# Large multi-touch screens to enhance collaboration in the classroom of the 21st century: an Italian experiment.

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**Abstract.** Thanks to technology-pervaded learning environments, digital natives can experiment new engaging ways of learning together at school. In particular, large displays with multi-touch technology hold new opportunities for the learning process, through the dialogic interaction between students and the simultaneous physical interaction with the screen. Our research suggests the use of a context-aware platform with multi-touch displays to support digital storytelling, in order to increase students' involvement, motivation, and participation. We start our work by designing an application to create fairytales using multi-touch screens, to stimulate new collaboration opportunities during everyday classroom activities. The paper presents the results of an experiment with Interactive WhiteBoards (IWBs), carried out in an Italian primary school.

**Keywords:** Collaborative learning, participative learning, multi-touch technology, single-display groupware, technology-enhanced education, IWBs.

## 1 Introduction

In Italy, technology-enhanced environments are changing our everyday activities both at home and at work. On the contrary, in most of Italian schools, the tools, the activities, the buildings and, in general, the "environments" of Italian classrooms are designed for students born in the 20th century. When grandparents have the opportunity of visiting their nephews' classrooms, it is common to hear comments like "*This was my classroom! It has not changed so much; it seems smaller!*".[1]

Our research attempts to move the first steps towards a pervasive classroom [1,2], in order to bridge the gap between digital natives' generation and the actual out-of-date school and to stimulate new pedagogical practices. We start our work by focusing on applications suited for large interactive screens, or Interactive WhiteBoards (IWBs), trying to exploit at best the affordances of multi-touch

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[1] In some case, grandparents are rigth. It is not because they have grown old and the classroom seems smaller, but because it is really smaller than before. As a matter of fact, various restorations – made on buildings hosting Italian public schools from the beginning of 20th century – augmented the number of rooms/classrooms hosted in the same building. The actual number of children per classroom is the same of the 60's, i.e. 25-30 children.

technology, which could allow new collaborative learning strategies in classrooms, while consolidating the verified benefits of using IWB with single-touch technology, already placed within many Italian schools [3].[2] These new possibilities can really lead to a different learning approach, where technology permeates all educational world and where knowledge is really built through group activities.

### 1.1 The Technological Context

Nowadays the entire process of creation and communication of knowledge is in the middle of a profound transformation. In the background there is our civilization of the World Wide Web, of the so called “digital natives” [4], of the ever more massive computerization of public and private administrative services, of the prolific Social Network use, but above all our civilization is witnessing an anthropological change in the practice of reading and writing [5].

The school system, which is in pole position in the formative process for the acquisition of these skills and abilities, cannot look on. The educational world should have an active role in these changes, sometimes imposed by political choices or introduced without an effective debate within all the stakeholders: they should be involved in all the transformative processes of knowledge acquisition and production.

In particular, a radical change is affecting two of the most symbolic cultural objects of everyday didactical activities: the traditional blackboard and the paper book. Considering the recent introduction in some schools of electronic books, projected on Interactive Whiteboards, and of other touchscreen devices (I-pads, e-readers, smartphones etc.), a complete redesign of the classroom and its educational tools is needed.

After the slow introduction of PCs at school over the last decades, it seems that computers are now really “disappearing” [1,2]: schools are transforming into new learning environments where technology – permeating all the activities – disappears within school desks, walls, and all objects of the classroom.

It stands to reason that such a new educational environment asks for different didactical practices and that digital natives’ generation needs more technological-oriented learning activities.

### 1.2 Digital Natives’ Needs

Children, independently from when and where they are born, use to collect information and build their own knowledge exploiting all sources and stimuli they receive. However, children born in the 60’s in Italy received the majority of information and stimuli from their family, school and books. In a middleclass family of that period, children usually had a limited number of toys and a limited number of books.[3] They watched TV only few hours a week and went to the cinema once or

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[2] In 2009 in Italy started the national project LIM “*Lavagne Interattive Multimediali*”, i.e. InteractiveWhiteBoards.

[3] Including all sort of books from the still famous encyclopedia “*Conoscere*”, to scholastic books, till the world-wide famous Disney comics “*Topolino*”.

twice a year, therefore they had limited opportunities to watch cartoons, children-movies and alike.

As a matter of fact, children of the 21st century have been part of a multimedia digital world from birth: they are comfortable with technologies and accustomed to communicate by using simultaneously various media (e.g., chatting on PC, texting on mobile phone, etc.). They are used to collect information and build their own knowledge exploiting multiple sources: not only family, school, and books, but also from children-movies, cartoons, TV, cinemas, DVDs. In most cases, the Internet is the "place" where all these sources of information are accessible in few clicks.

