Digital Storytelling at School
Does the TPCK Model Explain What's Going On?

Nicoletta Di Blas
Department of Electronics and Information (DEI), Politecnico di Milano, Italy
nicoletta.diblas@polimi.it

Paolo Paolini
Department of Electronics and Information (DEI), Politecnico di Milano, Italy
paolo.paolini@polimi.it

Aldo Torrebruno
Department of Electronics and Information (DEI), Politecnico di Milano, Italy
aldo.torrebruno@polimi.it

Abstract: From year 2006, thousands of students (aged between 5 and 18 years) and hundreds of teachers have taken part in PoliCultura, an initiative by HOC-LAB of Politecnico di Milano calling Italian schools to create multimedia "narratives". A number of user studies show that relevant and substantial educational benefits are achieved thanks to this program. On the ground of the collected evidences, as well as of data from previous experiences with educational 3D-multiuser environments, this paper aims at raising a theoretical question: what is the role of the "Technical Knowledge" of the teachers in a successful technology-based learning experience? Does the TPCK model provide an adequate explanation? From our experience, Technical Knowledge, in fact, seems to play a different role with respect to Content or Pedagogy Knowledge.

Introduction and Motivations

This paper has a double motivation: on one side, we wish to describe an interesting experience (PoliCultura) leading thousands of school pupils, in Italy, to create digital multimedia "narratives", as a class effort supported by their teachers (Di Blas, Poggi, 2008; Di Blas, Garzotto, Paolini, Sabiescu, 2009; Di Blas, Paolini, Sabiescu, 2010). Since 2006, almost 500 classes with 10,000 pupils aged between 5 to 18 have been involved in the PoliCultura initiative, using "1001stories", an on-line authoring environment developed by our lab (HOC-LAB of Politecnico di Milano). Systematic surveys and interviews to teachers have shown that through the initiative a substantial, multi-faceted educational impact is achieved. On the other side, at a more theoretical level, we would like to raise some doubts on the capacity of the well known TPCK model (Mishra, Koehler, 2006) to fully account for what goes on in a classroom when ICT-based educational experiences are introduced.

We do agree that "most educational technology research consists of case studies, examples of best practices, or implementation of new pedagogical tools" (Mishra, Koehler, 2006) and, even more, that "until we examine the impact of computer technology … from a theoretical perspective, we will continue myopically and unsystematically to define the isolated pieces of the puzzle" (Selfe, 1990).

We raise, however, some doubts about the role that the 3 types of Knowledge (Pedagogy, Content and Technology) play. While the TPCK model seems to assume that they play an equivalent role, and therefore should equivalently be part of the professional training of a teacher, we argue that Technology seems to play an important, but different role. We will support this argument mainly in the light of the findings of PoliCultura, but also making reference to the results of other large-scale ICT-based programs that we ran, namely, educational experiences in Multi-Users Virtual Environments (MUVEs). Since 2001 we have run five different programs aimed at middle and high school students. The subject matters varied a lot, from biblical studies (in cooperation with the Israel Museum) to European history. More than 9,000 students from 18 European countries plus Israel and the USA have taken part in them, with remarkably positive results (Di Blas, Garzotto, Poggi, 2009; Di Blas, Paolini, Poggi, 2008; Di Blas, Poggi, 2006; Di Blas, Paolini, Poggi, 2005).

This paper is structured as follows: in section 2 we describe the background about digital storytelling and the TPCK model; in section 3 we describe the PoliCultura initiative, that can be considered as an example of "Design

Research" (McKenney, 2010); in section 4 we discuss the educational impact of PoliCultura; in section 5 we discuss the theoretical aspects; in section 6 we draw the conclusions and sketch our future work.

