The International Education Journal: Comparative Perspectives Vol. 17, No. 4, 2018, pp. 97-112.
https://openjournals.library.sydney.edu.au/index.php/IEJ

Digital Storytelling, comics and new technologies in education: review, research and perspectives

Maria Sagri
School of Film Studies, Faculty of Fine Arts, Aristotles University of Thessaloniki, Greece: *sagrimaria@film.auth.gr*
Filippos Sofos
School of Engineering, University of Thessaly, Greece: *fsofos@uth.gr*
Despoina Mouzaki
School of Film Studies, Faculty of Fine Arts, Aristotles University of Thessaloniki, Greece: *filmdirector.tiff@gmail.com*

This work reviews the current application of one of the most widely used techniques in education around the world: Digital Storytelling (DS), along with comic and animation tools, and presents a study about the Greek educational system as well as posing questions concerning the form of a new study, design, implementation and assessment of educational project across all educational levels. Nowadays, people and students at all educational levels in the developed world are surrounded by multiple electronic media and are familiar with a variety of pictures, video and information from early childhood. The educational process, as it proceeds in parallel with fast technological and societal evolution, tries to smoothly adjust new educational methods without abandoning traditional teaching and moving away from its main aim: the establishment of knowledge.

Keywords: digital storytelling; comics; multimedia; education

INTRODUCTION

Children have their first views of the world through tales and stories and, in this way, learn to communicate and share their feelings. As they pass into adult life, people tend to represent facts and behaviours through storytelling, so as to understand their social and cultural environment (Bruner, 1997). It is common sense that telling stories can attract one's interest. From the very beginning of storytelling and the era of cave arts, to our Internet and social networks' days of mass storytelling, creative people have explored ways to stimulate the imagination of others (Hulburt & Voas, 2011). Memories from our childhood include a familiar storyteller, usually a parent or a grandparent, accompanying our time before we go to bed.

By embedding storytelling in the classroom, learning is empowered; students are asked to adapt their knowledge, to investigate their assumptions and, through an iterative procedure, to write down the process of composing a concept. As stories reflect students' ways of thinking, teachers could use this fact to gain access to their personal progress through learning targets. With the support of new technological tools available in terms of physical devices (for example, tablets and smartphones) or software (media authoring tools), storytelling can become digital, amplifying the power of the story and bridging the high-tech world outside school together with the traditional low-tech school learning

(Ohler, 2008). Through the creation of their own digital stories, students actively take part in the learning process. In this way they do participate in the media-dominated world, they are not only passive watchers (Ohler, 2006).

In Gregory-Signes and Pennock-Speck (2012), a review is made on some of the most relevant studies on digital storytelling (DS). The authors propose an initial classification of DS into two main types: educational and social. DS is stronger in the world of education; however, it is rather difficult to separate the two types completely. In Dush (2014), the social impact of DS is emphasized when students are asked to work closely with people from nonprofit and community-based organizations in order to learn how to produce their own new media. The use of DS is even applied in an organizational setting, where people try to express their way of thinking and convince their business partners about it (van Boeschoten, 2011).

Of paramount importance is the selection of methods employed in educational research. A research methodology has to be carefully organized from the beginning so that results can be applied to a broader audience, not only the participants. A good research tactic, as discussed in Cronbach and Suppes (1969) and further analysed in Shulman (1997), is characterized as "disciplined inquiry". Disciplined inquiry leads to knowledge and knowledge in education (Frick, 2004), as long as some kind of generalizability is obtained. Disciplined inquiry uses either a qualitative or a quantitative approach, although mixing of the two approaches is also popular. For example, a qualitative research approach could be used in a case study, while a quantitative approach fits well for an experimental research in education, as reviewed in Evans (1998).

In the context of this paper, we discuss current applications of digital storytelling at all educational levels, investigate new technologies used in parallel when creating a digital story, like comics, animations, machinima and multimedia tools, and comment on the characteristics of educational tools used nowadays. Finally, we present a test case where a DS project has been applied to various classes in the Greek educational system in the last six years. We compare students' needs as years go by and as new technological tools enter all aspects of life. Emphasis is given on DS utilization as an alternative source of knowledge to assist teaching. The development of an educational tool is proposed that aims to serve current pedagogic concepts, fully taking advantage of possibilities arising from technology and functioning supplementary to teaching. The development team consists of a primary school ICT teacher, responsible for most of this work, a university ICT lecturer that assists with the literature and data processing and a Fine Arts School Professor that controls and reviews the whole process.

