalization of this case study, exploring how a deep impact (cultural and pedagogical) upon users can be achieved through technology, and in particular, the role of 'virtual presence' in collaborative 3D virtual environments.

Keywords: cooperative 3D worlds, 3D graphics, evaluation, edutainment, eLearning, virtual presence.

Introduction

Introducing technology in schools is both welcome and difficult. Educational authorities in all countries strongly support this goal, yet the real purpose is often unclear: no meaningful educational tasks are given. How, for example, should a class make use of cooperative technologies? With whom, given that virtually interacting with your neighbour seems rather meaningless? For what purpose?

In this paper we present two case-studies of effective use of cutting-edge technology in schools, demonstrating that ICT can produce significant educational benefits if projects are carefully designed and adequately introduced into regular school's activities and curricula.

Technologies can be successfully integrated in schools provided that:

- they are valued as tools supporting educational experiences rather than for their own sake
- they are used in blended educational experiences, in which traditional aspects of the pedagogical process (e.g. studying!) intermingle with technology-supported activities
- they help and do not substitute for the teacher in the pedagogical activity

The paper is divided into four sections. In the first, we provide the necessary background on the projects (for more details, see the works of Di Blas, Paolini, Barbieri, et al.); in the second, we describe how we monitor the impact and then summarize last year's results; in the third, we draw

lessons and provide guidelines for making innovative technology effective in the teaching/learning process; and in the fourth, we suggest what future developments are required.

1. The Projects

Learning@Europe and *Stori@Lombardia* projects are both based on the same concept, format, and technology. The first deals with European history (in specific, the birth of the nation-states) and targets European schools. In 2004-05, it involved more than 1000 students from 6 European countries (Belgium, France, Italy, Poland, Norway, Spain); it is currently running its second implementation, which involves a wider range of countries (including the United Kingdom, Germany, Greece, and several Eastern European countries), and triple the number of students. *Stori@Lombardia* deals with medieval history and addresses Italian students. In 2004-05, it involved 800 students from the Lombardy region (Italy); it is currently running its second implementation, involving more or less 2000 students.



Fig 1: *Learning@Europe* (www.learningateurope.net): one of the countries' domes



Fig 2: *Stori@Lombardia* (www.storialombardia.it): the dungeons

Both programs can be defined as "educational experiences" in which traditional activities (i.e. studying, group work, research...) intermingle with technology-supported activities (on-line meetings in a virtual world and asynchronous cooperation via electronic forums or mailing lists).

The Basic Steps Of The Experience

For simplicity, and in that the two projects share the same format and features, we shall refer from now on to *Learning@Europe* only.

The Overall Organization

Each experience in *Learning@Europe* foresees the participation of four classes from four different European countries, divided into two teams. Each class is required to cooperate with another class of a different country and to compete against another team of two classes. The cornerstones of the experience are four on-line sessions in a 3D world, each lasting more or less one hour. During the on-line sessions students meet each other, play, discuss, and are involved in highly motivating activities. Each class collaborates in each session through three or four computers. From two computers users participate in the graphical 3D environment, while the third (and sometimes a fourth) computer is only used for chatting. Two "on-line tutors" accompany participants through the activities in the 3D world and on the forums.

Before And During The 1st On-Line Session

Before the first session, students are required to prepare a class presentation providing a text and a few pictures of their class and town, and to study preliminary material concerning the meaning of history. In this way they get ready for discussion and games in the first session. During the first on-line session they get an initial feel for the competition and the 3D environment.

Before And During The 2nd On-Line Session

After the first session there are some important things that each team must do. First, the teachers and their students download a set of interviews with international experts concerning the history of the countries involved in the experience. In addition, students are required to start working on their homework. Asynchronous activities (the electronic forum or the mailing list) begin, and the students start to cooperate. The initial part of the homework consists of finding material evidence (monuments, street names, buildings...) about national identities. During the session, through the game **Treasure Hunt** and other activities, students must prove that they have understood the basic concepts of the histories of the other three countries and of their own.

Before And During The 3rd On-Line Session

Between sessions two and three, students download and study four or five additional interviews related to more general themes, such as the welfare state, wars of independence, and the role of religion or culture in the development of national identities. Students keep working on their homework and are required to cooperate with the other classes using the forum or the mailing list. Session three is about the general theme of national identification. Games and activities (as well as the discussion) are more complex.