Background

The TPCK Model

In year 1986, Lee Shulman introduced the PCK framework: Pedagogy Content Knowledge (Shulman, 1986). His observation was that in teachers' training it would be much more effective to offer an integrated vision of the specific subject matter *and* pedagogy, in a common theoretical framework rather than deal with them separately. His starting point was a simple, yet profound question: "How are content knowledge and pedagogy knowledge related?". By intersecting the two, he obtained the domain of "Content and Pedagogy Knowledge" (CPK) by which he meant "the ways of representing and formulating the subject that make it comprehensible to others" (p. 9).
After the advent of digital technology and its large-scale adoption even in a traditionally "lagging behind" sector such as the school system, a third component was added to the PCK model: Technology (Koehler, Mishra, 2005 and then Niess, 2005; Mishra, Koehler, 2006; Koehler, Mishra, Yahya, 2007; Mishra, 2008; Archambault, Crippen, K. 2009; Angeli, Valanides, 2009; etc.). The new TPCK model (or, inverting the order, the TPACK model) pinpoints that in teachers' training the "dynamic, transactional relationship between all three components" must be taken into consideration and again, like for pedagogy and content before, technology must not be taught per se but as a component of a larger scenario. (Niess, 2005) offers a very clear definition of the model: "TPCK (…) is the integration of the development of knowledge of subject matter with the development of technology and of knowledge of teaching and learning. And it is this integration of the different domains that supports teachers in teaching their subject matter with technology".
The TPACK model is a powerful and comprehensive tool for interpreting ICT-based educational experiences. Still, like (Archambault and Crippen, 2009) point out, "it remains to be determined if knowledge in each of these domains truly exists". In this paper, we aim at enlarging the scope of this question by adding "…and if so, what kind of knowledge it is". More specifically, through surveys, interviews and focus groups, we investigate what kind of technological knowledge teachers who run successful ICT-based educational experience have, in view of re-defining the role of this element in the TPCK framework.

Digital Storytelling

The field of digital storytelling is quite huge (Iurgel et alii, 2009) and can be defined by crossing the following parameters: passive vs. active participation (i.e. listeners vs. authors of stories); individual vs. group activity; young vs. adult users; formal vs. informal setting (i.e. school vs. museum, home…). The focus of this paper is on the following grouping: story-authoring as a class-room activity (therefore a group activity) by young, even very young, students, in the context of formal education.
In spite of the well-known positive benefits the storytelling activity can provide, as backed up my many pedagogical theories (Jonassen et alii 2000; Cassell, Ryokai 2001; Madej, 2003; Kritzenberg, 2004; Richards, 2006), few attempts are there to actually cross the boundaries of a lab and introduce it in school environment, even less in a large-scale manner. Some systems explicitly or implicitly respond to Maria Montessori's (Montessori, 1996) and Friederich Froebel's (Brosterman, 1997) theories on the power of familiar objects and surroundings to trigger the understanding of abstract concepts in young children. Digital MiMs, by MIT Media Lab, makes use of digitally augmented building blocks to support the story authoring experience (Zuckerman et alii, 2005). The playground metaphor is also exploited in the POGO project (Decortis, Rizzo, 2002), where children capture and manipulate various media and combine them in sequential form. KidPad (Druin et alii, 1997; Hourcade et alii, 2002) is a "magic carpet" that supports collaborative and synchronous storytelling by means of a tangible interface. StoryMat (Cassell, Ryokai, 2001) also supports collaborative story-authoring by means of stuffed toys moved over a quilt which records kids' voices and tracks the toys movements. A similar sensorial approach to storytelling is also behind the StoryRoom (Alborzi et alii, 2000) and KidsRoom (Bobick et alii, 2000) projects, where a room-sized environment, sensible to kids' movements and interactions, is used. 2D or 3D environments can also be used to support a collaborative form of storytelling, as in FaTe2 (Garzotto, 2006), MOOSE crossing (Bruckman, 1997), MyStoryMaker (McKinley, 2008) and PUPPET (Marshall 2002), where students learn the basics of drama. Other approaches exploits a role-play paradigm, like for example Fear not! (Figueiredo et alii, 2008) that has the aim of

