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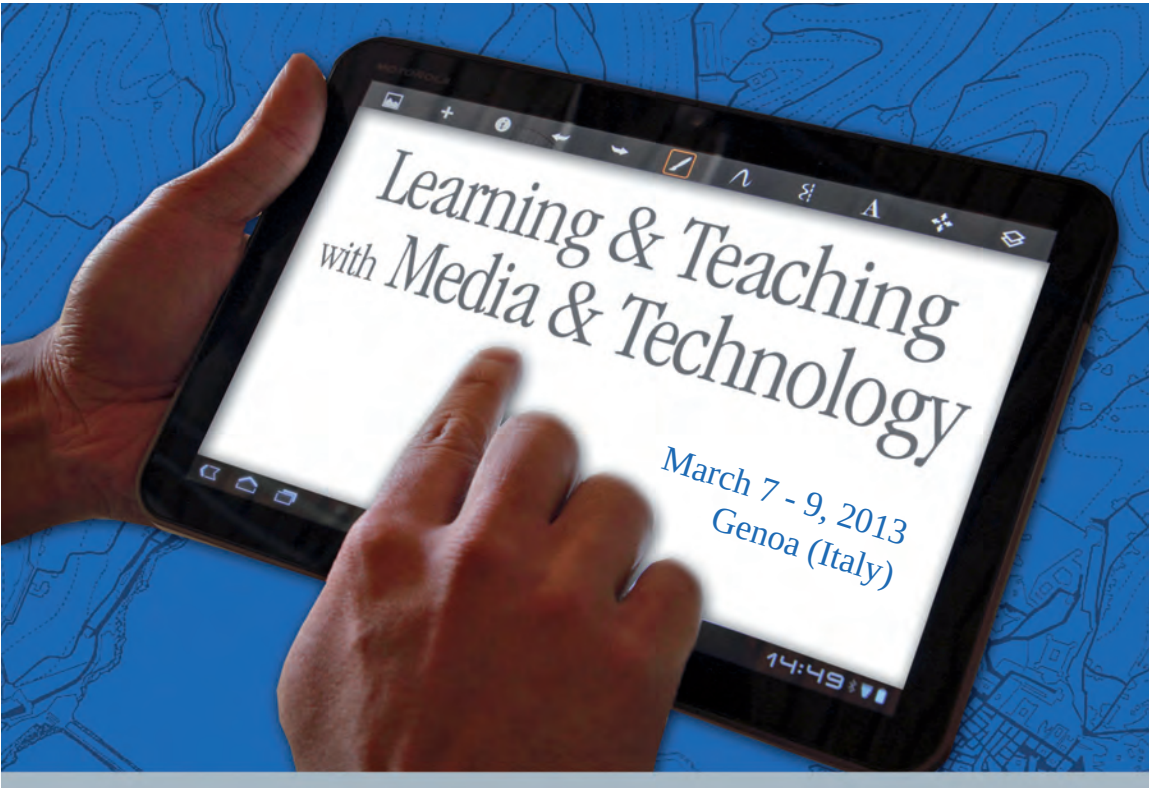

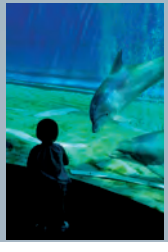

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Digital Storytelling as a new meaningful teaching/learning strategy for mathematics and geometry

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Abstract
The goal of our research was to evaluate the effectiveness of teaching mathematics using a Digital Storytelling approach, and show how it can be an appealing communication method for students. The research focused on the students' and teachers' ideas about mathematics and the different teaching and learning methodologies comparing the efficacy of three teaching strategies: traditional lessons, lessons that incorporate the use of simple multimedia tools such as Power Point, and lessons that incorporate the use of a digital storytelling video. From our first analysis, it seems that students are very motivated to learn using digital storytelling videos. This methodology also seems to help teachers in communicating about topics that are usually taught with difficulty in a more 'formal' way. Digital Storytelling seems to be specifically effective when compared with traditional lessons and classes which make use of traditional multimedia tools. The research had a strong innovative impact on the teaching methods among schools involved in the project. For example, students seemed to appreciate this kind of teaching approach and their level of attention, motivation and comprehension of concepts grew. In addition, Digital Storytelling supported teachers in the communication of abstract content, contextualizing it into a narrative format and giving it a precise meaning.

Keywords
Digital Storytelling, math teaching/learning, innovative teaching.

