Collective digital storytelling at school: a whole-class interaction

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Abstract: There is a growing interest in the use of collaborative technologies for education. However, their adoption and implementation in formal education is still lagging behind. One feature of cooperative technologies makes them particularly unusable in classroom settings: most tools, environments and interfaces for co-located collaboration are designed to support the interaction of small groups rather than entire classes. This paper proposes 'collective digital storytelling' as a way to engage whole classes into activities that provide substantial educational benefits. The paper draws on empirical data from a large-scale digital storytelling project in Italy, in its fourth year of implementation, and examines several aspects and benefits related to the use of digital storytelling in formal education, focusing upon two specific issues: (1) how digital storytelling can engage the whole class, rather than individuals or small groups and (2) how digital storytelling can be integrated in the curricular activities, generating substantial learning benefits.

Keywords: children; digital storytelling; educational technology; educational applications; e-learning; computer-supported collaborative learning.

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1 Introduction and background

The use of computers in education engenders teaching and learning patterns that bear significant differences from traditional educational models. One aspect that research has intensively harnessed recently is the potential that digital technology holds for supporting collaborative use and interaction. The recent relevant literature about HCI (e.g. Czerwinski et al., 2008; Olsen et al., 2009; Rosson and Gilmore, 2007) and interaction design for children (e.g. Cassell, 2008; Paolini and Garzotto, 2009) shows a pronounced interest in the development of cooperative technologies that can support interaction of groups at a distance or in co-presence. However, the application of new cooperative technologies is usually limited to short spans of time, often times in experimental settings and prone to provide an unfaithful account of how learning occurs in daily classroom activities (Light and Littleton, 1999, p.7). When it comes to large-scale application in formal learning settings, contextual constraints make the adoption of cooperative technologies a difficult to reach aim. In addition to costs, learning curves in technology use or space constraints, one feature of cooperative technologies makes them particularly unusable in classroom settings: most tools, environments and interfaces for co-located collaboration are designed to support the interaction of small groups. Single display groupware, for instance (Rick et al., 2009; Stewart et al., 1999), can support the simultaneous interaction of a group of users performing a common task, using the same display; however, the number of users that can interact at the same time with a display is limited, and cannot accommodate numbers as large as an entire class of children. Cases in which shared displays are used as support for whole-classroom interaction are rare (an example of whole-class interaction with a shared display and handheld devices is described by Moher, 2009).

The combination of cooperative technologies and storytelling is thought to bring substantial learning benefits, especially in early childhood education for fostering

balanced socio-cognitive development and improvement of narrative (Cassell and Ryokai, 2001; Decortis and Rizzo, 2002) and social interaction skills (Di Blas et al., 2009). Still, technologies for supporting cooperative storytelling are not making their way in the classroom. Most tools and environments that support collaboration in story creation (e.g. (Alborzi et al., 2000; Antle, 2003; Cassell and Ryokai, 2001) are applied in experimental or informal learning settings. Some notable exceptions regard initiatives that have been purposefully built, considering potential application in the school environment (e.g. Benford et al., 2000; Cooper and Brna, 2000; Decortis and Rizzo, 2002). Despite proved learning benefits, the application of these technologies beyond local scale and the integration in the curriculum meets a whole series of obstacles, from the constraints imposed by technology – costs, learning curves – to the difficulty of integrating them in formal curricula, alongside traditional classroom activities. Looking more carefully at these examples, whether employed in formal or informal education, we can detect a peculiar pattern: in most cases the different authors do not actually create *one* story; collaboration can go from giving feedback, peer review, integrating suggestions, up to, in fewer cases, the development of a story by couples or 3–4 peers at most. Collective storytelling is, in these cases, an umbrella term for covering several, and loosely coordinated authoring efforts.

In this paper, we claim that interaction as part of digital storytelling activities is possible at classroom level, and also that authoring one story collectively brings about substantial learning benefits, as well as a peculiar interaction pattern in which individual, small-group and classroom inputs are alternated. We sustain our claim by bringing empirical evidence from a large-scale case study of hundreds of classes developing collectively multimedia, interactive, digital stories.

PoliCultura is a competition for schools, organised each year by the Politecnico di Milano. The competition requires whole classes to create a multimedia digital story about a subject of their own choice. Some specific topics (like local cultural heritage) are sometimes suggested, but in most cases schools show a high degree of independence, selecting a large variety of subjects. Interactivity comes in two ways: in the process of cooperative story authoring, using a web-based tool, and interactivity in playing the story. Playing can be done via web, offline via a CD-ROM (families like to have their own CD) and via iPod (as a series of podcast episodes). The authoring is made possible by 1001stories, an authoring-delivery kit developed by the Politecnico di Milano, discussed in the next section.

Although the competition is open for classes at all levels, in this paper, we will highlight some of the results of its implementation in kindergarten (4–5 years of age) and primary schools (6–10 years of age). In the school year 2008–2009, 211 preschool and primary school classes initially registered for the competition, with 97 completing the narrative on time for taking part in the competition. We can, therefore, estimate about 2,900 pupils (between 4 and 10 years of age), involved with their teachers in developing digital stories.

Our presentation of this case will revert around the following key topics:

- The high degree of engagement of pupils in the storytelling activity, considering the case of collective, classroom-based authoring of one story.
- The integration of the activity in a formal learning curriculum, taking place throughout a period of 2–3 months.