teaching students how to effectively handle bullying behavior at school. StoryBuilder (Antle, 2003), by CBC4Kids (Canadian Broadcasting Corporation), is a web-based tool which enables children to create multimedia commix-style stories by combining pre-defined story elements and passing them on to other children. StoryBuilder is one of the very few examples of large exploitation of a storytelling tool, involving thousands of real users. Two more programs share a similar approach: Renga (Cassell, Ryokai, 2001), exploiting the add-a-sentence to a story mechanism, and ToonTastic (Russell, 2010), a tool, still in its Beta phase, that enables children to create and share animated stories based on a set of predefined scene types. Eventually, NIMIS, a EU-funded project, has developed a story authoring software called T'riffic Tales, tested in three schools, to support individual and collaborative story authoring (Cooper, Brna, 2000).
Most of the above tools and programs are designed to support individual or small groups interaction (Rick et alii, 2009); another strong limitation is that these systems are too demanding, in terms of technical skills, settings, budget, to allow for a large exploitation in school environment (with the remarkable exception of StoryBuilder). Teachers do need to master technology to effectively use them, and this requires, if nothing else, a long start-up time. Our goal with the PoliCultura initiative (and the 1001stories toolkit that goes with it) is to support a different approach, in which technology fades in the background while the storytelling activity emerges as prominent.

Policultura and the Authoring Tool

PoliCultura (Torrebruno, Paolini, Garzotto, Di Blas, Bolchini, Poggi, 2008; Paolini, Di Blas, Torrebruno, 2009) is an initiative that aims at fostering the adoption of ICT technology in Italian schools and promoting a "poly-cultural" approach to education smoothly combining technology and humanities. PoliCultura is also a national competition, where participants are requested to create a full "hyperstory" on a cultural theme of their choice, using a special tool developed by Politecnico di Milano: 1001Stories. This tool supports the process of translating conceptual narrative structures into a suitable interactive digital format, filling them with multimedia contents, and delivering the resulting hyperstory on different channels (CD-ROM, Website, Videos, podcast).

The Authoring Tool

1001Stories is a very simple toolkit for building hyperstories that we call "narratives". Each narrative is composed by a customizable number of main topics (generally, from 4 to 8), each with a customizable number of sub-topics (again, from 4 to 8). Users can surf the hyperstory using two pre-defined paths: a short overview (i.e. the sequence of the main topics) or a thorough exploration of the content (all the topics and sub-topics). Of course, a user is also free to select any topic/sub-topic she wants. Each topic and sub-topic is composed by an audio (suggested length: 1 minute), a slideshow of images (pictures, drawings, power point slides…) and the audio's transcript (available on demand).
The authoring tool is available online using a standard web browser and the Adobe Flash plug-in, and the process of data entry requires basic technological skills only: creating plain text, creating audio files (mp3 format), creating jpg pictures, uploading files. The handling of the technological aspects, the deployment and the generation process, which would be more demanding from a technical standpoint, are server-side. 1001Stories is quick to learn (average learning time: 20 minutes in primary school), quick in the delivery of a complete multimedia hyperstory, and easy to use, hiding the complexity of the implementation underlying the tool. It is the perfect "trick box": users put their content in the trick box, without any technical difficulty, and the trick box gives back a high-quality output, ready for the school website and for podcasting. Thus the production of multimedia (and multi-channel) artifacts turns out to be simple, fast and easy.

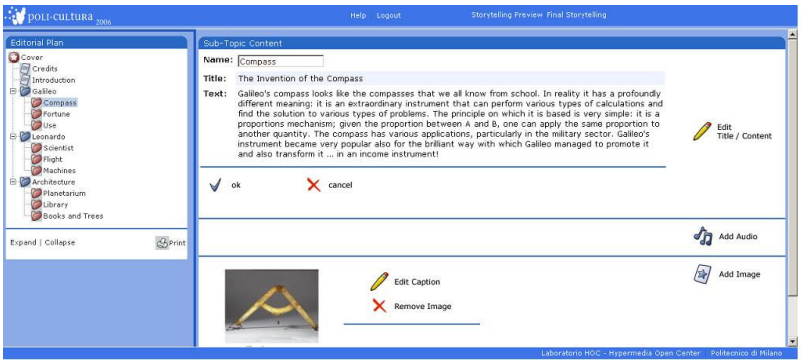


Figure 1. The data entry interface of the 1001stories tool.