REVIEW OF MODERN METHODS ADOPTED IN EDUCATION

As new technologies enter our lives, smartphones and tablets, cameras, and advanced software authoring tools have enabled teachers (especially ICT teachers) to embed innovative approaches in teaching and help students to construct their own knowledge and ideas to present and share them more effectively (Standley, 2003).

Digital storytelling

DS has been applied in many countries' educational systems from preschoolers to university students, either as a research project or as an embedded learning process in classes. Hartley & McWilliam (2009) categorize the impact of DS in achieving learning

goals by students' age. During the primary education years DS is suitable for the stimulation of the student's interest, but it would not be advisable to focus on scientific or methodological learning. In middle grades, the emphasis shifts to DS for improved composition and narrative construction, as well as on basic media production skills. In older grades, the emphasis shifts to more advanced print and media literacies and to wider community applications of school digital storytelling, and the terminology used is more sophisticated.

Sylla, Coutinho, and Branco (2014) found that the interaction of pre-school children with DS seems to promote their imagination and creative thinking, as well as fostering early literacy skills and metalinguistic awareness. An interesting library activity based on a mobile game was introduced by Wood et al. (2014) to support DS among primary school children in public libraries to develop their creative reading and writing skills while at play. Wood et al. (2014) recommend that designers create playful digitally based activities that encourage children to explore libraries and get to know the physical books.

As students become familiar with new, nearly cinematic computer games, and interact with the virtual characters, they are potentially able to develop their own interactive stories. Charles, Mead, and Cavazza (2001) describe a model that adopts virtual reality, computer games and storytelling in parallel, engaging two major modes of interaction: physical interaction and linguistic interaction. Di Blass and Paolini (2013) conducted a large-scale project on the impact of DS on formal education in Italian schools. They found that DS promotes not only curricular benefits (like increased knowledge of a subject matter), but benefits such as the development of a professional attitude and improved relationships within the class. DS is one of the methods used for language proficiency development in English language learners (Won Hur & Suh, 2011). Through the student-computer interaction, DS can be particularly useful because it combines visual resources and speaking experience, which are essential to language learners.

Sadik (2008) found that DS encouraged students in basic education to think and act as individuals during the process of creating their stories. Science and mathematics lessons can be also the subjects of DS. Tan, Lee, and Hung (2014) note that, while it seems obvious to enhance knowledge in the social science, humanities, languages and literacy education, DS also works in science and technology classes. However, every task has to be prepared carefully in order to achieve pedagogical success. Valkanova & Watts (2007) found that DS is the key element for children playfully exploring science concepts and advancing their self-learning ability. Enriching the learning process with animations and simulations in science classes is also a field of investigation in Falvo (2008).

As classes move from "teaching-based" to "learning-based" approaches, DS stands out as the means of communicating religious issues for theologians (Hess, 2014). Suwardy, Pan, and Seow (2013) used DS to complement traditional classroom lessons on accounting, such as how to set up accounts, perform bank reconciliation etc. and thus assist students to learn better. In the work of Price et al. (2015), a DS project is conducted in student learning about complex topics, such as nursing education, through the application to personal stories and experiences.

The work of Kocaman-Karoglu (2016) presents the application of DS in a university course, where, conclusively, pre-service teachers found it as an attractive way to share ideas and feelings and wish to use it as an educational tool at school. Moving from under-graduate to post-graduate educational level, university students are encouraged to engage DS in their research. In this way, they participate in knowledge production processes,

which may inspire them to become experts in their fields. This contrasts with the traditional supervisor–student model, where the academic expertise, experience and authorial voice of the supervisor tends to overshadow the active involvement of research students (Ramble & Mlambo, 2014).

DS, as a means of the human-computer interaction process, may be applied to children with disabilities. It has been observed that many researchers do not understand how the life of children with disabilities may be and it is very difficult to create an interactive technology close to their needs. However, technology uptake has a positive effect on the children's education, as the incorporation of new means gives them a sense of ownership and empowerment (Frauenberger, Good, & Alcorn, 2012). For students with special needs within the primary and secondary curriculum, Smeda, Dakich, and Sharda (2014) argued that DS can provide support to them and concluded that it can help to improve their confidence and contribute to better social and psychological skills.