- The substantial educational benefits generated. The final section of this paper makes an overview of these benefits based on the teachers' opinion.

1.1 Setting the grounds: How many ways to collaborate for learning?

At present, several terms are used loosely in the literature to describe the field at the intersection of learning sciences and technology, with a focus on aspects of group interaction and collaboration in tasks development. Theories of cooperation place an accent on the underlying motivation and the dynamics of cooperation. Argyle (1991, p.20) suggests there are three main reasons that can trigger cooperation: for external compensation; for building relationships and for sharing and enriching the activities the participants are involved in. Some authors insist on the *intrinsic* motivation to cooperate as a key element for successful cooperative learning (McConnell, 2000, p.7).

Cooperative learning can be defined by insisting on a shared goal or reachable outcome in group work (Underwood and Underwood, 1999, p.12), or on the relation between collaboration in group work and learning, with a focus on the process (McConnell, 2000, p.8). The analytical premises in the field of computer-supported cooperative learning (CSCL) are tied to different theoretical schools. Koschmann (1996, pp.11–12) identifies three major theories influential in the CSCL field:

1 constructivism insists on the role of interaction among peers in cognitive development and on the socially constructed nature of knowledge, building on the steps of Piaget

2 sociocultural theory, building on the legacy of Vygotsky, places an accent on the role of the tutor, or a more skilled person and their support in defining 'the zone of proximal development'

3 situated cognition theories stress that learning occurs through participation, not individually; communities of practice have embedded specific knowledge, and learning occurs by entry and participation into such a community through active sharing.

In the variety of approaches and theories that can serve to explore the relation between interaction and learning in group settings, two common denominators of cooperative learning can be pointed: the existence of a group, and a shared goal, purpose or outcome to achieve (McConnell, 2000, p.12). From here, a rich variety of cooperation pattern may arise and is currently practised in schools worldwide. For the purpose of this paper, we find useful McConnell's (2000, pp.16–19) framework for analysing the types of collaboration in cooperative learning, based on a set of six aspects:

1 structure (highly structured–no structure

2 teacher control (high–low)

3 moderation of learning (external–internal)

4 learner motivation (external–internal)

5 learning content (curriculum based–learner based)

6 assessment (unilateral by teacher–unilateral by learner).

1.2 Collective digital storytelling in formal and informal education

The emergence of collective digital storytelling as practice in didactic environments is theoretically backed by the consolidation of theories which look upon learning as knowledge building rather than knowledge transmission, and emphasise the social nature of meaning construction (Jonassen and Land, 2000). Building on the legacy of Piaget's constructivism, Papert's constructionism, and situated learning theories, scholars increasingly recognise the role of context and social interaction in the process of meaning, making and knowledge formation in kids. Development of technologies for supporting collective stories, authoring in a shared physical environment is, however, still lagging behind. Commercial products tend to focus on children as listeners of stories, or, if seeing them in the posture of story creators, provide ready-made characters or scenes which children can combine for making their narratives. Initiatives which allow children to play with computers, using freely their imagination to create and share stories collectively are still few, and most of them are the result of academic research (Cassell and Ryokai, 2001). In the following part, we recount some illustrative examples of tools and environments that foster collaboration in story authoring, and the learning benefits brought. Most of the initiatives and technologies described have been used in informal, rather than formal education. To effectively introduce collective digital storytelling in the curriculum, we argue, a complex range of factors need to be considered related to technology availability and costs, but also to the practical possibilities of involving whole classrooms, rather than small groups, in successful collaborative storytelling experiences.

A way to involve, especially pre-literate children in story authoring is the integration of digitally augmented physical objects in the story-authoring experience, fostering experiential, sensorially driven learning. Years before the advent of the digital wave in education, scholars and educators have pointed to the advantages of integrating physical objects in the learning experience, drawing on the familiarity of small children with the surrounding environment for introducing more abstract concepts. For instance, Montessori (1966) and Friederich Froebel (Brosterman, 1997) have designed and explored the benefits of using physical objects – manipulatives – in children education, for designing real-world structures or for enhancing the understanding of abstract concepts. Digital manipulatives refer to computationally enhanced versions of physical objects (Zuckerman et al., 2005), which can be used by children for playful learning through direct, hands-on manipulation. For example, MIT Media Lab's Digital MiMs (Zuckerman et al., 2005) are digitally augmented building blocks used for enhancing the understanding of abstract concepts in young children. Computationally enhanced physical objects can also support the telling of stories. For instance, StoryMat (Cassell and Ryokai, 2001) involves children in a collaborative experience of story authoring, sharing and listening, using stuffed toys. Children can play with stuffed toys on a quilt, which records their voices as they tell a story, and tracks the movements made on the quilt with the stuffed animals. When new stories are told, the system replays past stories based on a pattern that considers their length, the movement on the carpet and the type of toy used.

A similar sensorial approach to exploration and/or authoring of stories is taken in room-sized interactive environments like StoryRooms (Alborzi et al., 2000) and KidsRoom (Bobick et al., 2000). Authoring and active exploration experiences in interactive spaces of this type offer a series of important benefits, especially in terms of engagement, a fun approach to learning, social interaction and motivation. However, their development and implementation bring about significant shortcomings, such as space

constraints, maintenance costs, advanced and costly technology not easily content adaptable (Alborzi et al., 2000).

