Digital Storytelling for Children with Autism: Software Development and Pilot Application

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Digital Storytelling: Definition and Benefits

As narration is the symbolic presentation of a sequence of events (Scholes, 1981), storytelling might be defined as a form of narrative (Lathem, 2005; More, 2008). Narrative is defined as a sequence of events which refer to a unifying subject represented in a perspicuous order in time (Carroll, 2001; Worth, 2005). The terms "narrative" or "story" are used interchangeably in the literature (Velleman, 2003; Worth, 2005). It is well known that children begin to write their stories through images that often entail a symbolic function. They use pictures to create a sequence with a plot, which tells a story (Gershon & Page, 2001). Children's stories may be short and serve different aims such as telling a personal tale, recounting a historical event, or making a presentation aimed to give information or instructions on a particular topic of interest (Robin, 2006). This process, reflecting an old concept, has been defined as storytelling and has been used extensively in different levels of education (Lathem, 2005; Robin, 2006; Valkanova & Watts, 2007; Yuksel, Robin, & McNeil, 2011). It refers to

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a linear narration of a story with a starting point, a middle point (climax), and an ending point (Gershon & Page, 2001). Storytelling may include text as well as other forms of media such as images, sounds, animation, and videos (Lathem, 2005). Following the expanding use of digital media, it has been developed into a different form of creation and presentation. Digital storytelling (DS) is based on digital images, videos, text, and sounds to form a genre in order to present a story to readers, viewers, and listeners via a computer system (Li, 2007; More, 2008; Robin, 2006). In educational terms, new instructional methods, based on the use of technology, have been developed for facilitating learning. As Levin (2003) argues, known concepts are adjusted in a new pedagogical setting and enhanced with the use of technology.

There is a range of DS software such as PhotoStory3, Animoto, ComicLife StoryBird, Digital Vaults, VoiceThread, and Glogster, Kerpoof that offer the tools to create a story with images and text through a computer system. Users can freely place images in a sequence in order to create their own story, since there is no correct or wrong order. Digital storytelling offers several benefits to the educational process in variable domains and for different learning groups (Heo, 2009; Kulla-Abbott & Polman, 2008; Li, 2007; Meadows, 2003; More, 2008; Robin, 2006; Yuksel et al., 2011). In particular, Kulla-Abbott and Polman (2008) suggested that a digital storytelling program can assist students in improving their writing skills because learners need to create and organize a sequence of images in correspondence to their ideas for making a story. They also concluded that DS can make students more engaged and creative, by helping them to discover different ways to express their own ideas. Other researchers, such as Valkanova and Watts (2007), asked children to make sound "voice over" in a narrative form for their own videos. They reported that this procedure enabled children to express themselves verbally and visually in an artistic, productive, and inspiring way. The same conclusion was reached by Burgess (2006), whose research offered evidence for the positive effect of DS for creative thinking. Sadik (2008) explored teaching and learning through the application of digital storytelling with Microsoft Photo Story 3 and found that it increased their comprehension and learning. Meadows (2003) observed that when students used multimedia software to visualize their thoughts, they were more active and engaged with the subject matter. Li (2007) evaluated the integration of multimedia technologies into higher education and concluded that through DS students improved their learning. Furthermore, DS has been used as an educational tool for learners with special needs. O'Neill and Dalton (2002) used successfully digital story books for teaching literacy to students with learning difficulties.

Overall, researchers agree that DS is an effective approach that engages learners and supports teachers to effectively integrate technology into learning. Its application with special learning groups has been examined in a few research projects (Daigle & Sulentic Dowell, 2010; Daigle and Free, 2007; Gal et al., 2005; Tartaro, 2005). Researchers have also examined the implementation of DS to students with ASD regarding activity schedules via computer applications (Stromer & Kimball, 2004; Stromer, Kimball, Kinney, & Taylor, 2006). Activity schedules are defined as a set of pictures or words that cues someone to engage in a sequence of activities (McClannahan & Krantz, 1997; Stromer & Kimball, 2004). They can be considered as a form of storytelling, as they are often used to display a sequence of steps for the

completion of an activity and this could also form a story constructed with a sequence of images and text. Moreover, the potential benefits of activity schedules presented with computer support have been well documented (Stromer et al., 2006).

The Education of Students with Autism

Autism spectrum disorders (ASD) have been identified as pervasive developmental disorders with neurobiological background, causing impairments and delays in social communication and imagination (Barry & Burlew, 2004; Welton et al., 2004). Consequently, children with ASD prefer to get engaged in solitary repetitive activities, avoiding social interaction. Moreover, they have a cognitive bias to local processing, that is, they pay special attention to details which prevents them from grasping the purpose or the steps of an activity (Carnahan, Musti-Rao, & Bailey, 2009; Odom, Collet-Klingenberg, Rogers, & Hatton, 2010; Rajendran & Mitchell, 2007). Also, persons with ASD present major difficulties in executive functioning (Carlson, Mandell, & Williams, 2004; Pellicano, 2007), which involves organizing and following sequences of steps. Therefore, educating people with ASD can be challenging and it is necessary to adopt appropriate educational methods matching closely the needs of these individuals. A range of educational interventions utilizing visual methods have been successfully applied to children with ASD for overcoming the aforementioned difficulties. Structured teaching has been found to be an effective educational method for increasing on-task behavior and independence of children and adults with ASD (Ganz, 2007; Hume & Reynolds, 2010; Mesibov, Shea, & Schopler, 2005). The main component of Structured Teaching is the application of visual structure in the physical environment, in daily schedules and tasks, so that individuals with ASD can follow predictable routines and visual instructions for executing tasks and participating in activities.