The Competition

In 2006 we launched the PoliCultura competition, inviting schools (from pre-school to high school) to develop their own multimedia narratives using 1001stories. Nearly 660 teachers, 1187 classes, 18.000 students from all over Italy have taken part in the initiative so far. Every year, 75% of those who register online to use the tool complete their work; 50% actually submit the work to the competition. Those who do not complete the narrative point at organizational problems and constraints as the main reasons for dropping out. Table 1 shows participation to PoliCultura by school type: in the first year (2006/07) the competition was aimed at *high schools* only, but one pilot was run in a primary school, under our supervision. In the next year (2007/08), since the experiment had been successful, the competition was opened to include junior high schools and primary schools too. In that year, a pre-school voluntarily took part in the competition (this time, without us knowing it). The narrative was of surprising quality, therefore from year 2008/09 all schools were allowed to participate, even pre-schools.

	Classes registered					**Classes that submitted the narrative**				
Year	Total	Pre-school	Primary school	Junior-high school	High school	Total	Pre-school	Primary school	Junior-high school	High school
2009/10	**332**	23	127	80	92	**140**	10	51	35	44
2008/09	**414**	38	173	113	90	**190**	18	79	53	40
2007/08	**338**	-	149	98	91	**135**	-	57	38	40
2006/07	**103**	-	-	-	103	**56**	-	-	-	56

Table 1: Participation to PoliCultura in 2006-2010 by school type. The columns on the *right* refer to the number of classes which accomplished and submitted the narrative, out of those initially registered

Figures 2 and 3. Screenshots from the narrative by the first pre-school that took part in the competition in year 2007/08. On the left, a little boy recording an audio commentary; on the right, a scanned drawing representing all the pupils.

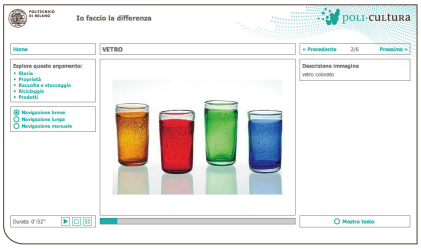
It takes approximately 3 months for a class to finish the work: the competition acts as a powerful spur to finish in time and do a good work. Once the works are delivered (which means that the teacher selects the "close the narrative" option in the tool), a panel of experts identifies the shortlist of the finalists. Finalists and of course winners (one for each school level) are celebrated at Politecnico's premises.

Some Examples

During these four years, students of every school grade who have taken part in PoliCultura have surprised HOC-LAB researchers on many occasions. The works are of very good, if not excellent, quality; the strategies devised very creative (going far beyond our guidelines). Another element of surprise is that in most cases (76%) the teacher who enrolls to the activity is not the technology expert of the school, but teaches in the humanities area. The fact that they can successfully lead their class to the development of a multimedia and multi-channel application is a source of pride and also lowers the "awe" that sometimes is felt with respect to technology. Figures 5 and 6 show a hyperstory developed by a pre-school class, in video podcast and website version.

Figures 4 and 5. The same hyperstory (*A boy called Kandinsky*, by a pre-school class) delivered over two channels: video-podcast on iPhone and website.