Before And During The 4th On-Line Session

Session four is about discussion of the homework of each class. This homework shows whether the students understood their national identity, the processes that brought it about, and whether or not they could relate it to the experience of other countries' identities. Homework is delivered through the Web site, and each team must study the work of the other team. After session 4, if students want to they can still keep in touch by using the project's forum and mailing list.

2. Monitoring the Impact

A huge amount of data was collected to verify the cultural impact of the project. The main monitoring tools were surveys (to teachers and students, before, during and after the project), reports by the on-line tutors, analysis of chat transcripts for every synchronous on-line session, forum posts' analysis, analysis of student-produced artefacts, focus groups with teachers, recording of on-line sessions (from the point of view of the 3D on-line tutor), and videotapes of students in the classes.

The educational benefits were analyzed in terms of knowledge, skills, and attitudes. All the data refer to year 2004-05 and are on a scale from 1 to 5, where 5 is the highest mark. Please note that we shall present only some examples: the comprehensive set of data can be found on the project's Web site (www.learninggateurope.net).

Benefits Related To Knowledge

One of the substantial benefits of *Learning@Europe* is an increased knowledge of the subject matter. Educational benefits concern better understanding the history of one's own country (Poland for Polish students, Italy for Italian students ...) and also a better grasp of the history of the other countries.

Let's see some data. Teachers rated the understanding of national history 3.77 (with 16% rating it 5, and 49% rating it 4); students rated it 3.56 (with 15% rating it 5, and 39% rating it 4). Understanding of the history of other countries: teachers rated it 3.81 (with 21% rating it 5 and 44% rating it 4); students rated it 3.55 (with 14% rating it 5 and 40% rating it 4). The on-line tutors' reports substantiate the above data, stating that in 46% of cases, students were able to answer very complex questions involving historical processes and not just facts.

Benefits Related To Skills

Given the nature of the project, "skills" was the area where we obtained the greatest educational benefits. Let's see some examples. Use of English as foreign language: teachers rated it 4.16 (with 42% rating it 5 and 33% rating it 4); students rated it 3.79 (with 23% rating it 5 and 46% rating it 4). Use of technologies for learning processes: teachers rated it 4.30 (with 42% rating it 5 and 47% rating it 4); students rated it 3.72 (with 42% rating it 5 and 40% rating it 4). Learning how to work in a group: teachers rated it 4.30 (with 60% rating it 5 and 35% rating it 4); students rated it 3.79 (with 26% rating it 5 and 44% rating it 4). These ratings are also corroborated by the quality of the cooperation exhibited during the sessions, while doing team presentations, presenting homework, etc.

Benefits Related To Attitudes

Results concerning attitudes were also rewarding. Again, let's turn to the data. More motivation: teachers rated it 4.10 (with 29% rating it 5 and 55% rating it 4). This opinion is also strongly corroborated by the active participation of the students in the set of activities proposed. Increased proficiency (getting better marks): teachers rated it 3.60 (with 12% rating it 5 and 38% rating it 4), and surprisingly, 57.7% of the students believe that they have increased their overall proficiency. This benefit is particularly relevant for the project's objectives: *Learning@Europe* addresses not only the best students in the best classes, but also difficult students in difficult classes. In several cases, we found that after completing the program, students became more interested in school activities and subjects. Increase of curiosity and tolerance towards other cultures: teachers rated it 4.02 (with 24% rating it 5 and 55% rating it 23%).

Unexpected Results

Most of the results of *Learning@Europe* were somehow planned, in the sense that they were in the designers' minds. Others were not foreseen and were detected only afterwards (to our own surprise). Some teachers said that the benefits of *Learning@Europe* went far beyond what had been planned. One teacher reported that he had improved his relationship with his students. Other teachers said that their students had improved not only in history, but in all the subjects! Others reported that students had acquired a sense of responsibility, because they had to hand the homework in when due and cooperate with students from different classes. ("They start understanding what a deadline is", said a Polish teacher). These anecdotes do not represent statistical evidence, but are still important clues to understanding the complexity of the impact of *Learning@Europe*.

Eventually, we must note that these benefits, both relevant and conspicuous, become also benefits from the teachers' point of view. Many teachers who took part in *Learning@Europe* experienced for the first time the effectiveness of a combination approach, blending technology and traditional educational methods in order to get substantial improvements in their work with their classes.