Even preliminary neurological studies show that they are able to handle multiple stimuli concurrently better than digital immigrants are. The day-by-day world of digital natives is permeated by digital technologies while, in some way, school is still mostly clung to chalks and blackboards.

Firstly, the gap between digital natives' generation and the actual out-of-date school asks for adopting new technology enhanced tools in the classrooms. Tools that support new ways of teaching, engage students, and stimulate their active participation to the lessons, in order to penetrate the digital world of the new generations, which are nourished of clicks and buttons [6]. Secondly, schools cannot abdicate to their educational role about teaching not only through new technological devices but also how to develop a digital wisdom and awareness of the opportunities offered by technology for learning [7].

In this transitional phase, only a wise use of old and new devices, of old and new teaching methods could offer a wide range of didactical opportunities to match the needs of both "digital natives" and "digital immigrants". As a matter of fact, our perspective is against imposing established technologies to students, or predefined teaching methods to teachers.

### 1.3 Importance of Cooperative and Social Learning

Despite the introduction of new technologies at school, current views of learning regard the notion of a teacher-dominated classroom; however, learners are also capable of creating and generating ideas, concepts and knowledge, and the ultimate goal of learning in the knowledge age is to enable this form of creativity [8]. The participation metaphor is characteristic of how learners engage in the processes of social interaction, dialogue and sharing, all of which are linked to socio-cultural theories.

Cooperative and social learning (i.e. participative learning) have been a matter of discussion and experience for many years now [9,10] and have long been recognized as ingredients of effective pedagogy. In spite of research demonstrating the benefits of participative learning, still the educational world is permeated with the misleading concept that teaching means only to transfer notions and capabilities as well as cultural and moral values from teachers to students. This conception has been generating a sharp dichotomy between teachers and students, as the knowledge flow is strictly unidirectional: from teachers to students, who are accustomed to passively assimilating the lessons. On the contrary, participative or social learning approaches shift the focus "from the content of a subject to the learning activities and human interactions around which that content is situated" [9]. Moreover, our approach, in line with CSCL perspective, "viewing collaborative learning as a group process versus as an aggregation of individual change" [11], focuses on the entirety of the learning process and on supporting discussion within the classroom, for promoting active learning [12]. Actually, as underlined by P. Dillenbourg, the kinds of interactions that we can consider as *collaborative* are interactivity, synchronicity and negotiability [13].

Learning occurs as a socio-cultural system, within which learners interact to create a collective knowledge; typically, they receive scaffolding through the help of others: peers and teachers, but also virtual communities, sources and technology.

It is the combination of technological tools facilitating a co-learning approach to education and collaborative learning activities that can stimulate more active participation of the whole class during the learning process.

After all, only new educational agendas and priorities, that offer the potential for radical and transformational shifts in teaching and learning practices, can really move schools towards a 'Pedagogy 2.0' [8].

# 2 Pervasive Classrooms

## 2.1 Technical Approach and Devices

Imagining the educational environment of the future, in line with [14] and taking into account previous experiments of "the classroom of tomorrow" [15,16], we plan to have a technology-pervaded classroom, with few interactive tables and large screens (e.g., augmenting desktops and blackboards); various tablet and portable computers and a multitude of technology-enhanced gadgets (e.g., bracelets, pens). All these technologies, embedded in everyday tools, could allow collaborative and participative learning of students during classroom activities; moreover, some gadgets follow the students outside the school, allowing a learning process available 'anytime, everywhere'[17] .

All these artifacts are part of a context-aware platform, providing appropriate adaptability and personalization to the users. In particular, we adopt a platform called SIS (Space Integration Services) [18], which supports the exchange of contextual information among client-components, using a publish-subscribe mechanism. This platform represents, in our vision, the technological background for the development of the classroom of the future: the pervasive classroom.

At present, we focus on designing applications suited for large interactive screens, or Interactive WhiteBoards, with multi-touch technology. On purpose, we start from IWBs for their valuable characteristics. It is well known that pupil's learning is reinforced by the physical and tactile interaction with the IWB. By adopting multi-touch technology – allowing multi-user interaction – students' engagement in learning activities and collaboration in building knowledge could be stimulated. Our application is developed on MultiTouch Cells [19], where multiple persons can interact at the same time and the software tracks every user's hands, not only points of contact. MultiTouch Cells are modular LCD displays that can be connected to create a single large display array. We use RFID technology for recognizing students in front of the board or in the classroom; sensors and cameras, already available in our experimental classroom, will be adopted for recognizing persons in the next future.