1. Theoretical Framework

Recent research, - Schank (1990, 2007), Caine, Caine (1994), Bruner (1997), Gardner (2002), Jonassen (2000), McDrury and Alterio (2003) - seems to confirm the importance of the narrative approach in the process of teaching/learning, especially because it is able to effectively integrate emotionality and rationality (Damasio, 2006), the different dimensions of intelligence (Petrucco, De Rossi, 2009) and interpersonal communication (Stephens et al, 2010). Storytelling from a certain point of view has always been a part of teaching, although it is most often used in an inconspicuous manner: Abrahamson (1998), Schank (2007) and Egan (1989) state that what the teacher does, in reality, is nothing more than a form of storytelling, all the more effective the more it is connected to the telling of "stories" about problems and solutions related to the disciplines taught.

The decision to use digital storytelling as a specific method for teaching mathematics is due to the recognition of the difficulties that Italian students have in this field (OECD PISA Report, 2000-2009, INVALSI tests) and therefore the need to experiment with new strategies to improve the 'teaching'. With this in mind, therefore traditional mathematics education should be rethought, not only as knowledge that is transmitted through a formal set of rules, theorems and formulas that students need to learn, and memorize, without understanding the meaning and context, but also through new methods of communication (Chapman, 2008).

2. Objectives and context of the research

The pilot research on the use of Digital Storytelling for teaching mathematics is part of a larger study conducted in 2011-12 by the Department of Education of Padua and the Institute of IPRASE of Trentino, at various primary schools and secondary schools in the Province of Trento (North East Italy). The purpose of the research was to compare different teaching and communicative methodologies and to evaluate their effects on learning and the perception that they had on students. We took into account three different ways of conducting the lessons:

1) traditional method, based on a direct oral explanation by the teacher;
2) using the aid of multi-media material, via a PowerPoint presentation;
3) using a video-narrative methodology

The research involved three classes of fourth grade primary school students, for a total of 55 test subjects (M = 28, F = 27). We used semi-structured questionnaires, video recordings and tests. Through a first pre-questionnaire we discovered the pupils' perceptions about mathematics, their self-assessments about their levels of learning and their perceptions regarding the various teaching methods. The students were divided into 3 groups: in this "quasi-experimental" design our control group was made up of the students that took part in the traditional lecture mode and the experimental groups included the students who took part in the lesson with the PowerPoint and the students who watched short videos in the Digital Storytelling class. Finally, students were given a post-questionnaire investigating the specific type of lesson experienced, and these were completed by the students a couple of days after the experiment, in order to receive their feedback on the effectiveness of the different teaching approaches proposed.

We evaluated the actual comparability of the groups through a statistical analysis of the t-test with independent samples (p-value>0.05), starting from their assessments of the first quarter and the gender distribution. We did not however, take into account other potentially significant variables such as: the "quality" of the teacher, prior knowledge and the presence of students with learning disabilities. The three different lesson types had the

same duration (45 minutes) and the specific mathematics topic addressed during the lesson was fractions, as they are considered particularly important and difficult for teachers to teach and for students to understand (Bonotto, 2007). The lesson that included the use of Digital Storytelling had the same content as the traditional lessons and the Powerpoint lesson, but was rendered through the presentation of a story in a context of everyday life familiar to students and in which the protagonists were their peers. Finally, each lesson in the three groups was video recorded to monitor the reactions of the students.

3. Research results

The analysis of students' perceptions measured by the pre-questionnaires showed that mathematics is a subject not appreciated by 41.82% of the students, even though more than half of the students like this discipline (25.45% very much and 25, 45% a great deal). Also, math's is not perceived as difficult in regards to completing exercises, for 60% of schoolchildren it presents minor problems and for 29.09% it does not pose any difficulty. The topics explained in class are very understandable to 44,44% of the students and are understood perfectly by 12.96% of the subjects involved. What seems to be more problematic is the student's attention span: in fact, 50.91% stated that they are able to keep a short attention span and 3.64% state that they become distracted immediately. It seems that most students are able to remember well (47.27%) or very well (9.09%) the contents addressed in school. There were no specific gender differences.

The students' perception about the learning tools that they would like to use in the classroom in order to understand mathematics are at odds with the one's used by the teachers and show a strong attraction for technologies that are used less frequently: 77.78% of students greatly appreciate the use of LIM, 68.52% really like Power-Point presentations and 59.26% of student are very satisfied with the use of audio-visual materials. Forty-two point fifty nine percent of students really like to use objects and materials. In contrast, the traditional blackboard lecture attracts only slightly 57,41% of students (or not at all, 22.22%) and lessons based only on voice / reading do not appeal at all to 27.78% of students.