3. Innovative Technology in Education

What do such good results depend on? The answer to this question is not easy, due to the program's great complexity, and we must admit that we have only tentative answers. We present now what we deem are the most relevant features of the projects, how they were designed, and in pursuit of which benefits. What we cannot tell is, which ones are the ingredients without which nothing would work (or would hardly work).

Blended Learning

Our projects do not display technology for its own sake, but attempt to use technology to provide substantial benefits; they are based on an innovative educational paradigm which blends eLearning with traditional learning, and in which teachers, as we explain below, play crucial roles. The overall experience was designed to mix different types of activities harmoniously, with a view to achieving substantial educational benefits in traditional terms, keeping the leading role of the teachers (who organize the work according to their preferences and their students' attitudes) and eventually keeping students motivated.

More detail regarding the technology-based activities:

- 4 on-line sessions: sessions are designed to provide a pre-defined set of activities, alternating playful moments with question/answering and very short lectures. In that they are the most involving part of the experience, they are meant to enhance students' motivation.
- asynchronous on-line activities, supported by either forums or e-mail: between one meeting and the next, students and teachers must cooperate, in order to complete assignments and pursue topics of discussion. Asynchronous activities help building a virtual community, often lasting far beyond the end of the experience.

As regards "traditional" activities, we have:

- studying of background material (interviews with European leading experts) and auxiliary material (chronologies and maps): the experiences are meant to be educational; therefore they must be based on robust cultural content; we chose to produce "in house" the material

on which all the testing (i.e. quizzes, riddles, assignments...) is based, so as to provide all schools with a common background.

- assignment completion: students are required to perform different assignments - they must prepare a class presentation; they must look for material evidence of their past (such as monuments, street names, statues, etc.); they have to cooperate with their remote team partners in answering difficult questions about their countries' histories.

The assignments have different educational goals: they are meant to make students better understand history (their own as well as others'), to critically reflect upon historical processes, and also to learn to work in groups, both within the class and with their remote peers.

Innovative Content

One of the particular aspects of *Learning@Europe* is the content provided, together with the way it is used. The content is based on history and organized in interviews with leading European experts. We chose the format of the interview because it provides a very fresh, provocative and stimulating approach intended to raise curiosity and interest in the students. The opinions of different experts provide the multiplicity of perspectives advocated by many theorists of Constructivist learning.

There are two kinds of interviews: *country-oriented*, providing details and interpretation of the history of a single country, and *horizontal*, in the sense that they discuss common themes; for example, the role of religious wars in shaping national identities: they deal with the topics more in general, using single countries as specific examples. The combination of the two kinds creates a provocative set of material for the students.

Games & Activities

Games in the 3D environments are the most exciting part of the on-line sessions. Games are mainly playful, except that at the end of the games, students have to answer quizzes. They fulfil therefore an educational function in that they motivate pupils to study the contents in order to be able to win.

Games and activities are fundamental parts of the experience: they keep students busy, they are exciting and engaging. ("When we won, students roared as if they were at a soccer match" reported one Italian teacher.) In short, they help build team spirit and provide the motivation for "doing one's best". Videogames have been found to engage users in activities that require them to concentrate on task for surprisingly long times and to learn a great amount of complex information (Gee, 2003; Johnson, 2005): the same kind of motivation related to goals pushes *Learning@Europe* participants to study hard.

Competition

One of the important features of *Learning@Europe* is the use of pedagogical competition. While competition among individuals can sometimes be detrimental to learning in educational settings (Slavin, 1995), through this competition we obtain a number of advantages. First of all, we create a strong need for collaboration among classes from different countries: they compete on the same team against two opponents. This motivates team members to use all sorts of different collaborative technologies that allow them to communicate with their remote partners in an effective manner.

The second aspect is that playful competition is one of the most exciting parts of *Learning@Europe*: students love to compete, to get scores, and... to win! Scores can be gained - and lost - for almost anything, from correct (wrong) answers to good behaviour (or misbehaviour).

New Role For The Teacher

Learning@Europe is not limited to technology-oriented teachers: it is meant for teachers in the humanities, history teachers in particular. Teachers do not need to possess advanced skills in the use of technologies, but they need to be able to manage a learning paradigm where technology plays an important role. The role of the teachers is by all means crucial: teachers are facilitators of the students' own learning processes, in accordance with the educational theories of Constructivism and active learning.