### 2.2 A Context Aware Platform

Our work is based on a project started in 2009 for a platform of Ambient Intelligence (AmI): the Space Integration Services platform. The SIS platform offers services to diffuse relevant information, supporting space-aware communication. As a matter of fact, the SIS is able to detect the presence and the orders of people populating it in a precise moment and to react consequently, using a heterogeneity of electronic devices. These devices have to use the same communication protocol, to interact one another, independently of the device's nature. Focusing on the range of technical devices included in the project, we can find large interactive screens, surveillance cameras, RFID readers, wireless sensors, mobile robots, electronic paper, and various PCs and servers. The SIS does not need to identify all these devices, because it is each client-component that is recognizable by the other components which need its contextual information, through the spatial model. It is the publish-subscribe mechanism that support the flow of contextual information in spatial terms among client-components (e.g. applications, sensors, lights, screens etc.). In particular, "information is delivered whenever a non-empty intersection among publication and subscription contexts is recognized according to the space mappings" [18].

Considering that the idea is to create a common environment, we have to think to the infrastructure as a unique identity, managed by a multitude of devices, but necessary flexible and dynamic from the point of view of the offered services and useful for the exchange of information among the various applicative areas.

The AmI project aims at identifying persons inside the environment (using the information coming from the different devices), detecting paths or movements of groups, using data of the entrance of people to make statistical analysis on their habits, or to avoid dangers.

Therefore, the AmI project and the SIS platform have been studied to enlarge the vision of a pervasive classroom to an entire school building. However, there are some relevant issues concerning the communication and the integration of devices, in order to have a complete communication network among different environments and classrooms, to enhance the possibility of collaboration and participation to didactic. For instance, the SIS platform can support the development of lessons or activities involving pupils from same level-classrooms or of different age: the output of a classroom's activity can be used and discussed by another one, in the next hour, or recalled by the teacher of another subject matter.

### 2.3 The School Building Space Model

After enlightening the salient architectural characteristics of the SIS platform, in this section we are going to describe the specialized spatial model, oriented to a specific domain: the school building.

Our objective is to create the school building as an AmI environment, in order to support more pervasive classrooms, using the SIS platform, and to offer the better communication among the devices introduced for collaboration and active participation in the classroom.

First of all, we have identified the basic elements of the spatial model, which are: the students, the teachers, the devices used in the platform (the client-components), the devices external to the platform (that can subscribe to it), the physical space in which the platform is configured.

Afterwards, we have created some name spaces ad hoc: Person (to define people frequenting the school building); Role (useful to provide context-aware information); Room (graph space to identify classrooms); Device (to list the range of technological devices inside the school building); Feature (to describe specific characteristics or functionalities of the devices); RFID (to identify RFID readers); Recognition (to show recognition devices with wifi or RFID technology); Floor (a Cartesian-2D space to represent a floor of the building); Camera (for future image recognition); Sensor (to collect other context-aware information); Map (a Cartesian-2D space to track the position of people outside the school building); Building (name space to identify physically the building found in the Map space). For each of these spaces we have described a specific mapping; for example, the mapping RFID-Device defines which are the RFID readers that are proximity readers: when a student is near to the device (e.g. an IWB), the reader can detect her/his presence.

In order to understand how the SIS platform works using our school building spatial model, we propose the following simple scenario of use.

The RFID reader, which is placed near the entrance of the classroom, can recognize each single student wearing the bracelet with the RFID tag; the SIS will receive the name of the RFID reader and each tag recognized. So, the teacher can have the list of the teachers or students (in the name space “Person”) being in the classroom (thanks to the mapping between the name spaces “RFID” and “Room”). The IWB (in the name space “Device”), having subscribed to a specific context of interest, can receive the thematic info about the names of the people being in the classroom. This publish/subscribe mechanism allows the IWB to know if a particular teacher (e.g. the literacy one) is in the classroom and to start the proper applications (e.g. the FairyTale Box).

Summarizing, the SIS platform has been chosen allowing the simple automation of certain operations (e.g., roll call), the possibility of connecting various kinds of devices (e.g., IWBs, tablets) integrating them in everyday didactic activities, the awareness of what is going on within a specific classroom or among different classrooms of the school building, thanks to its publish-subscribe mechanism.

# 3 The Interactive WhiteBoard as Cornerstone

## 3.1 IWBs in Classrooms: Roles and Rules

Considering the wide range of opportunities offered by the adoption of different technological devices in classrooms, we start our research by studying the introduction and use of Interactive WhiteBoards, focusing on applications suited for large interactive screens with multi-touch technology, even if we plan to insert some tablets for further experimentations, as anticipated describing our vision of pervasive classrooms.