There are also cases where teachers perceive the technology that comes with DS to be beneficial to their students. Thang et al. (2014) observed that the teachers might resist accepting the role of technology in their classes. The authors believe that a transition phase to deal with emotional and social issues relating to change could be useful. However, if teachers are well-prepared and develop their personal skills in order to be able to guide students, then the whole process could be a fruitful experience for students to acquire IT and media skills (Sadik, 2008).

Comics

Comics can be a familiar tool for supporting learning in the classroom. They have already entered the educational system of many countries, such as in French primary school. In the UK, comics have been used in the classroom for lessons such as literature, arts, and history, as well as comics as a lesson created by students themselves (Gibson, 2008). In Japan, manga comics have been used for more than 25 years, while in the US, comics are about to enter all educational levels with the project "*Maryland comic book initiative"*.

Comics in the classroom can be a good starting point for the teacher to discuss difficult meanings with the students, such as in literature (Jacobs, 2007; Versaci, 2001). In an early experimental work on the use of comics as an educational tool by Hutchinson (1949), it was found that comics have strengthened poor readers' desire to read well, for they see reading as an immediate means to obtain the full pleasure that can come from comics. Web comics (Vassilikopoulou et al., 2011) were used in language teaching and it was found that the comic creation process helps students acquire linguistic skills and to apply their imaginations and use their cultural experiences for creating multimodal texts.

Currently, a great number of comics are used as an exciting way of communicating science inside the classroom, as found in a review by Tatalovic (2009). For example (Zehr, 2011), a Batman comic was used as the vehicle for popularizing concepts of exercise science, neuroscience, and physiology. In this way, the author believes that science is translated into terms that are interesting and accessible to the general public and nonacademic specialists. Moreover, in a controversial science, such biotechnology, comics could contribute to the evolution of the human face of biotechnology through the world of colours, drawings and paintings that emphasize the cultured face rather than the delinquent side of humanity (DaSilva, 2004).

Machinima

Technology has made it possible to incorporate new techniques in the representation of information, such as machinima (machine, cinema, and anime). Machinima is a contemporary storytelling and filmmaking practice involving the capture of existing animated characters (from video games or movies) in order to create a Do-It-Yourself film (Frølunde, 2011). Van Langeveld and Kessler (2009) presented a way of engaging engineering and fine arts university classes by focusing on games, special effects, animation and other areas that require interdisciplinary efforts for the current entertainment industry. Park (2012) refers to education acquired by modern digital experience for the user by online role-playing games.

Multimedia tools

Multimedia learning is reviewed in Mayer (2002) when investigating how people learn in a multimedia environment. Significant factors and issues on multimedia design is analysed in Woo (2009). Modern multimedia tools designed and proposed for educational reasons are discussed by Lazarinis (2010) and Gordon (2006). Cordero et al. (2015) created and presented a tablet-based tool. Students that took part in the production of the tool seemed to be engaged with what they were doing and saw the proposed tool as a powerful one for fictional narrative creation. The success of such educational software must be supported by a teacher capable of supervising and guiding students to use it. Of importance is the assessment process accompanying an educational. In this way, the educator can investigate the percentage of learning targets achieved in every application and present the weak or the strong points of the tool (Saxton et al., 2014).

A DIGITAL STORYTELLING COMIC-BASED TOOL

In this section, we present an implementation scenario that adopts contemporary educational techniques, such as digital storytelling with comics. It involves the development of an educational tool for primary school students. The presented tool is part of a broader educational tool being currently investigated for all educational levels.

In the digital storytelling tool, the teacher enters an objective, shows the learning object as a comics sequence and surveys students, and the tool automatically formats the level of satisfaction of the initial objective. Thus, the teacher has a complete teaching plan in digital storytelling with comics. Further educational activities with comics enhance student self-activity and place him/her in a designer and creator role. There is multiple assessment possibility; from the teacher towards the students, from the teacher for the estimation of the degree of satisfaction of the objective being set and the student self-assessment through the activities, the games and the multiple-choice questions.