These shortcomings are easily overcome in virtual spaces, where collaboration among children in story authoring impose less constraints and is made possible by simpler technology. Virtual collaboration in story authoring can be accommodated in 2D or 3D environments like FaTe2 (Garzotto and Forfori, 2006); start from predefined story elements that can be combined and passed on by children for creating multimedia stories like the experience supported by StoryBuilder (Antle, 2003); or reflect the real-like experience of participating in a story creation by taking turns and adding a phrase like Renga permits (Cassell and Ryokai, 2001). ToonTastic is a tool – still in its Beta phase – that enables children to create and share animated stories based on a set of predefined scene types; ToonTastic software can be used over the web, using conventional mouse (launchpadtoys.com/toontastic/), or can enable collaborative story creation of several children around an interactive multiple-pen display (Russell, 2010). As far as the application in school contexts is concerned, virtual collaboration in story authoring can bring important benefits, by fostering creativity, engagement, curiosity and openness beyond the boundaries of the classroom. If employed in multinational settings, virtual collaboration in storytelling activities can also enhance cultural understanding, and enable children to embrace openness to diverse cultural viewpoints. However, to our knowledge, there are no significant cases of wide adoption of technology-enabled tools for supporting virtual storytelling in educational contexts, at levels comparable to those reached, for example, by complex multi-user virtual game environments like Learning@Europe (Di Blas and Poggi, 2007) or Quest Atlantis (Job-Sluder, 2004).

Some digital storytelling initiatives draw on role-play elements, enacting typical social interaction situations where participants take upon a role. One such application is Fear Not! (Figueiredo et al., 2008), meant to help students cope with and react effectively to bullying behaviour in schools. Other tools are meant to foster the development of specific knowledge and skills; for example, PUPPET (Marshall et al., 2004) is an example of a virtual environment used for teaching basics of drama production and enactment to children.

A promising direction of research considers the relation between programming and storytelling. While some researchers have looked into how storytelling can support the acquisition of programming skills (e.g. Storytelling Alice, in Kelleher and Pausch, 2007), the reverse relation has also been approached, or how programming can help foster the acquisition of storytelling skills (e.g. the use of Scratch programming environment, in Burke and Kafai, 2010).

Despite the substantial learning benefits increasingly associated with collaboration in authoring of digital stories, most initiatives remain either local in scale, or restricted to informal education settings (e.g. museums, theme parks, etc.). When considering implementation of tools for supporting collaborative authoring of digital stories in formal education, aspects related to the type of involvement solicited and the range of learning benefits emerging for students need to be considered alongside very practical aspects related to adoption and implementation of technology – like simplicity of use and the possibility of integration in the curriculum (Di Blas et al., 2009). An important issue at stake is also the type of interaction sought out in authoring: most authoring tools support either individual or small-group authoring, whereas in school settings, solutions need to be found for involving whole classes in the authoring experience. The EU-funded project NIMIS (Cooper and Brna, 2000) departed from these premises; how can classroom-based

learning experiences be enriched by the use of technology, and what type of software can be used for sustaining collaborative story authoring? The project was implemented in three European classrooms; through the direct participation of teachers and pupils in designing 'the classroom of the future', the project successfully integrated the use of cooperative technologies combined with more traditional technologies in the formal learning experience. The project also developed a story authoring software, 'T'riffic Tales', supporting individual and collaborative story authoring. Evaluation showed that classroom use of cooperative technology significantly increased engagement, motivation and collaboration among pupils. Of course, not many schools can afford the expenses and time-consuming activities for the integration of custom-made technologies in their regular class activities. At present, school teachers supplement the need of technological tools built specifically for digital storytelling activities by using regular hardware and software for audio and video recording, editing and presentation (e.g. Feher, 2008; Oliveira et al., 2008; Pierre, 2006; Susono et al., 2008).

2 Authoring digital stories at school: the PoliCultura experience

In this part, we describe the authoring experience in the PoliCultura contest, supported by 1001stories, an authoring-delivery toolkit developed by the Politecnico di Milano.

2.1 The 1001stories Toolkit

For the PoliCultura contest, Politecnico di Milano makes available to Italian schools the 1001stories authoring tool, a web service accessible for free to registered users. There is no particular technical pre-requisite for using the tool, which is also very easy to use and intuitive. The 1001stories supports the creation of multimedia presentations that we call 'narratives' in that lightweight in terms of content (lasting on average 20–30 min), pleasurable, and meant to be 'listened to – looked at' in a relaxed manner.

1001stories is an authoring environment that goes with a small number of delivery engines. It supports three basic functions:

1 the creation of the narrative structure (i.e. the set of topics and sub-topics and their organisation)

2 the data entry of the content (audio files, images and text)

3 a preview of the current version of the narrative, in order to allow the authors to check how the work is going.