In fact, in recent years, the usage of large interactive displays is considerably increased thanks to the consolidation of the equipment as well as the reduction of their cost. Large interactive screens are used in different situations for a wide range of purposes: organizations adopt them to facilitate group activities and circulation of knowledge [20,2]; interactive walls begin to populate our cities [21].

Focusing on the introduction of Interactive WhiteBoards at school, from the teachers' viewpoint the use of IWBs in the classroom provides new opportunities to both teach creatively, thanks to the multimedia content, and teach creativity [22]. From the students' point of view, digital natives are comfortable with technologies and their experience must be exploited in the learning environment [23]. Moreover, IWBs seem to stimulate a more decentralized role for the teacher as facilitator and knowledgeable guide. These tools facilitates a co-learning approach to education, where teacher and students work together, rather than adopting the usual formal roles. This can induce more independent and self-directed learning [23]. In particular, we suggest to rethink IWBs as learning instruments, adapting their didactical use and position (e.g. height in the classroom/laboratory) to young students more than to their teachers. From our viewpoint, teachers should rarely interact with the technology, acting as a mediator between the technology and the class, as well as a facilitator of learners' collaboration, thanks to her/his experience. Our approach is in contrast with the teacher-centric one proposed in [24] for the use of multi-touch surfaces in classrooms, in which "teachers and learners in classrooms have different roles and responsibilities and thus they need to have different technological capabilities available to them on tabletops".

However, IWBs, by nature, support a beneficial knowledge sharing across the whole class. Collaboration in building this knowledge could be stimulated by adopting multi-touch technology, which allows a simultaneous use of the tool by small groups of students.

## 3.2 New Technologies and Interaction Paradigms

As a matter of fact, large multi-touch surfaces have several natural affordances, which can simplify small group collaborative work, establishing new ways of interacting. First of all, this kind of devices allows multiple-user input, involving all group members to manipulate objects on the display at the same time. Then it is possible to support natural gesturing, helping users to notice their partner's actions, providing rich interpersonal interactions, enabling users to both impart and understand each other's intention seamlessly. The naturalness of these interactions allows exploiting our existing capabilities for interaction in the physical world in the digital domain [25,26]. The size of the surface and its multi-touch features support bodily interactions with the display, allowing to be expressive towards other participants, and helping them to take up roles and to negotiate turn-taking, as well as different kinds of collaborative activities [21]. A larger display area gives the opportunity to organize objects spatially. In addition, multi-touch input may be a more appealing and natural means of input as users manipulate objects directly and easily with their fingers [27], but most of all, we want to underline that multi-touch surfaces offer "the strong benefits of face-to-face collaborative learning" [28].

However, for text insertion tasks, it is uncertain whether, or how much a pure touch-based input – i.e. without devices such as pens or styli – can really be effective. On multi-touch tabletops, people point and touch virtual artifacts on a table in the same way as if they were physical objects, often using both hands [25], while this is not possible in the single-touch condition, which simulates a mouse-based interaction. Multi-user surfaces allow imitation mechanisms of peers, while discovering new concepts, like physical properties of the displayed objects [28]. In another study [27], the system supported both multi-touch and single-touch interaction. In the multi-touch condition, various children could interact with the digital content simultaneously, talking more about the task, while in the single-touch condition they talked more about turn-taking. The multi-touch mode supports better collaboration by allowing more equitable participation at the tabletop, because everybody can interact whenever they want. Their discussions involved explicit reasoning and justifications, while they can work in parallel way on the same task: this interaction was more collaborative in nature. A project investigating the impact of using Interactive WhiteBoards for literacy and mathematics in primary schools underlines that children are more motivated in lessons because of the high level of interaction and discussion [29].

Children enjoy interacting physically with the board, manipulating text and images. Literature relates the unique physical and tactile nature of the board with the reinforcement of pupil's learning, especially when they can interact directly. Actually, the single-touch feature of the adopted IWBs limits the number of pupils interacting during the lesson. Moreover, not all the teachers let children interact with the IWB most of the time, because lessons are still planned in a traditional way, even if using a new tool. With a single-touch IWB the teacher has to concentrate on developing new practical strategies to keep the rest of the class mentally engaged, while one child is working at the IWB [30]. The children that are not interacting with the device may lose involvement during the lesson. By introducing an IWB with multi-touch technology, groups of children can really work at the screen at the same time and interact more often with the device. A multi-touch IWB maximizes these kinds of interaction during the activities within the classroom, offering new ways to think, plan and develop the lesson from the point of view of collaborative work. Considering all the multimedia and multimodal opportunities offered by the IWBs, the adoption of multi-touch technology can enable more children to work and interact together on the display, increasing the number of interactions and the level of participation of the whole classroom.