Participants

Shulman (1997) pointed out that generalization depends on the sample under investigation. Participants in our research included: 12 primary school teachers, 8 secondary education teachers, 4 university professors, 12 other individuals, and 358 students come from five primary schools in the cities of Larisa and Volos, Greece, and three high schools in Deskati town, Grevena, Greece. Student research was conducted during the students' classes of Informatics. The researcher served as the primary instructor in the course and guided the students to design, narrate and publish the multimedia file. Data was collected through questionnaires and interviews. Participants

were prompted to answer questions on renewable energy sources and general questions on the process.

Data span

As our investigation focused mainly on technology issues and how digital storytelling improves the learning process, we present results over two years in time, in 2011, when our first results were gathered, and 2016. Apart from gaining knowledge through the comparison of results, we wished to be able to relate the method with technological evolution, which affects students' views of the educational process. A range of data was collected throughout the years and exists in our database. It is worth mentioning that technological evolution in terms of wireless devices, smartphones, virtual reality and their use by students even from the first classes of primary rose steeply between 2011 and 2016 (Smith, 2017). For example, back in 2011, only a small percentage of students were familiar with smartphones, since their prices were relatively high, and their capabilities limited. In 2016, most of primary school students were active smartphone users and familiar to the aforementioned technology issues. This was retrieved as an observation during our research and supported by relevant literature (Al-Harriri & Al-Hattami, 2017; Goksu &Atici, 2013).

An example lesson

A test version of the tool was created with the use of software languages HTML, CSS and JavaScript. HTML was used for the working environment and graphics, and JavaScript for the programming demands of the application. The ability of JavaScript to run without the presence of a server (client-side scripting) allows the application to run both on the Internet and locally on the user's computer. Tool graphics are simple as they have been co-designed from primary school students as part of the learning process.

The log-on screen is presented on Figure 1, from which the user enters the system and chooses an available lesson, depending on his/her class. The user moves forward or backward with the relative arrow on the basic menu and reaches the lesson page with information on the lesson and the students. At this point, the teacher enters the lesson objective on the available text box and goes on with designing the application (Figure 2).

In this example, we refer to a general lesson of "*Renewable Energy Sources*". In Figure 3, the design canvas appears on the centre of the screen; backgrounds, pictures and characters relevant to this subject appear on the design database on the left of the screen, while on the bottom screen the selected (or the created) numbered scenes appear. The mouse coordinates appear on screen, as well as a text box which assists the user during the design. On the right side, there are various designing tools, such as pencils and erasers, colours, ready-to-use schemes, such as circles, rectangles etc. In addition, there is a link for entering textual and recorded/narrated messages.

As soon as the teacher ends with the design of the multimedia tool, she or he presses the presentation button from the basic menu and moves directly to the multimedia application presented to the students (a printscreen shown in Figure.4).