The narratives can be about various subjects: a school activity, a school outing, a visit to a cultural institution, a curricular topic, etc.
Example 1**.** *Stones, pebbles and rocks* (pre-school). This narrative documents a laboratory about the artistic usages of stones. Pre-school kids selected the images and recorded their audio commentaries (Di Blas, Boretti, 2009).
Example 2. Visiting a cultural heritage institution: *Milan during the Roman Empire Age* (primary school).
Kids from a primary school visited the Archaeological Museum and some relevant spots in the city of Milan, took pictures, made drawings and gave their own interpretation of the city's historical past.
Example 3. Raising awareness on environmental issues: *I recycle* (high school). 8 different classes of a high school in Rome have worked during the year on the theme of recycling. In the narrative, their points of view on ecology are presented and blended.



Figures 6, 7 and 8. Screenshots from narratives.

Method of Research and Benefits

We monitor the impact of PoliCultura in many ways. From the first year (2006), we have administered teachers an online questionnaire investigating organization, educational benefits and students' engagement and motivation. In addition, we hold a focus group at the end of each school year with a selected group of teachers. From this school year, in the frame of a national project called Learning for All (L4ALL), we are conducting interviews (over the phone or skype) to hundreds of teachers. Our goal is to gain a deep understanding of the educational impact of ICT-based activities in school and of the role technology plays in them. Eventually, an additional source of information are the delivered narratives their selves, the quality of which is scored first by HOC's staff members and then, after this first round, by a committee of experts.

Through all these tools we mean to investigate not only how the activity is organized in the class but also what educational benefits, in terms of knowledge, skills and attitudes, are achieved, if any. Also, we investigate whether inclusion issues are taken into account and how and whether any benefit is achieved. Eventually, we investigate whether students are engaged and if any motivating factor is triggered. We ask teachers to evaluate the achievements comparing them to canonical/regular school activities. The results are positive, as the reader can see from table 1 that summarizes the quantitative data for year 2008-09 (the data for year 2009-10 are currently being processed).

Educational benefit	*Achievement with respect to regular teaching activities*				
	1 (much lower)	*2 (lower)*	*3 (equal)*	*4 (better)*	*5 (much better)*
Deep understanding	0.00%	0.70%	4.60%	54.60%	40.50%
Content organization skills	0.00%	0.70%	9.20%	62.10%	28.10%
Retention	0.00%	0.70%	5.90%	39.50%	54.20%
Interest in a subject matter	0.00%	0.70%	3.30%	28.90%	67.30%
Engagement	0.00%	0.00%	2.60%	20.30%	77.60%
Technical abilities	0.00%	1.30%	8.50%	35.90%	54.60%
Communication abilities	0.00%	0.00%	7.90%	51.00%	41.40%
Teamwork capacities	0.00%	0.00%	6.60%	38.20%	54.90%

Table 2. Learning benefits evaluation of the PoliCultura experience as compared to regular didactic activities (year 2008/09, 153 teachers).

For the sake of the argument we are conducting in this paper (see section 5), we want to focus now on two elements that too often get erroneously mixed up: engagement and motivation. We take "engagement" in the sense that a person finds an on-going activity enjoyable, while "motivation" means that an activity acts as a trigger for putting effort into something. As regards engagement, 77,60 of teachers (again, year 2008-09) declare that PoliCultura is much more engaging than normal school activity. Even in the case of very young pupils (preschool, 5 years of age), engagement is high. A teacher reports: "*when I arrived at school in the morning, the kids would search my bag asking 'teacher, do you have your laptop today?', in hope that we would work at the narrative. And then they would fake the activity in their games, pretending for example they were recording the audios with a toy-mic*" (Di Blas, Boretti, 2009). The same result was obtained with the MUVEs based programs, as largely discussed in previous papers (see for example Di Blas, Paolini, Poggi, 2008).
We find that PoliCultura enhances motivation too. A teacher says: "*I believe the educational benefits are obtained much more effectively than with usual frontal lessons. Students are well motivated because they get to use computers, which they are very fond of.*" Again, MUVEs seemed to trigger the same effect: in year 2006-07 (61 respondents), 69,5% of the teachers declared that their students had become more proficient at school (we stated very clearly that we meant... getting higher marks!) after the program.