In this sense, *Learning@Europe* is not a fully eLearning project. Its aim is not to substitute for the teacher: rather, it strongly relies on the teachers who supervise activities in their own classes. Our previous experiences have shown that even very difficult students can achieve the best results when helped by good teachers, whereas, if the teacher is not really motivated, the students do not receive as many benefits as they could. It is up to the teacher to fix the details: decide how to organize the class (will all students study all the materials, or will different groups of students study different chunks of content? Will all students take turns using the keyboard, or only the most skilled in using computers move the avatars while the others suggest the answers? etc.). *Learning@Europe* is a project where the "traditional" role of the teacher is emphasized, although in a non-traditional way and in an unusual setting.

Virtual Community

Learning@Europe provides three kinds of forums. The first is the "operational" one: it serves all the practical purposes related to the competition, for which participants have to collaborate closely in asynchronous mode with their remote team partners. Then we have a special forum, called "Meet the Expert". This forum allows the students to ask questions directly to the experts who granted interviews with *Learning@Europe*, thus giving them the opportunity to discuss historical issues at "academic" level. The third forum is a global discussion involving all the teachers and students of *Learning@Europe*: this allows the creation of an overall on-line community. Participants can discuss all issues, such as content curricula, ways of teaching, sharing of resources, etc. The overall goal is to create bonds across Europe, despite national barriers and different school systems.

Besides this official pedagogical purpose, electronic forums have also the purpose of favouring social relationships among students from different classes and nations (Preece 2000). Students often start chatting about their own way of living, their every-day life. As participating in a community always has an impact on an individual's identity (Wenger 1998), this is very good for the purposes of the project; that is, creating better understanding of identities across different countries in Europe.

Virtual Presence

If, as we said at the beginning of this section, we do not know what the crucial ingredients of our recipe are, we do know what the magic glue holding it all together is: it is the sense of **virtual presence**. Virtual presence is a phenomenon widely discussed in literature (Carassa et al., 2004; McIntyre et al., 2004; Presence 2004), described as the feeling of "being there" in a "virtual situation" made possible by technology. If users of a 3D world, for example, remember their experience as "having been to some place" rather than "having seen a series of computer-generated images", then a sense of presence has been created.

Virtual presence is easy to detect, while difficult to measure. While some use questionnaires to measure the users' subjective impressions (Witmer & Singer, 1998), others prefer to register users'

biological data, such as pulse and body heat, especially when breaks in presence occur, i.e. something interrupts the source of stimuli from the virtual environment, and the users' attention focuses again on their real surroundings (Slater & Steed, 2000). The most interesting clues of the "presence of virtual presence" in *Learning@Europe* are:

- teachers' comments ("my students were so involved that I think they did not even notice they had been chatting in English for an hour", a French teacher said)
- on-line sessions' chat analysis, showing that even in the case of technical/organizational failures (e.g. avatars getting stuck, frequent disconnections, etc.), the engagement remains high. This means that the sense of being involved in a situation (the competition, the discussion) is so strong that it cannot be easily destroyed

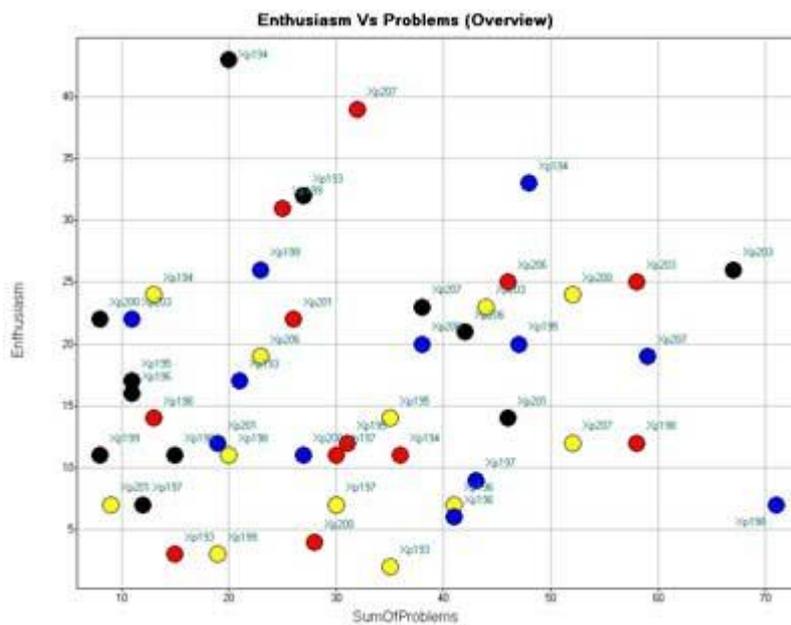


Fig. 3: Spotfire chart showing the relation between tech failures and excitement. Every spot represents a session: the x value is the number of chat messages mentioning problems, the y value those denoting enthusiasm

- videos of students during on-line sessions, in which we see groups of 4/5 students gathered around the PC, smiling, pointing at the screen, deeply focused, etc. The interesting thing is that we have a sort of enlarged virtual presence: not only in the one who is actually using the technology, but also in those on the circumference.