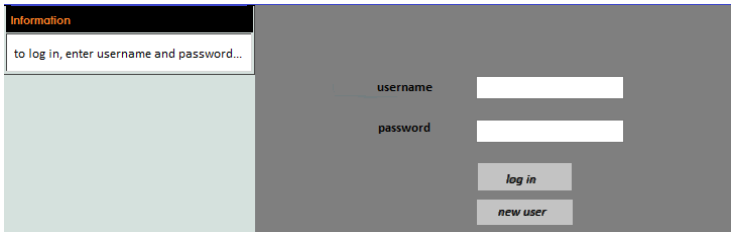

Figure 1: Entering the application

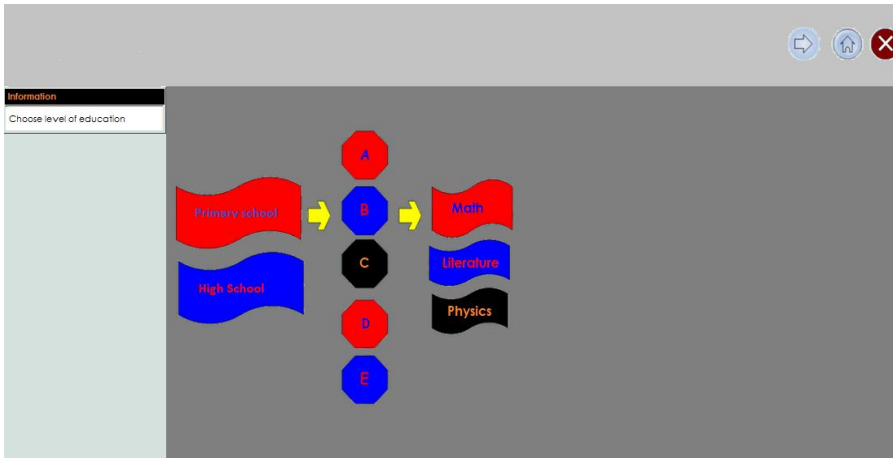

Figure 2: Application menu

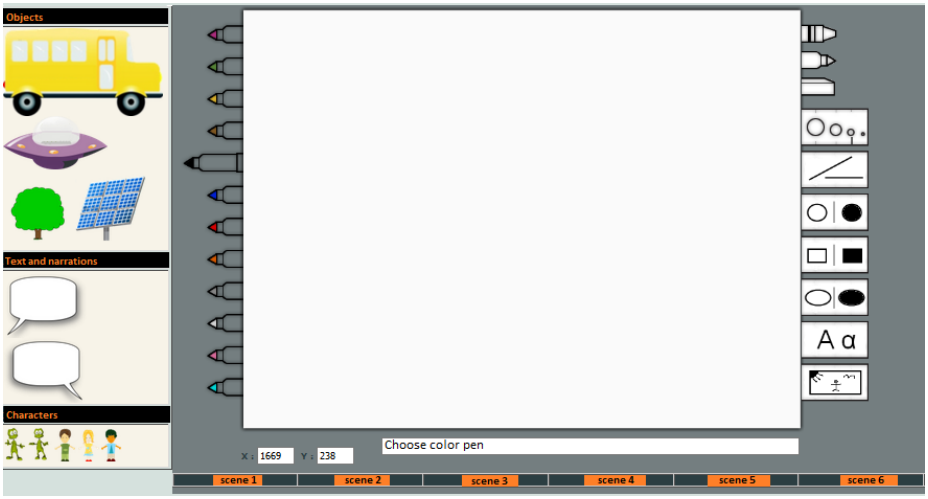

Figure 3: The design canvas

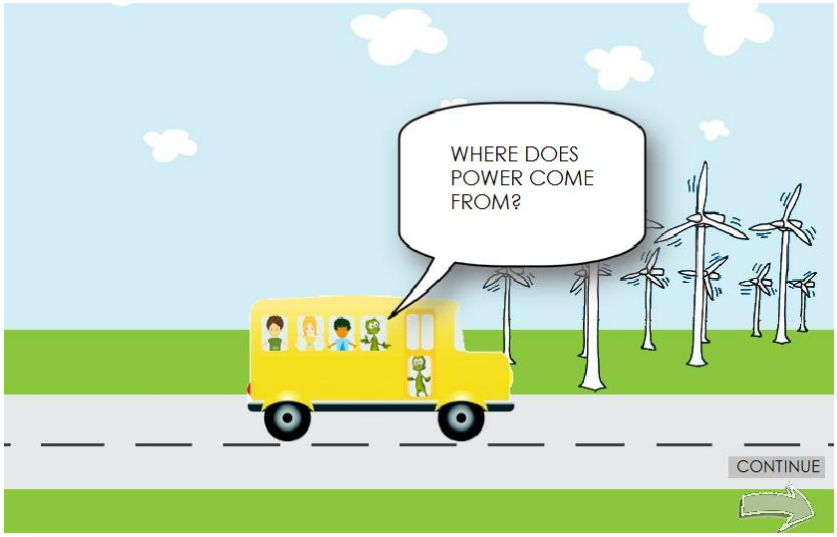

Figure 4: A print screen of the comic story

Post processing

The evaluation sheet with multiple-choice questions was prepared, along with a success evaluation counter. When asked, the students answer the questions and submit the evaluation sheet. The percentage of the objective achieved is estimated, as it is calculated from the summation of the right answers and their degree of difficulty. All sheets are gathered in a database and are applicable for further post-processing. There is a possibility of expressing the objective achievement in diagrams. Most of the post-processing has been done with statistical techniques provided within the open source statistical and mathematical platform Octave (Eaton, 2002).

RESULTS

Questions were asked of a relatively broad audience (educators, students and external participants), and answers and feedback were gathered to create new questions. The longitudinal nature of our study is aimed at building a strong inquiry for knowledge-based activities at schools.

The following questions and answers may serve as a guide for the further development of digital tools.

Question 1: How did you understand the short course on renewable energy sources?