An analysis of the educational approach, highlights that according to most of the students involved, the narrative method, (storytelling) is rarely or never used (41.82% never and 40% rarely), just as multi-media methods are rarely used (48.15% never and 31.48% rarely) or lessons based on games in the classroom (never 27,27%, 43,64% rarely). Examples are used more frequently (often 47,27%) and didactic materials created ad hoc (often 32,73%).

In addition, there is a strong liking for teaching methods that are the most neglected by the teachers (fig. 1); Eighty percent of students like to use stories to explain mathematical concepts (56.36% much, 23,64% very much) and also appreciate the explanations given by the PC software (much 23.64% and 43.64% very much). It's also significant to note the appeal for teaching through games in the classroom (47.27% much, 45.45% very much).

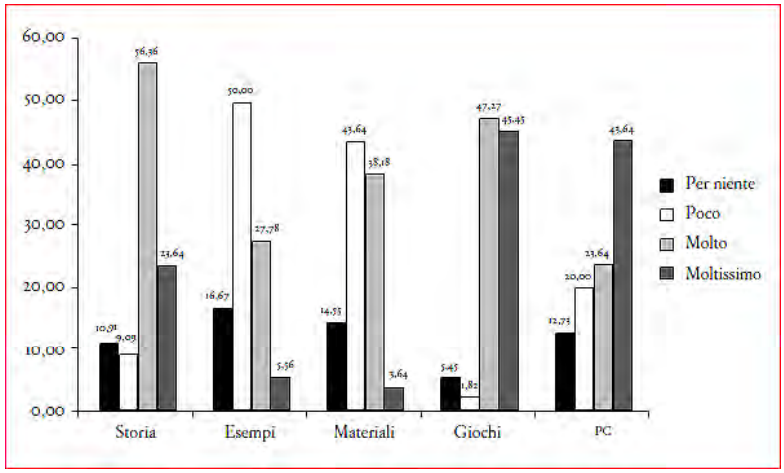

Figure 1. Student perceptions about their level of satisfaction in regard to the different methods of teaching in the classroom (%).

An analysis of the results of the post-questionnaires administered after the experiment to compare the perceptions of students, in regards to the 3 teaching methods used(traditional oral lesson, lesson with Digital Storytelling, and lesson with Power-Point) illustrates how the group that took part in the lesson with Digital Storytelling is the most enthusiastic about this approach, demonstrating a high degree of appeal (83,33%) compared to the group that only saw the PowerPoint 55,00% and those that had a traditional lesson, 17.65% (fig.2).

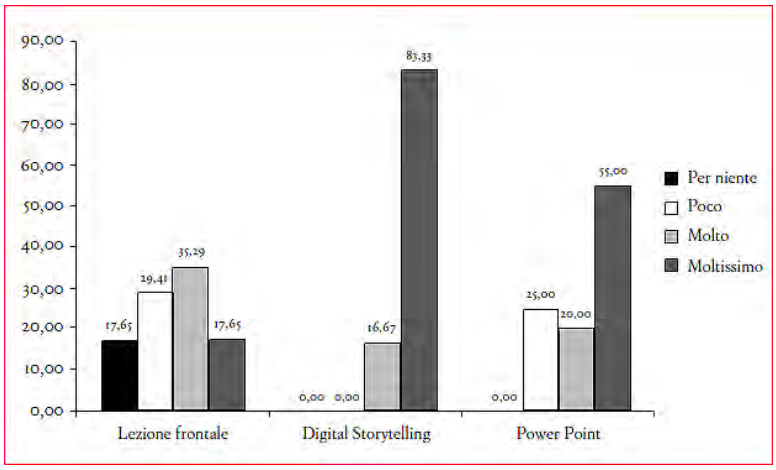

Figure 2. Perceptions of the students about the level of satisfaction with regard to the various teaching methodologies used in math class (%).

Comparing the level of understanding of the lessons, the 3 groups of students obtained very similar scores: 64.71% reported that they understood the lesson well with the traditional lecture format, 61.11% likewise using Digital Storytelling and 70% with the PowerPoint respectively; while 23,53% of the students that took part in the traditional lesson understood the lesson very well, compared to 38.89% of those who used digital storytelling and 20% of students who used the PowerPoint respectively.