Fig 4, 5: Students gathered around the PCs

4. What's Next?

As regards future steps, we have a number of developments as well as of issues to report.

Learning@Europe must be expanded to become a permanent self-sustainable service, with costs paid directly from European schools. In year 2005-06, our target is 160 classes; we believe that the target of 500 classes (i.e. 12,500 students) per year would constitute the beginning of real impact on the European school system. But this is a challenge that involves cultural-political issues and technical-economic issues.

On the cultural-political side, there is the problem of cultural vs. curricular activities: most schools in Europe (as in North America) are under pressure to fulfil the obligations of their "curriculum", i.e. a set of mandatory elements that "must be there" in their educational program. This may hinder innovation: there is "no time" for whatever does not fit in the curriculum! The push for innovation (essential in schools) does require a certain degree of freedom.

A second important cultural-political factor, peculiar to Europe, is the nationalism which goes with the curricula: although everyone in Europe claims that we must get rid of the remnants of nationalism, when we look at curricula (in history), we observe that 95-98% of the concern is for national cultural heritage. Very little room is left for real knowledge of different cultures. Technology in general, and collaborative technologies in particular, can represent an important ingredient for the internationalization of curricula - in Europe and maybe also in other parts of the world.

School systems (including Universities) are not really ready for collaborative technologies. All the activities go on essentially among a closed group of people: the teacher and the pupils of the class. Wide introduction of collaborative technologies would disrupt the standard organization, stretching the notion of a class as a closed group of people. Other than by experimentation, this is a concept difficult to introduce in the educational systems.

The service and the approach must be extended to include other geographical areas (North America, South America, the basin of Mediterranean sea, the Middle East, China, etc.), in order to foster better understanding of different cultural heritages world-wide.

Changing subject matter is another pragmatic issue: can we replicate the successful experience with different content? This is more difficult than it may seem at first sight. Scientific content (of major relevance in much of the world, especially Europe), for example, that would be in several respects a strong candidate, has a major drawback: it has "global flavour" (it is common around the world) but it totally lacks "local flavour". Our perception is that an Italian class has an interest in cooperating with a French class since the French class has a lot of "local" stories to tell. But how would it work with, let's say, mathematics? We are afraid that losing the "local factor" may severely lessen the effectiveness of the collaborative experience.

Considering now the methodological issues (among several that we have no room to examine), two seem to stand out:

- defining pedagogical (cultural) impact (with reliable evaluation methods) and
- introducing collaborative technologies in the context of cultural institutions.

The **pedagogical impact** of a short experience is not easy to define and to assess. We have two extremes that we would like to avoid: simple "customer satisfaction" on one side and acquisition of "notions [ideas]" on the other. First of all, "impact" means that something has changed, but what is it? Can we define and measure the change of attitude, curiosity, interest, basic understanding, etc.? How can we define the notion of "cultural impact"? Can we evaluate it? Evaluation of pedagogical/cultural impact is difficult in general, and in particular when it comes to a collaborative

experience. One on-line session involves about 100 students and 4 teachers, in 4 different locations; a fraction of them (about 12) use computers, while the others are cooperating with them in an unpredictable manner. How can we keep track of what is going on? Surveys are helpful but not enough; we need additional observations (recording, videotaping, chat analysis, etc.). Improving our capability of evaluating collaborative experiences is a major challenge for the near future.

The final and most difficult question concerns the **use of collaborative technologies for** cultural institutions. We think that, overall, it is still unclear what should be done and how. We know that in real life, socialization and fruition of cultural heritage go together very well: groups of friends (families, schools,...) go together to visit museums, individuals enjoy talking to other people and sharing their thoughts while observing works of art. Far fewer people would go to museums or exhibitions if they had to go alone. Multimedia interactive technologies, on the other hand, are one-at-a-time technologies: combining this solitary experience with socialization, as collaborative technologies promise to do, is a major challenge that, if met, will make virtual experiences much closer to real-life experiences.

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