The data entry (Figure 1) is a simple control panel that enables the user to edit the editorial plan of the story (the narrative structure) and to enter content for each element. Once the narrative is complete, different delivery engines generate different versions of a multimedia narrative. Currently, the following formats are supported:

- interactive narrative: (web, e-key, Cd-ROM)
- playlist (MP3 and MP4 players)
- interactive phone (the narratives can be played – audio only – over any ordinary phone)

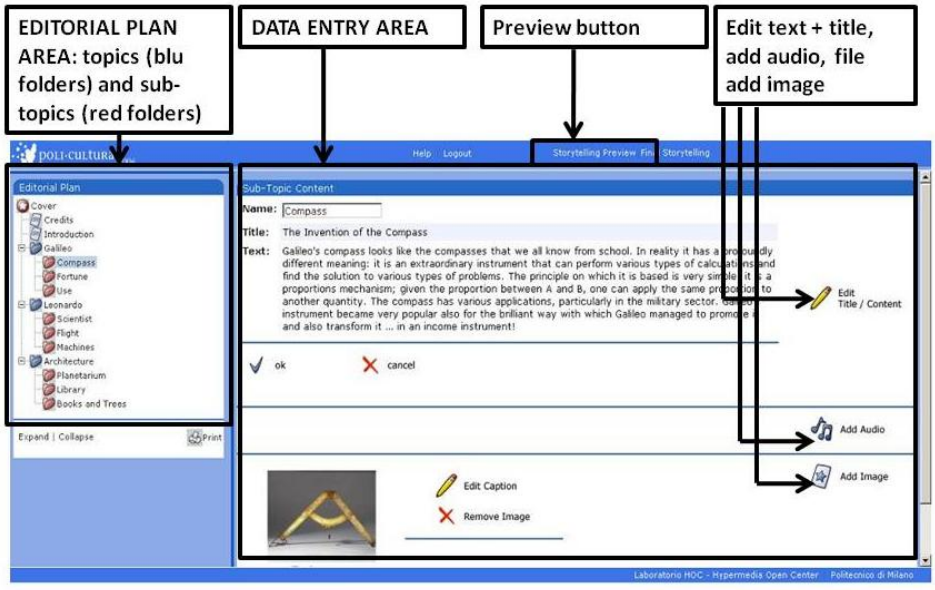
- leisure browsing
- interconnected narratives.

The implementing technologies are MySQL as DBMS and PHP as scripting language.

The tool is very easy to use (children aged 10 and unattended learn how to use it in 20' approximately) and it allows an effective generation of the different formats: less than two hours are needed in order to generate (from a single authoring process) all the different versions.

The narratives produced with 1001stories are characterised by a tree-like structure, the main nodes of which are called 'topics' and 'sub-topics' (see Figure 1, left-hand side). Additional nodes are the 'cover' and some ancillary information about the story as a whole and those who made it (e.g. 'credits' section). The user cannot change the overall information architecture (i.e. she cannot, e.g. add a new navigation layer). The aim is to leave not only technological, but also design issues aside, to allow authors to directly focus on communication: the story, the plot, the images, etc. Customisation, therefore, regards communication issues only. Authors can take decisions upon the overall organisation of the story, the number of content nodes (How many topics? How many sub-topics for each topic?), the kind of visual and audio content (slideshow with pictures, scanned drawings, music or spoken text, etc.). In spite of these constraints and of further advice provided in the user manual, including clear content development guidelines, the works done by schools, and especially by very young pupils are surprisingly creative (Di Blas et al., 2009).

Figure 1 The data entry interface of the 1001stories engine (see online version for colours)



2.2 Learning and the collective dimension of digital storytelling

Among the nine tenets engendered by a cultural psychology perspective on education, Bruner (2002, pp.26–55) cites the constructivism, the interactional, the externalisation and the instrumentalism tenets. Each of these four tenets have been further approached by novel education theories (like, e.g. in the constructionist approach, Kafai and Resnick, 1996; Papert, 1991; Resnick, 1996) in relation to the role and purpose of technology usage in education. Our concern, in this part, is to understand to what extent collective digital storytelling can support learning and what are the peculiarities of the authoring process supported in the PoliCultura experience. We do this first by applying the four tenets of cultural psychology mentioned above to the collective authoring process with 1001stories in class. Starting from Bruner's tenets, the collective dimension of digital storytelling can be described, drawing on some salient points also to be approached in constructivist, constructionist and situated learning theories, having to do with: learning as knowledge construction; learning through social interaction and learning through the externalisation of a meaningful experience. All along, technology plays a synergetic role, driving the efforts of children towards a commonly pursued goal, achievable through the practical implementation and integration of the media components into a collective digital story.

2.2.1 Learning as knowledge construction

The collective digital storytelling experience supported in the PoliCultura contest can be described as an active process of knowledge building, in which phases of internalisation (research phase) and externalisation (writing, discussing and sharing) of information are alternated. With primary schoolkids, not familiar with reading large quantities of data, the internalisation phase can be creatively handled by a variety of other means, ranging from open lectures by the teachers, to a lived experience, or noteworthy local event, about which children can receive information from various sources, not restricted to the school context. The externalisation phase – writing the texts – is also, at their age, a process which requires extensive collaboration with peers as well as with their teacher. Some teachers report that after work groups accomplished part of the creation process, they used open lectures or video projections for collective revision and validation of contents.