These new possibilities can lead to a different learning approach where participative learning practices (e.g. Digital Storytelling) are really enhanced by a new technology, suited for group activities.

### 3.3 Digital Storytelling for Participative Learning

During the last years the development of Web technologies has changed the way persons tell public or private narrative contents: blogs for textual narration and YouTube for the videos. This new way of communication, called “Digital Storytelling”, is nowadays widespread in different levels and fields. It is used in professional environments, for socialization, for a dialogue between different generations or cultures, and in all learning contexts. As a matter of fact, neurosciences underline the importance of storytelling in the learning process, because it allows an integrated use of different dimensions of the human intelligence (linguistic, interpersonal, etc.). Significant researches on the educational benefits confirm that storytelling develops specific abilities, such as problem solving, task completion and literacy skills [15]. Moreover, it is possible to increase interest in the subject matter and motivation towards learning activities, making more interesting topics (e.g. Prehistory) which are usually found boring [31]. Promoting learning in a more involving way, using emotions and references to everyday life is really effective, especially for children. Exploiting the multimedia possibilities of a digital environment can better stimulate a more engaging and funny way of learning.

Finally, school buildings and classrooms are equipped with large screens for enhancing the social and learning experiences of children [30,29].

The process of creating narrative structures and integrating Digital Storytelling in the curriculum of primary schools has been experimented with positive results in children participation and attainments, thanks to “Teatrix” [15] or “T’rrific Tales” [16] applications, developed within the European NIMIS project.

Our proposal is different from these previous experiences, considering the overall approach, the design of the interface and the technology adopted. Firstly, our primary goal is not to teach reading and writing to young children, offering a predefined wordbank [16] or a set of preloaded scenes, characters or actions [15], but we propose an application whose contents can be integrated with further materials directly by pupils, exploiting the Internet or, for instance, uploading their preferred images. Secondly, we have not planned any training, trying to develop a self-explanatory application, while in other cases [16] the complexities of the interface had been introduced through a sequence of activities to help children grow in competence and confidence. In addition, collaboration within the whole class could be stimulated by adopting multi-touch technology, which allows a simultaneous use of a large interactive screen by small groups of children, instead of providing LCDs with touch sensitive displays, which support no more than two pupils at a time [15]. Our approach concerns a choral learning process, during which both students and teachers have to be completely aware, without delegating to technology automatisms or decisions, which are in our vision the result of class discussion and mediation.

Taking into account these considerations, the main goal of our project is exploiting at best the affordances of multi-touch technology, which allows new collaborative learning opportunities in classrooms for storytelling activities. Digital Storytelling is not only a multimedia product, completed in its realization, but a real process, living in a context of social actors, technological artifacts and clear purposes.

### 3.4 An Application for IWB: the FairyTale Box

Considering what has been explained so far, our research aims at stimulating new pedagogical practices and, more specifically, allowing participative learning, which could increase students' engagement and attainments.

In this context, we propose the FAIRYTALE BOX application for primary schools' literacy lessons during which 7-10 year-old pupils can create stories through collaborative storytelling activities on a large interactive screen, which can "increase the level of engagement of less motivated children without affecting the involvement of the more active ones" [32].

The first screen area of the proposed application contains four rounded sets, empty at the beginning: *Where* the tale takes place, *When* it happens, *Who* the main characters are, and *What* the characters are going to do. All around the four sets, the application shows images of nouns and verbs, each labeled with proper words, that have been chosen and pre-loaded by the teacher, but can be modified by children at runtime within the application.

First of all, the teacher is free to reuse the digital content of the other lessons, to use the default Library provided in the Home folder of the program, or to create a new folder with personalized digital content. The folders contain images, words, and pictures (Fig. 1), that the teacher can arrange on the screen, in order to suggest some ready-made elements for the developing of the tale by the children. The template built so far can be saved at any time by the teacher and it is made available for everyday classroom activities. At the beginning of the activity, pupils fill sets little by little choosing the images to build the fairytale (for a complete scenario of use see [33]).


**Fig. 1.** The first screen of the FairyTale Box Application: choosing images.

They can comfortably work together on the screen at the same time, helping each other. For the sake of clarity, all the interactions with the screen are touch-based, both for dragging and dropping images and for writing in the textual area. After this phase, within a second screen of the application, the four sets, filled in with the chosen images, appear at the top of the screen during the collaborative writing activity as reminders, to support the wording of the tale (Fig. 2). At every moment of the writing process, pupils can easily turn back to the choosing phase to add or delete images.