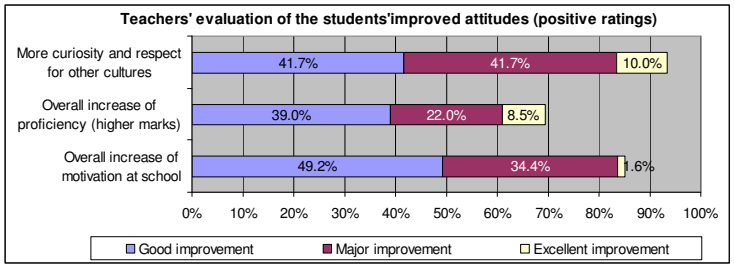


Table 3. Teachers' rating of their students' improved attitudes. Apart from increased curiosity towards other cultures (that was the program's goal), the reader may note the increased proficiency at school and the increased motivation (Learning@Europe project, based on 3D shared environments. Year 2006-07).

The apparent explanation was that the "re-shuffling" of roles determined by such an unusual activity had helped some students to surface up and experiment what it meant to be "good at school", thus encouraging them to put more effort in school activities. A teacher reported: *"One of my students is the only boy in a class of girls and was never among the high-achieving ones. However, being good at using computers, he was chosen to supervise any activity involving the use of technologies, and to play all the games. He worked with great commitment, and his classmates began to rely on him so much that he practically became the 'champion' of the class. I also gave him a*

good mark in my subject to reward his active participation." (Italian teacher, 2005-06). A class of Polish students, since their server had been damaged severely by a thunderstruck, went to an internet café to take part in the planned online meeting with their European peers in the 3D environment. A strong motivation lies behind this kind of behavior.

Theoretical Interpretation and the TPCK

The discussion of this section is based upon the evidences shown in sections 3 and 4, and also upon data collected for other ICT-based learning experiences that we ran in the past (see introduction).
Two theoretical questions are raised by our experience:

a) Is the *Technical Knowledge of teachers as necessary* as the Pedagogical Knowledge and the Content Knowledge are?
b) Is the *role of Technology* the same as the role of Pedagogy and Content in a successful technology-based learning experience?

Let's face question "a" first. Another way of phrasing it could be: "what should teachers know about technology and when should they acquire this knowledge, in order to manage successful technology-based learning experiences?". In (Mishra, Koehler, 2006), Technical Knowledge (TK) is described as the "knowledge of operating systems and computer hardware, and the ability to use standard set of software tools. TK includes knowledge of how to install and remove peripheral devices, install and remove software programs…". Speaking of TCK (the intersection between Technical Knowledge and Content Knowledge), the same authors state that "teachers need to know (…) also the manner in which the subject matter can be changed by the application technology". Speaking of TPK (the intersection between Technical Knowledge and Pedagogy Knowledge) authors say that it is the "knowledge of the existence, components and capabilities of various technologies, as they are used in teaching and learning". When the three types of knowledge are put together (TPCK), the description reads: "nuanced understanding of the complex relationships between technology, content and pedagogy, and using this understanding to develop appropriate, context-specific, strategies and representations."
We do not dispute that it would be desirable for teachers to get a sophisticated understanding of technology, as advocated by the TPCK model. The question is: *is this really necessary?* Most of the teachers, who successfully participated in PoliCultura did not have any technological skill, they hardly knew how to save files, they could not record MP3 audios, and so on. Still, they were able to supervise, manage and run highly rewarding technology-based learning experiences. If the reader suspects that we (as Politecnico and organizers) did the job for the teachers, we may reassure her that this is not the case. We do not even meet the teachers, nor do we cooperate remotely. The online help that we offer is seldom used, and mostly for questions about how the competition works. Teachers are absolutely "in charge" in their classroom: they select the subject, prepare the class, organize the groups, supervise the work, motivate the kids, check what is going on, etc. Some teachers, more technology aware, stepped into the development process more than others, especially in the case of pupils younger than 7 years. But we know that is a small percentage (something between 20% and 25%) and, overall, pupils worked quite autonomously, developing their technological skills "by doing".
Similar observations apply for the experiences based on the 3D-immersive environment a sophisticated and (relatively) complex technology. Most teachers did not understand 3D technology at all, nor did they fully grasp its implications for pedagogy or content. Still, they were able to manage very rewarding learning experiences (Di Blas, Garzotto, Poggi 2009; Di Blas, Paolini, Poggi, 2008; Di Blas, Poggi, 2006; Di Blas, Paolini, Poggi, 2005). Interestingly enough, also (Archambault, Crippen, 2009) reach the same conclusion in the analysis of teachers' knowledge when managing online courses.
In synthesis, our experience shows that good teachers *do not transmit technological knowledge (that in most cases they do not have), but rather play the role of facilitators, tutors, coaches. So: is TK (or TPK, or TCK) a necessary "ingredient" for a teacher? We have some doubts about it.*
Question "b", is strongly related to question "a": if teachers do not need a strong TK for conducting successful technology-based learning experiences, what is the role of Technology in those experiences? Does it play the same role as Pedagogy and Content?
If some authors overemphasize the role of technology in those experiences (Druin, 2009) other authors almost dismiss it. (Reeves, 2010), for example, equates the role of technology to that of a "truck delivering groceries". You do need the truck, otherwise the groceries will not reach the store; the truck, however, has no influence on the quality of the groceries being delivered. We find this similarity a little too dismissive: people do not choose a store depending on the quality of the delivery truck, for example, nor they declare that a shop is very good (or bad)