In Figure 5, the user is asked how he/she understood the short course on renewable energy sources. It seems that as students and teachers become more familiar with technology and, especially, multimedia techniques, the degree of understanding the subject presented reaches 60% in 2016. The simplicity of the application does not stress students and enhances their learning. However, there exists a standard percentage of 20 to 30% of the participants that continue to show little understanding of the subject in both 2011 and 2016.

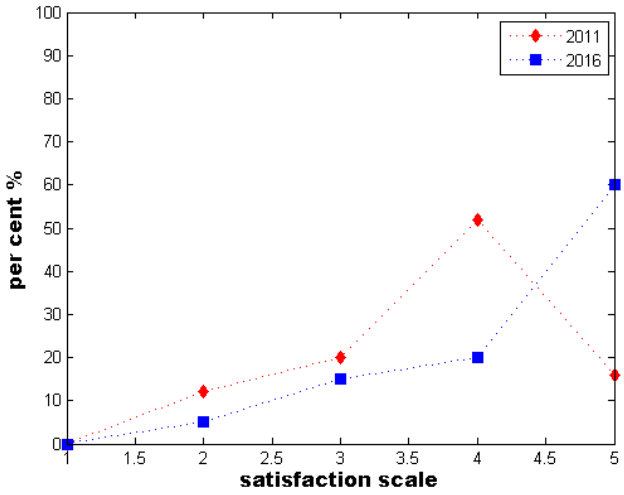

Figure 5: How did you understand the short course on renewable energy sources? (Dotted lines are key to the eye)

Question 2: How do you fancy the idea of teaching/being taught with digital methods?

Participants fancy the idea of teaching/being taught with new digital methods (Figure 6). To support this statement, Ng et al. (2017), note that college students use their smartphones during class time, while completing homework and while studying. A small percentage of students and teachers that do not wish to adopt new methods in learning exists can be considered as a standard finding that does not seem to change throughout the years.

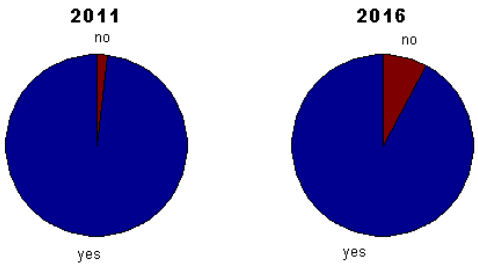

Figure 6: How do you fancy the idea of teaching/being taught with digital methods?

Question 3: Which lessons would you like to have in digital form?

The answer to this question back in 2011 was limited mostly to Math, History, and Literature, but in 2016, the number of preferred classes increased (Figure 7). Physics and religions are now among the most popular answers. The trend seems to be that, after employing new digital methods in basic classes (e.g., math, history, literature) and getting familiar with them, students are ready to move further, including all classes. In Beavis, Muspratt, and Thompson (2015), in a parallel study on the use of digital games in learning, students' most popular answers for use of digital lessons were for English, Maths, Society/Environment and Technology, while drama, foreign languages and health/physical education were reported as the three subjects least used. But, overall, as students and teachers become more familiar with technology in their everyday life, they seem open to adopt new methods in learning (Rung, Warnker, & Mattheos, 2014).

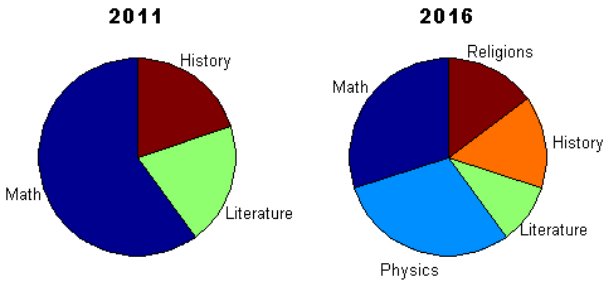

Figure 7: Which lessons would you like to have in digital form?

Question 4: Would you wish to participate in the application using your own avatar?

An important finding is that the majority of 95 to 97% wish to design his/her own comic and participate actively in the learning process (Figure 8). Although well-known comic characters and super heroes are the first choices for students and teachers when they are asked to build a story, they get enthusiastic when they are prompted to design a character based on their photo and, especially, when this avatar makes the storytelling. Lee (2014) investigates the learning outcome when student avatars are employed in a virtual community and have a specific role in an environment designed to simulate real-world scenarios. They found that the sense of freedom offered in the virtual community enhances interactions between individuals and communities and helps building skills.