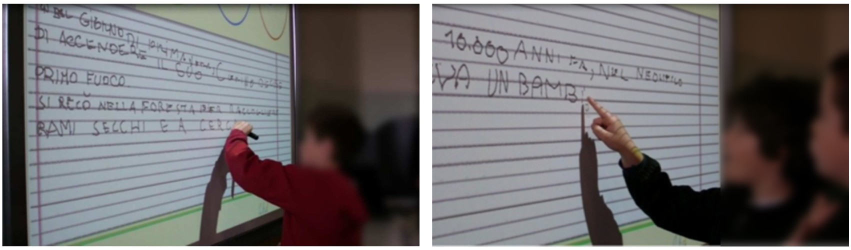


**Fig. 2.** The second screen of the FairyTale Box Application: writing modalities.

In order to involve all students as much as possible, the FAIRYTALE BOX facilitates a smooth turn-taking in using the IWB by splitting the writing activity into different phases, that can be easily assigned to different groups of pupils. By default, we provide three phases (Preface, Development, and Conclusion), which can be revised as necessary.

Therefore, small groups of children, one at a time, write the sentences in a textual area placed in the bottom, using touch-based input (Fig. 2, right) or the provided marker pen (Fig. 2, left). Pupils get familiar with the technology while working, both during the choice of images and the writing phase. Whenever necessary, appropriate corrections and revisions are made with the collaboration of the whole class: the IWB represents a shared score, facilitating discussion and mediation among all pupils, supported by teacher.

Beginning from a particular fairytale and its subjects (e.g. Prehistory), the FAIRYTALE BOX supports various extra-activities allowing teachers the design of a complete multidisciplinary project. Teachers need to be engaged with ICT not only at the level of consumer, but also at the point of design and development [22]. In particular, the teacher should be able to create, or at least to personalize, the content of the lessons instead of receiving complete pre-defined lessons in specific subjects, provided by the vendors. An active participation of teachers in the wise use of technology contributes to their smooth integration within the curriculum and to the wellness of teachers trying to personalize technologies within everyday classroom activities.

In addition, the FAIRYTALE BOX provides Internet access to look for information on the Internet (whose connection is protected by password), giving to teachers the opportunity of teaching to digital natives' generation how to overwork the Internet, considering the critical choose and use of online sources.

Moreover, our application offers a built-in selection of didactical materials, that can be chosen and added by the teacher. Pupils can discover new characters, objects and other useful information for creating the tale, or for other interdisciplinary purposes, stimulating their curiosity and enabling serendipity in the learning process.

# 4 An Italian Experiment

## 4.1 Guidelines and Phases

In line with J. Dewey[4], arguing that the measurement phase cannot ignore the qualitative judgment, we have accepted them as complementary aspects, sometimes considered as diametrically opposed, of our research. As a matter of fact, these two moments, explorative research and descriptive moment on one hand and intervention and measurement on the other hand, are defined, not only in the educational field, within the experimental method [34].

In general, referring to the experimental method, we can consider 4 phases: the observation, at first occasional and then systematic, to underline significant and problematic events, in order to describe them accurately; the hypothesis formulation about the observed events, the relationships between them or the effects of controlled interventions on these events; the experimentation in the strict sense of the word, to verify the hypothesis; the interpretation and elaboration of the collected data.

Our experiment has involved two classroom of an Italian primary school during the 2010-2011 school year. Considering that repeatability is one of the characteristics of the experimental method, we are planning to involve other classrooms, in order to validate our first outcomes. The proposed experiment has involved 40 pupils, in order to test a single-touch version of the FAIRYTALE BOX application and to observe the teaching methods adopted by the two different literacy teachers. Our proposal has been articulated into different phases; firstly, we have arranged preliminary meetings with all the teachers of the two classrooms involved, in order to decide together the main theme (e.g. Prehistory) and the kind of images to create the tale, but also to illustrate the simple structure and the objectives of the FAIRYTALE BOX application; secondly, we have planned four meetings within the school laboratory to carry out the experiment; finally, we have arranged a conclusive meeting with the teachers, to discuss together the main issues and to reflect upon the whole experiment.

## 4.2 Research Instruments and Setting

In this section we are going to explain some details of the research. We have decided to use both traditional and digital research instruments: participant observation, systematic observation (filming classroom activities), pre/post questionnaires for teachers and pupils, focus group with teachers. All these instruments have been adopted in specific phases of the experiment and have been useful for the qualitative analysis. In particular, the experiment took place within the school informatics laboratory, where the IWB had been installed.

[4] In “Le fonti di una scienza dell’educazione”, La Nuova Italia, Firenze (1929).