With respect to the ability of the 3 teaching methods to capture and hold the student's attention, it would seem that students have more difficulty with traditional lectures: 29,41% of students in the traditional lecture group have some problems in keeping their attention on the material, and 5.88% have major problems. On the other hand, only 5.56%

of students had minor difficulties following the Digital Storytelling class and 10% had some difficulty with the PowerPoint lesson.

Much the same can be said about students' perceptions about their ability to memorize content discussed in the classroom (Fig. 3), 47.06% of the students that were in the normal lesson group stated that they only remembered very little of the information conveyed by the teacher compared to 5.56% of the group that was in the Digital Storytelling group and 20,00% of the group that saw the PowerPoint. In these two latter groups, the highest memory retention peaks are found for explained concepts (66.67% a lot and 27.78% very much for Digital Storytelling and a lot for 50% and very much for 30% of the PowerPoint group).

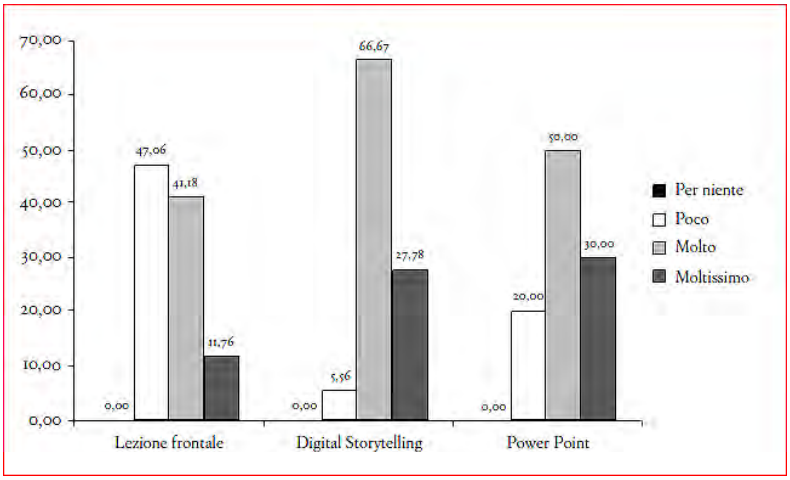

Figure 3. Perception of the students about the level of memorization favored by various methodologies of teaching mathematics in class (%).

Finally, as to the students opinion on the effectiveness of the lesson methods they had been exposed to, the group that took part in the traditional teaching methods expressed positive opinions about this methodology only in a limited way: very effective for 17.65% of students, compared to 44, 44% for Digital Storytelling and 50% for the PowerPoint, and extremely effective for only 5.88% of students, compared to the high percentages of extreme satisfaction for Digital Storytelling (44,44%) and PowerPoint (30%).

The test results obtained after the lessons on fractions were compared with each other and also compared to the marks of the first term of the school year. After carrying out an ANOVA univariate statistical analysis (p-value> 0.05) on the marks obtained by the three groups, there were no significant differences in the performance of students who took part in the traditional lecture, compared with Digital Storytelling and with the PowerPoint (analysis of variance). Even the comparison of means (t-test) showed no major differences. The same conclusion was reached by comparing the marks from the first quarter with the marks of the test carried out by the students post intervention, through a comparison of means for paired samples (t-test p-value> 0.05). We even compared scores on the post hoc test to see if there were differences between pre and post, but there were no significant differences.

Certainly analyzing the marks obtained on the post intervention tests there is a slightly higher average for the class that took part in Digital Storytelling (14.1 points out of 18) compared to the scores obtained post traditional lecture (13.4) and PowerPoint (12.8). There was also an improvement in the performance of individual students who took part in the Digital Storytelling lessons, However, we would require further studies to investigate the effects of different methods of teaching on students academic performance.

4. Conclusion

From the data obtained, we are not able to confirm an actual increase in the levels of learning and performance in math. Therefore other tests would have to be conducted and probably the duration of the experiment would have to be extended while including a larger sample size. The data does show, however, that Digital Storytelling can help the teacher and can become an effective tool to introduce in a captivating and engaging manner specific disciplinary topics, in order to significantly increase levels of attention and pleasure. From the analysis of the video recordings taken of the class that took part in the Digital Storytelling lesson, it is evident that students were fascinated by the flow of images and sound of the narrative story, remaining silent throughout the lesson and following with their full attention. In conclusion, Digital Storytelling can certainly become an instrument and method of teaching that is complementary to classical teaching methods, stimulating interest and the involvement of students.

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