2.2.2 Learning through social interaction

Bruner holds it that the traditional interactional patterns of education, based on the dichotomy teacher–student and one-way transmission models, are outweighed by patterns in which peer-to-peer interaction and learning are emphasised, and where the teacher acts as orchestrator rather than the omniscient information source (Bruner, 2002, pp.34–35). In the case of PoliCultura, the process of authoring with 1001stories involves an alternation of individual and collaborative endeavour, where the teacher has a determining, though not exhaustive role. For creating a digital story, children need to agree on a design pattern; write the texts for each topic and sub-topic of the narrative; gather images and allocate them for each topic and sub-topic; record the audio and upload the media using the 1001stories tool. How do individual and collaborative inputs come together consistently? Central in making individual and collaborative work complementary is discussion and sharing of the work among peers. In key moments in

the creation of the narrative, participants share the results of their work, comment and give feedback. A more extensive description of the authoring steps and the type of interaction engendered are provided in the next section.

2.2.3 Learning from the externalisation of a meaningful (shared) experience

The defining aspect of Papert's vision of constructionism (Papert, 1991), as compared to Piaget's constructivism, stands in the aspect of externalisation and sharing. If Piaget asserts that knowledge is acquired through a process of active construction, Papert adds that this process is particularly effective when individuals build something external, shareable with other people. Resnick, a theoretician of constructionism himself, further insists on the fact that effective learning occurs when people are involved in the construction of *meaningful* artefacts. 'Distributed constructionism asserts that a particularly effective way for knowledge building communities to form and grow is through collaborative activities that involve not just the exchange of information, but the design and construction of meaningful artefacts' (Resnick, 1996). Hence, effective learning, based on constructionist theory, occurs through the construction of meaningful artefacts – tangible or intangible – that are shareable with the others. Bruner also insists that externalisation, the creation of collective *oeuvres,* can contribute in building identity and solidarity in a group or community, and further, in supporting a proper division of labour in the creation process, in correspondence to the talents and aptitudes of each participant (Bruner, 2002, p.36).

From our observation of the collective narrative works in the PoliCultura contest, one of the difficulties in driving a class of children towards building a collective story is to find a subject easy to understand and internalise at an early age. Most coordinating teachers have solved this difficulty by opting for themes that children are already familiar with as a group, and in many instances the themes are drawn from an experience in which the children have been jointly involved. Some of the most successful narratives have been built based on a common experience, place or event in which the children have participated together or which is meaningful to them as a group. These can range from physical, situated events, such as the visiting of a museum, an archaeological site; to a story meaningful for children as members of the city or community in which they live like a past event in the city history. The local or commonly shared nature of the theme approached is, in the case of PoliCultura, one of the drives for a successful experience in collective digital story authoring.

2.2.4 Mediation and the synergetic role of technology

Resnick concentrates on how computers and computer networks can be used for building knowledge in communities of users. He identifies three types of construction activities:

1 discussion on constructions

2 sharing constructions

3 collaborating on constructions (Resnick, 1996).

Discussion, sharing and collaboration in creating are all identifiable in a typical class-based authoring experience with 1001stories. One of the defining features of this process is the time factor: the collective stories are not one-time spontaneous collaborative

creations, but the result of sustained effort stretching over a period of around 3 months. Sharing, feedback and cooperation activities occur in key knots in the advancement of the story authoring, for ensuring that the collective product is not a puzzle result of many minds, but a consistent, sense-making artefact, reflecting the common vision of a group of children. All throughout, technology acts as a driver, by helping the picture of an accomplishable end product to slowly emerge, first conceptually and finally in digital format. The type of technology used for fostering the expression of this common vision in a collective digital story influences the collective process of work in at least two ways:

- work organisation and task attribution among kids
- succession of individual, small-group and class-based effort.

Children take different roles throughout the authoring experience, depending on the stage reached: in a single project, children perform information retrieval; text writing; images selection and editing; audio recording and editing and data upload. In some cases, roles are pursued by a child from beginning to end, in other's roles switch. Most teachers report that children are assigned, or voluntarily take the roles akin to their previous inclinations or competences. A teacher reports, for instance, that since the time was short, he devised this strategy of assigning tasks for competence, e.g. assigning the data upload to children accustomed with the use of computers. What is important to note is the importance of having *one,* clearly articulated goal and vision for the collaborative authoring process to happen; the succession of individual work, group-based and class-based work is driven by a commonly held vision, while groups split to work on a task, they are contributing with the creation of conceptual and digital data that requires group and then whole-class validation in order to achieve an artefact that reflects consistently and coherently this vision.

2.3 Collective authoring in the PoliCultura experience: main steps

In this part, we take a closer look at each step involved in the process of authoring digital stories in the PoliCultura experience. The process of collectively creating a story revolves around five main steps:

1 the theme selection

2 the creation of the editorial plan, i.e. the set of main topics and their sub-topics

3 the creation of the multimedia pieces of content (texts, audios, slideshows…)

4 the assemblage of all the pieces to see how the work is going

5 after a reasonable check the final publishing. Countless variations of individual and collaboration patterns are possible along these steps.