We want to stress the fact that nobody considered that the Interactive WhiteBoard should have been placed at the proper height to facilitate pupils’ interaction with the screen, as considered in [16], adding a motor to vary the height of the screen from the floor. Unfortunately, the position of the IWB was too high for pupils, that can easily interact only with the lower part of the screen. During the choice of the images pupils could actually help themselves with a “magic” wand, within the IWB equipment, that allow them to reach also the images placed in the upper part of  the screen.

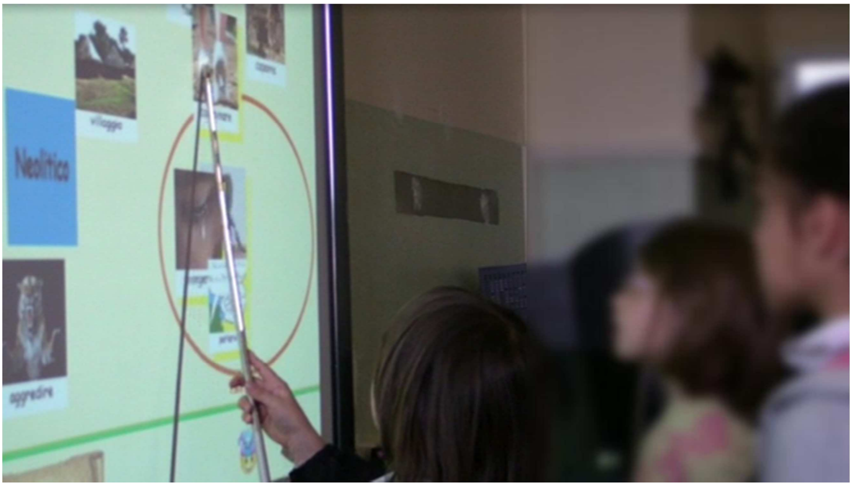


**Fig. 3.** The “magic” wand to reach far images.

As a matter of fact, this interactive wand transformed a real difficulty into a funny opportunity. On the contrary, during the writing phase, some pupils were not able to write fluently because they could not use the marker pen in vertical position on the screen.

Focusing now on the experiment setting we have introduced a camcorder near the IWB to recorder pupils’ interactions and speeches, the screen tracking of the activities on the IWB, and a couple of web-cameras in order to register classroom behavior and turn-taking. Pupils were arranged in small groups around desks, in order to facilitate IWB turn-taking and group discussion during the learning activity.

### 4.3 Description and Outcomes

Focusing on the dataset, the two classrooms, 3A and 3B, were composed respectively by 19 and 21 pupils, being 8 to 9 years old. The two literacy teachers, with a difference of 20 years of teaching experience in the primary school, adopted different strategies during the experiment. The younger teacher (3A) preferred the presence of a pupil at a time, interacting at the IWB during the creation of the tale: she stimulated the collaboration of the whole classroom proposing questions about the plot, making them voting for choosing the images and without interfering with the narrative content. On the contrary, the other teacher (3B) organized 5 small groups of pupils, in order to arrange in front of the IWB each group, devoted to complete one of the specific phases, starting from the Preface: pupils collaborated both discussing within the small group in front of the screen, and accepting suggestion from the other children at the desks. As a matter of fact, the first teacher, more comfortable with technologies, was always ready to help the pupil interacting alone with the IWB to solve difficulties or to reassure him/her: in class 3A the presence of negative feelings (e.g. embarrassment, difficulty) was higher than in the second situation (Fig. 4).