assessing the quality of the truck. We put forth another similarity instead: shoppers today look for "shopping experiences", not just products, therefore the interior design, the look and feel of the shop, as well as the way products are organized over the shelves are important ingredients for selecting one shop over another. It is true that the intrinsic value is given by the quality of the products, but the shopping experience plays a crucial, sometimes decisive role on the choice.
We thus argue that sometimes (not always) Content and Pedagogy are the groceries while *Technology is the shop: it may add flavor to a "learning experience", generating engagement, motivation and participation.* On our teachers' opinions, engagement-participation-motivation of the pupils are acknowledged as the most prominent benefits generated by the use of state-of-art technology. Teachers could, in principle, build interesting narratives in a traditional way (i.e. without technology); from a pedagogical point of view, they may reach comparable results, but the pupils' engagement would not be the same (Rubegni, Paolini, 2010). Just like shop-keepers can't dismiss the quality of their shop, *teachers today can't dismiss technology as a way to make the learning experience more rewarding and attractive, and, in the end, more effective.*

Conclusions and Future Work

We are planning to pursue and expand our activities with multimedia digital storytelling at school, in several directions:

a) Enlarging participation in Italy, to reach thousands of pupils every year.
b) Launching an international version of PoliCultura, involving different countries. We would like to verify if participation and impact will be similar to those detected in Italy.
c) Launching a specialized and international version of PoliCultura focused on the experience of visiting a cultural institution. We are creating, for this purpose, partnerships with few cultural institutions, worldwide.

The above "on the field" experiences will help us to conduct deeper empirical evaluations of the impact of digital storytelling at school. We are redesigning our surveys and our interviews technique, in order to reach a better and finer-grained understanding of the educational benefits generated. Of specific interest to us is "inclusion", i.e. the possibility, through digital storytelling activities, of improving participation and performances of pupils with diverse learning needs.
Finally, with the evidences accumulated, we would like to progress on the theoretical issues discussed in this paper:

1. what is the "authentic" role of technology in the learning process?
2. What should teachers know about technology, for actually using it in the classroom?

The answer to the first question will help us to design better tools and better technology-based learning experiences. The answer to the second question will help us to provide better training to teachers, since we provide online training to nearly 400 teachers, per year, in Italy (Torrebruno, Marini, 2005; Torrebruno, Marini, Mandrioli, 2010).

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