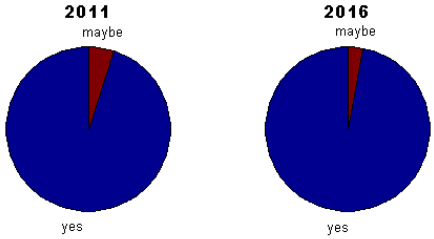

Figure 8: Would you wish to participate in the application using your own avatar?

Question 5: How do you rate the application you just used overall?

Figure 9 shows how participants assess the overall presentation of the course. Although, there is quite a positive view of the method, we observe that positive reactions become less in 2016 compared to 2011. We attribute this behaviour to the fact that the simple 2D graphics of the tool do not attract as much interest in 2016 as they did in 2011. Most of the people nowadays –students and adults– experience advanced digital content on their personal computers, mobile devices and TV, and their criteria have become more demanding. More sophisticated aesthetic features would yield in a higher learning outcome (Won Hur & Suh, 2012).

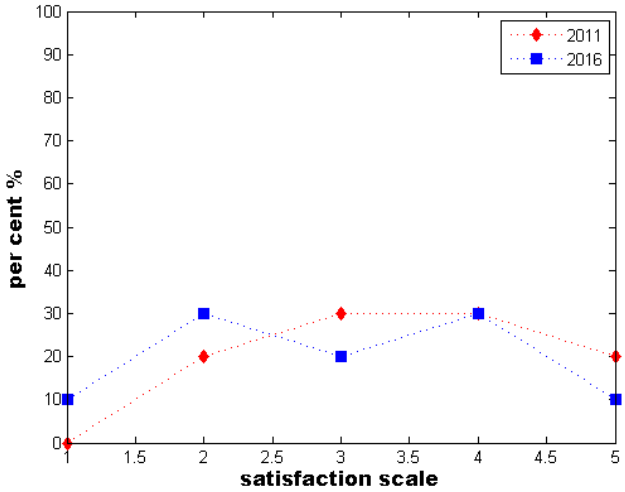

Figure 9: How do you rate the application you just used overall?

DISCUSSION AND CONCLUDING REMARKS

Education in future has to overcome the conservative model of transmission of information from the teacher to the students and move towards the creation of knowledge, following disciplines that engage prior experience with science and technology. Digital storytelling is a promising technique that intersects all levels of education and enriches the educational process. It is currently integrated in the educational system of many countries, providing new results and fruitful discussions. Comics, animations and other technological multimedia representations are also being investigated in parallel in the

classroom. Their impact on students and teachers is, conclusively, positive and work has to be done from the first grades of primary school so that they become common practice and fertilize classical teachings, especially if combined with new electronic devices (Ng et al., 2017; Tindell & Bohlander, 2012).

Studies have investigated digital storytelling, comics, animations, and other techniques as distinct techniques; there is a vacuity in studying the integration all techniques. Furthermore, a comparative study on the application of each technique for the same educational field could be of great interest. For example, an experiment in natural science could be approached by a digital story, a short comic book, or animation. The students would interact with all of these techniques and argue for the preferred method in terms of which one they would be willing to implement, or which one best achieves the educational target. In addition, DS methods in natural sciences, as a distinct region, have rarely been applied and thorough investigation of the method would be of great interest.

Each technique, from another point of view, has been inserted in one educational level, either in primary school, in high schools or universities; although in Di Blas and Paolini (2013) digital storytelling is employed in primary and high schools in parallel in Italian education. A systematic investigation of applying a general platform through all educational levels (primary schools, high schools and universities) would be an asset. Issues to be resolved are whether students, in every educational level, prefer to participate in authoring comic strip books or multimedia digital stories. However, the students can be authors only if they wish to be; in lessons in which they may feel hesitant they can just be observers until they start to fancy them. Teachers and students work together in order to derive the pedagogical implementation and group work is encouraged so that, even weak students can participate.

Our investigation has shown that students, teachers and other individuals fancy the idea of actively participating in the design of the learning process, as long as it stimulates their interest and their aesthetic and technological criteria have become more demanding. Education professionals should keep pace with this.

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