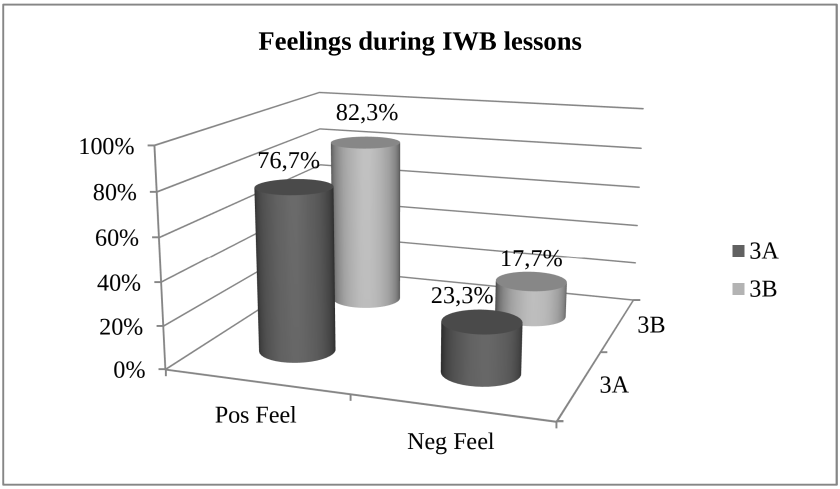


**Fig. 4.** Positive and Negative Feelings expressed in the two classrooms.

Within class 3B, the simulated multi-user interaction with the single-touch board counterbalanced shyness or interacting difficulties in using the device: pupils at the board helped each other in case of need. Moreover, the teacher that allowed multi-user interaction was able to parallelize the writing phase by the pupils at the IWB, with the expansion of the tale by the rest of the classroom: suggestions were collected by the children at the board, not writing in that moment. However, the naturalness of interaction with a wide range of artifacts (images, words, sounds, videos) offered by the IWB gave free rein to pupils' imagination and stimulated the formulation of thoughts and stories; the possibility to interact side by side with classmates during this creative process could encourage all pupils to share ideas and stimulate communication about the current activity. In general, both the didactical approaches have been appreciated by pupils, that have really enjoyed the digital storytelling experience, including the extra-activities about Prehistory (e.g. documentaries and puzzles) and the interaction with the IWB itself. They have been engaged during the whole experiment, enjoying the moments of active use of the interactive board, but also the times during which other pupils were in front of the device, sometimes with a challenging attitude (e.g. succeeding in the writing with the marker pen or solving the puzzles). Some of these issues can be derived from the questionnaires at the end of the experiment, which underline also that children have asked to use the IWB for other subjects and activities, especially for drawing and language (Fig. 5).

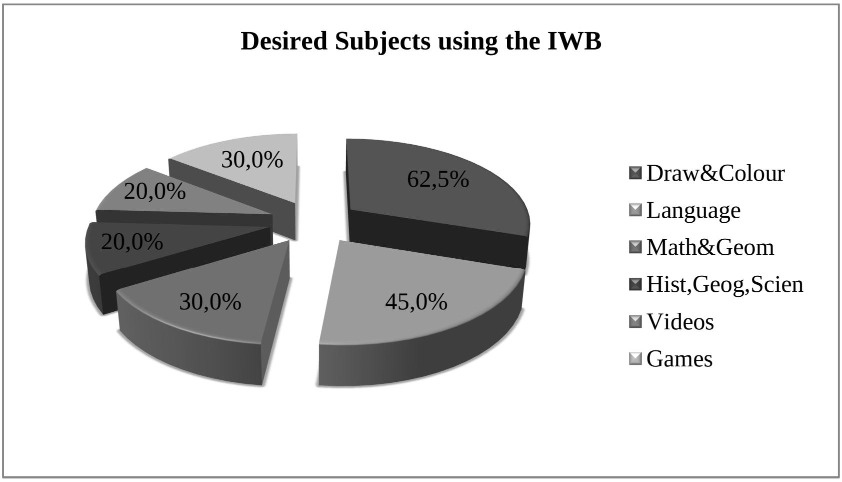


**Fig. 5.** Subjects and activities proposed by pupils of the two classrooms.

Also the recordings of the different phases of the experiment show pupils really engaged in the process of creating the tale and teachers highlight in their questionnaires that the level of attention and participation of their students during IWB activities was higher than during traditional lessons. In particular, a pupil with writing difficulties (possible dyslexia) wrote better than usual, both on IWB and on his exercise book. Referring to her classroom, one teacher underlines that “I have noticed more participation in identifying ideas for the text”. At last, both teachers and pupils were quite satisfied of the experience: teachers easily managed and run the lesson, while pupils well-behaved during the activities, really loving using the IWB.

## 5 Conclusion and Open Issues

Even if at a preliminary stage of our research, we have described in this paper our complete view of a new learning environment, where the classrooms of the future should be at the center of a process of transformation, considering both technological and methodological aspects.

By starting from previous research on the social impact of interactive screen technologies, we aim at maximizing the benefits of IWBs at school for creating narrative structures. The use of multi-touch technology, collaborative group activities and continuous turn-taking can really allow to as many children as possible to use the IWB, to stimulate more active participation and the collaboration of the whole class during the creative process. This can happen both for the appeal multimedia devices naturally have on children and for the collaborative mechanisms multi-touch-based interaction is able to trigger.

As a matter fact, starting from our preliminary experiment, children of the 21$^{st}$ century asks for using technological tools for all the subjects and school activities.

After a teacher-centric approach to school education, our proposal wants to underline the real importance of placing digital natives' needs as the focal point in this shifting phase towards new learning technologies and contexts. During our experiment, for example, the higher position of the IWB limited an easy interaction during the writing of the tale with the pen, whose position should have been vertical to the surface. In our view, this consideration is emblematic, because underlines the real distance between installing new technologies in classrooms (actually thought for teachers), and changing completely the didactic approach during every-day lessons.

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