Though thought out sequentially, these steps are rarely accomplished in a strict sequence: images can be gathered or drawings created while texts are not yet written completely; the design patterns might suffer adjustments after texts have been written, etc. Based on data resulting from online surveys, interviews and our experience of directly observing selected cases, we have identified a series of patterns of individual vs. collaborative involvement, and how these converge in making the narrative advance. Collaboration can occur either at the level of a small working group, or at classroom level. From our

observation, collaborative work at classroom level is required in *key knots* in the advancement of the story-creation process, related either with decision-making or with ensuring consistency. Deciding on the theme and the design of the editorial plan are classroom-based collaboration knots, for example, and after these are decided, work is usually split between groups (under the teacher's supervision). A third knot is the accomplishment of text writing: at this point, collective validation from the whole class is necessary, and some parts may be redone for ensuring consistency. A fourth point is after the allocation of the images, with the same goal of ensuring consistency and avoiding overlapping. Finally, a global vision of the overall narrative is mandatory after audios are recorded, images gathered and everything is uploaded using the data-entry tool. Let us see each of them.

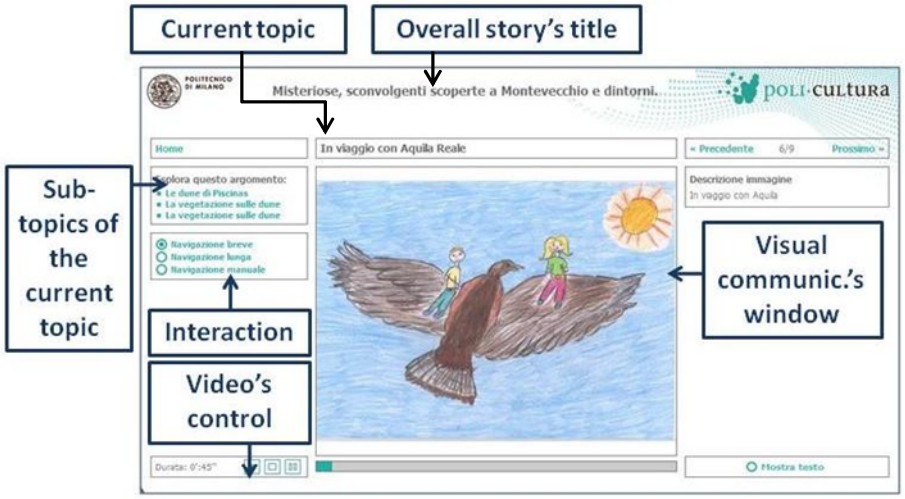
The *theme selection* is a fundamental knot. Drawing on Constructionism learning theory (Kafai and Resnick, 1996; Papert, 1991; Resnick, 1996) in order to have pupils involved in an activity, it is crucial that they feel it as personally relevant. It must be something involving, some way or another, the whole class. Many schools choose to tackle a school outing, others start from a school activity (like a social project or a research – Figure 2), others select a school subject and others make up a fiction. In all these cases, the approach is: let us find something that all students share, know and care about.

The *editorial plan creation* means dividing the main theme into a set of relevant chunks. Our surveys reveal that this activity is usually managed by the teacher, who discusses with the pupils in class and then divides them into sub-groups, each in charge of a specific 'chapter' (i.e. a topic with its tail of sub-topics). This is one of the most creative moments of the whole process, since it prefigures how the final reader's experience with the narrative will be like. Schools have devised the most various solutions, demonstrating in practice what communication scientists know in theory: that given a communication problem, there is not one and only one solution. For example, the creators of the story 'Discovering Montevecchio', inspired by a school outing, decided to mingle two literary genres in one narrative: the set of main topics unfolds a funny fiction, where talking animals teach two kids to care for the environment, while the sub-topics provide scientific information on the various animals and plants the kids encounter during their fantasy trip 'on board of an eagle' (Figures 3 and 4).

Creating the multimedia content is one of the most engaging and cooperative moments of the whole process, as well as one of the most educational. Students have to write texts of a narrative genre and in view of their audio consumption. Texts must be short (around 120 words is the best length), self-consistent (i.e. without phoric linguistic references to other chunks of the narrative – like 'this' or 'as we said before') and with an as much as possible simple syntax. Audio recording and the creation of the visual communication elements are two important moments, which support development of technical skills. Even preschool children are capable of understanding and managing the principles of audio recording (Di Blas and Boretti, 2009). As regards the slideshow creation, children prove very resourceful, searching the web, taking their own pictures or scanning their own drawings (Figure 5).

Figure 2 The narrative 'Together with you Grandpa' is about a meaningful experience for the whole class: a social project in an aged people's centre (see online version for colours)

Figure 3 In the narrative 'Discovering Montevecchio' (here shown as it looks on the web) two different literary genres are mingled (see online version for colours)



Note: The sequence of the main topics (illustrated by the kids' drawings) unfolds a cartoon-style fiction about the environment. If the user selects the sub-topics, scientific information is provided.

Figure 4 A snapshot of a sub-topic image, providing scientific information about real eagles (narrative 'Discovering Montevecchio') (see online version for colours)

Figure 5 Preschool children learn the basics of audio recording (see online version for colours)

Data upload, i.e. the assemblage of all the pieces in the engine is a very exciting moment, in which the community of authors witnesses the birth of their work. The whole narrative is checked for consistency and communication strength. Changes are made and eventually the final version is ready for publishing. A typical communication strategy, introduced by a primary school in 2007, is for the class to add a final multimedia 'signature' introducing the authors in the narrative itself (Figure 6). When the work is completed, it is not unusual for the community at large to be involved: parents (who volunteer to pay for CD-ROM production), the school principal and in some cases the town major and the population (Di Blas and Boretti, 2009; Garzotto and Paolini, 2008). There are further means of involvement: for example, a survey showed that 36% of the young authors of 'Milan during Roman times' took their parents to visit the Archaeological Museum of Milan after the work was completed (Garzotto and Paolini, 2008).

Figure 6 Three proud authors of the narrative 'Milan during Roman times' (primary school) (see online version for colours)

2.4 PoliCultura: educational benefits

Every year, we run an assessment of the didactic impact of the PoliCultura experience, through interviews, direct observations and online surveys to teachers. We aim at capturing the learning benefits of the digital collective storytelling experience from the teachers' viewpoint. Two dimensions have been used to measure the learning impact: the cognitive level (knowledge and intellectual skills) and the affective level (feelings, values, motivation towards learning activities) (Krathwohl et al., 1964).

One important aspect that we aimed to assess regards the comparison between educational benefits fostered by the digital storytelling activities and regular teaching activities. Table 1 shows an excerpt of the results of the surveys regarding this comparative assessment, from teachers of all classes participating in the year 2008–2009, from preschool to high school. We will base our comments on the interpretation of those data coupled with findings from the qualitative evaluation (interviews and observations), these latter focusing exclusively on preschool and primary school.

We can first note that negative comments or attitudes towards the digital storytelling experience are almost absent. This is a very encouraging response to the introduction of technologies for story authoring in school environments. However, the fact that participation is on a purely voluntary basis is a factor to consider: we can assume that teachers who decided to take part in PoliCultura are in principle open to the idea of integrating technology-based, engaging experiences in their curriculum, although they may be not fully aware of what this implies. Given the voluntary basis of participation in the project, we cannot conclude that for 'all teachers' the introduction of technology at school would be as successful as it is for those involved in this case. Still, our data show that engaging classes in interactive storytelling is something that teachers appreciate, especially considering the range of learning benefits it brings. Direct observations (in a few schools) and interviews to teachers tell us also that the experience is highly motivating for the children: building multimedia artefacts, using their own voices and seeing the result working on a screen creates something like magic.

Table 1 Learning benefits of PoliCultura: an excerpt (153 questionnaires, year 2008/2009)

	Achievement with respect to regular teaching activities				
Educational benefit	*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 organisation 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%

In the online questionnaire, teachers were asked to assess the benefits obtained through the PoliCultura experience in comparison with regular didactic activities. As we can see, from Table 1, all the educational benefits we inquired about received more than 90% of (high + very high) appreciation. Still, it is interesting to analyse the small differences in appreciation.

The highest appreciation is for *engagement*, which is something we expected: this is one of the most widely reported benefits of the introduction of interactive technologies in class (e.g. Cooper and Brna, 2000). What is important to stress is that engagement is generated by a collective (at class level), not individual authoring of a story: the awareness of the class as a cooperating group is thus dramatically increased (as pointed also in a study on the use of the same authoring tools in primary schools, by Rubegni and Paolini, 2010).

It is also relevant to notice that the three benefits related to the *curriculum* have received high appreciation: *increased interest for the subject-matter* dealt with in the story; *in-depth understanding; retention* of what has been learnt while building the story. The processes associated with these benefits deserve a better attention. At first sight, they can create the false impression that interactive storytelling alone can foster such benefits, while our qualitative analysis (based also on data from observations and interviews) reveals that it is *the teacher* who, capitalising on the engagement and fun generated by story authoring, can transform a digital storytelling activity into an *effective learning experience*.

Other learning benefits pertaining to the area of communication include:

- *Communication abilities*: textual and visual communication, as well as consistency between the two. The authoring activity requires writing a synthetic good text, suitable for becoming an audio narrative (possibly for a podcast), as well as selecting relevant pictures and properly pairing them with the audio.
- *Content organisation*: this is the ability of structuring the narrative in a coherent and effective fashion, paying attention to semantic relations between the different parts, so that a consistent communication product is achieved.

For both of these two benefits, we observed that the influence of the teacher was felt, especially for the younger pupils. The intrusiveness of teachers was stronger for the organisation of content (i.e. structuring the narrative) and less for content production.

In terms of *media literacy*, this experience brought about development of expected skills: starting applications, creating files and moving them around, selecting pictures, writing text, etc., but also less-obvious skills, such as audio recording and saving as MP3 files, or scanning drawings in order to obtain JPEG pictures, all required steps in developing the narrative.

We also point to the fact that the great majority of teachers (above 60%) with classes of pupils above 7–8 years of age did not possess media literacy abilities, and in most cases they did not even acquire them. We provided online instructions, based on which the teachers organised the work; hence in many cases, pupils acquired digital literacy skills on their own. Teachers of younger pupils, instead, needed to be more confident with technology; otherwise, the authoring would have been impossible for 4–6-years-old kids.

There is an educational benefit directly related to the collective nature of the authoring – improving the ability and the attitude for *working in groups*. Pupils had to learn how to work in a group, how to be responsible for something and at the same time to integrate their work with other children's work, how to meet deadlines, etc. This was hard in several cases, but it did work in most cases and generated in the pupils a great feeling of accomplishment. Our qualitative observations tell us that the teamwork and the feeling of self-accomplishment have generated additional benefits:

- *Inclusion*: it was often the case that pupils for some reasons marginalised or with diverse needs were highly motivated to participate and able to integrate their work with that of the other children. The collective storytelling activities helped them feel more integrated with the whole class, and increased self-confidence.
- *Reinforced cohesion*: in several cases we were told that the class became more 'cohesive', relationships and bonds among pupils were strengthened and in some cases, even the relationships with teachers improved.
- *Long-lasting effect*: the two above positive effects spawned from collective storytelling to other school activities, and lasted for sizable period of time (often until the end of the school year).

3 Conclusions and future work

Let us start with a few comments from teachers regarding the benefits of the story authoring activities:

- The experience thoroughly engaged my pupils and allowed them to refine many technical abilities as well as group work.
- Collaboration improved, motivation increased and active participation too.
- Improvement of class-group cohesion.
- In a rather problematic class from a relational point of view, this activity has developed the capacity to work in a team. Moreover, students got involved in the subject-matter (i.e. of the narrative).
- Engagement, also for students generally little motivated.

- Major involvement, especially from those students that usually do not stand out in class.
- Every child has been valorised in his natural gifts: speaking, drawing and researching. They naturally coordinated in small groups.

The data collected through interviews and surveys, teachers' comments and direct observation confirm two important facts:

1 Authoring digital stories can provide a *very engaging and rewarding collaborative experience* for a whole class (from preschool to senior high school level).

2 Authoring digital stories can be *integrated in the curriculum,* providing educational benefits.

Let us comment the first aspect first; it can be explained with a number of concurring causes:

- *The use of multimedia technology*: kids get excited by the fact that they use computers and multimedia at school. Using contemporary technology, in an environment often felt as conservative and backward, provides the most important factor for creating engagement.
- *There is a common achievement on sight*: the need to complete the work on time (for the competition deadline) and the 'relevance' of the perceived result makes students feel as a team.
- *Visibility*: the fact that the story authored will participate in a competition and that, even if delivered too late for the competition, it will be made public on the website of a prestigious institution (Politecnico) provides a strong incentive for producing a high-quality artefact.
- *There is a large and variegated task to perform*: a digital story implies a variety of things; here are a few of them: understanding the subjects, devising a content plan and organisation, writing texts (to be read aloud), selecting images and improving them, drawing and scanning, recording audio, and uploading the multimedia files to the web-based authoring tool. Each pupil can find something appropriate for her talent or interests.
- *Teachers organise the class*: one of the important advantages of working with a formally organised class is that there is a teacher, and the teacher has a crucial role in organising the collaboration; in the end it is the teacher (rather than the tool) that ensures that everybody has something to do, and that they do it in an effective way. In a very large number of cases, we have been reported by teachers that even pupils with diverse needs are eager to participate and find a way to provide their contribution. This evident *inclusion* effect is one of the most important – and pleasant – surprises to us.
- *Pupils feel in charge*: teachers very often report that pupils (say above 8 or 10 years of age) feel in charge and responsible for the results. This is due to two main reasons:

1 most teachers have very little confidence with technology and pupils have to do the technical job on their own; i.e. teachers supervise and direct, but technology is often left to kids.

2 with few exceptions, creating a digital story is a new experience also for teachers; they do not 'know everything' and act more as coaches than as knowledge dispensers; this situation favours a greater responsibility for pupils.

- *External involvement*: in many cases families are involved for finding material to complete the narrative (e.g. pictures); also, they are involved when the result is completed, since schools often organise public displays. In addition, often the stories are about the local territory, involving local communities and associations, administrators of small towns, etc. All this provides a stronger feeling of a common and relevant purpose for the whole class.

All the above ingredients seem to be present for most of the classes we have investigated. It can be relevant to notice that, with the exception of the first one (the use of multimedia), none of them is related to specific features of the authoring environment, whose main purpose is to provide an easy-to-use tool, with a result (website, CD, podcast, etc.) fostering pride and self-satisfaction.

Let us now investigate *the integration in the curriculum*. Often educational projects for kids based on interactive technology are carried on in after-school hours, and with little correlation with the official activities of the school. The storytelling activities supported in PoliCultura, instead, require a not negligible amount of hours of regular school scheduling; it is, therefore, important that the activity generates real educational benefits, related to the requirements of the curriculum. As we have discussed in the previous section, the data indicate that educational benefits are indeed achieved, but what is the cause? One strong reason lies in the actual content of the narrative, which is correlated to the curriculum; the narrative can be an essay or a fiction, but it is always related to a school subject, such as 'Roman history', 'ecology', 'a school outing', 'nature observation', 'social values', etc. Whatever the subject chosen, teachers can use digital story authoring as a way to foster motivation for school activities. In addition and specifically related to benefits related to the involvement in digital storytelling activities, specific skills are enhanced, such as 'text writing', 'content organisation', etc.

As far as the future work is concerned, we are currently improving our understanding of the actual process of collaborative storytelling. Through ethnographic observations, interviews (to hundreds of teachers) and focus groups, we try to better understand how children cooperate and how they participate in creating stories. This will lead us to improve the tool and also to shape a more rewarding experience, prone to generate sustainable educational benefits.

A specific direction, for the near future, is to encourage the use of mobile technology for gathering material (pictures, videos and audio) to be inserted in the narrative.

As far as PoliCultura goes, we are organising a wide partnership in order to increase the number of children involved in Italy and also to create an international version of the competition.

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