On the other hand persons with ASD seem to have a strong motivation to use computers for both learning and leisure (Heo, 2009; Moore et al., 2000; O'Neill & Dalton, 2002; Valkanova & Watts, 2007). The use of computers offers the opportunity to the learner with ASD to interact in a controlled environment, which is predictable and with minimal social stimuli. Besides, it has been found to be effective for students with ASD by increasing their attention span and their performance in a range of academic tasks as well as by developing a repertoire of social skills and behaviors (Bernard-Opitz et al., 1994; Moore et al., 2000; Tanaka et al., 2010; Williams, Wright, Callaghan, & Coughlan, 2002). There is considerable evidence showing that the main characteristics of people with ASD related with their learning are the following: (a) they have a different way of communication, (b) they prefer a predictable environment, (c) they find it difficult to understand emotional cues, (d) in general, they prefer images to text or oral information, (e) they concentrate better in structured environments, with clear expectations and visual instructions, (f) they learn by repetition of learning tasks, (g) they need frequent breaks in their schedule, and (h) they take pleasure using computers for learning and leisure (Bernard-Opitz et al., 1994; Hume & Reynolds, 2010; Moore, McGrath, & Thorpe, 2000).

Therefore the use of computers may entail several benefits associated with the special characteristics of persons with ASD (Golan & Baron-Cohen, 2006; Mineo, Ziegler, Gill, & Salkin, 2008; Moore et al., 2007; O'Neill & Dalton, 2002; Williams et al., 2002). In particular, computers:

- Are predictable and thus they are controllable devices. They do not display emotional behavior which can often be confusing for persons with ASD.
- Enable nonverbal or verbal expression.
- Present a less threatening environment compared to an adult or a peer.
- Can be used repetitively.
- Provide positive reinforcement.
- Are easy to use.
- Can be tailored to the individual needs of each learner.
- Are based on special hardware solutions designed to help persons with special needs.
- Are versatile, since they use software which can be adaptive and adaptable to users' needs and special interests.

Digital Storytelling and Students with ASD

In the field of ASD, DS has been used to achieve student involvement as it relies heavily on visual information; a suitable way of presenting stimuli to this special group of learner (Daigle & Sulentic Dowell, 2010; Flippin et al., 2010; Stromer et al., 2006; Stromer & Kimball, 2004). It also provides a framework integrating images and text to form a story that narrates useful information. In addition, this method could be viewed as an alternative means of instruction in an inclusive classroom.

Social Stories describe social situations aimed to share social information (Gray, 1998; Gray & Garand, 1993). Sansosti, Powell-Smith, and Kincaid (2004) presented Social Stories through DS to children with ASD and reported positive effects of the intervention recommending further research on the use of DS for effective learning. In addition, Heo's recent research (2010) indicated that DS increases children's involvement in the learning of subject matter. His research was conducted over a period of 6 weeks with 17 fifth graders and his analysis showed evidence that DS can offer a motivating and effective learning experience. It is commonly agreed that the creation of a story through digital media engages children's interest and increases their creativity and involvement in a subject matter being taught (Meadows, 2003; Robin, 2006; Valkanova & Watts, 2007; Yuksel et al., 2011). However, their use, in special learning groups, has not been thoroughly examined (Daigle & Sulentic Dowell, 2010; Gal et al., 2005; Tartaro, 2005).

In Daigle and Sulentic-Dowell's initial study (2008) on the use of DS as an intervention to improve the academic performance and social interactions of a sixth grade student with high-functioning autism, positive findings were reported. Similar findings were documented by Gal and his colleagues (2005) and Tartaro (2007) who

combined DS with virtual peers for children with ASD. Also, Lindsey-Glenn and Gentry (2008) reported promising results following the use of DS to improve vocabulary skills of students with ASD.

It is notable that the software tools that have been used in the aforementioned studies have not been designed specifically to cater for the special needs of this group of learners. Subsequently the software does not accommodate the components of structured teaching suitable for persons with ASD. Educators use the existing software by modifying its scope and operation in order to teach social skills to children. Special education teachers need to organize the learning material and the way information is presented in order to maximize the achievement of their instructional goals.

The Di.S.S.A. Environment

The present chapter presents a software system of DS targeting children with special needs. The software created is called Di.S.S.A., which stands for Digital Structured Storytelling for Autism. The software is designed and developed purely for this research work and is programmed in action script 3 in Adobe Flash authoring environment. It is an online application. This is the first time such software, based on combining visual supports with elements of structured teaching, is developed to cater specifically for persons with ASD. To our knowledge, similar software development has not been published.

The system is aimed to help people with ASD learn social skills through storytelling with the use of images, as sole text is, often, not the preferred way of presenting information. It evaluates user's performance and presents information about user's progress. Its design is imposed by the need for a structured way of presentation, which has been proposed as appropriate for this group of learners (Mesibov et al., 2005). Persons with ASD need to be aware of the meaning of an activity and clear guidelines on how it will be done, how long it will be, and when it will be finished. If this information is missing, they get confused and cannot perform tasks independently. The development of Di.S.S.A. accommodates the above components and users always know where they are in the application, what the purpose of their actions is, and what the desired outcome is.

The design of the system (Di.S.S.A.) is based on the A.D.D.I.E. (Analysis, Design, Development, Implementation, Evaluation) model. A.D.D.I.E is a framework that lists generic process for instructional design software (Dick & Carey, 1996; Leshin, Pollock, & Reigeluth, 1992). The content is adapted to the individual's capabilities by providing different levels of access (users have different capabilities depending on the severity of ASD), then the content is presented accordingly to the adaptation module, the user creates the story, the system evaluates user's performance, and a story with different actors but with the same concept is presented so that the users can interpret in a conceptual way the given task (children with ASD have difficulties *generalizing* what they learn in one setting to another setting) (Stromer et al., 2006).

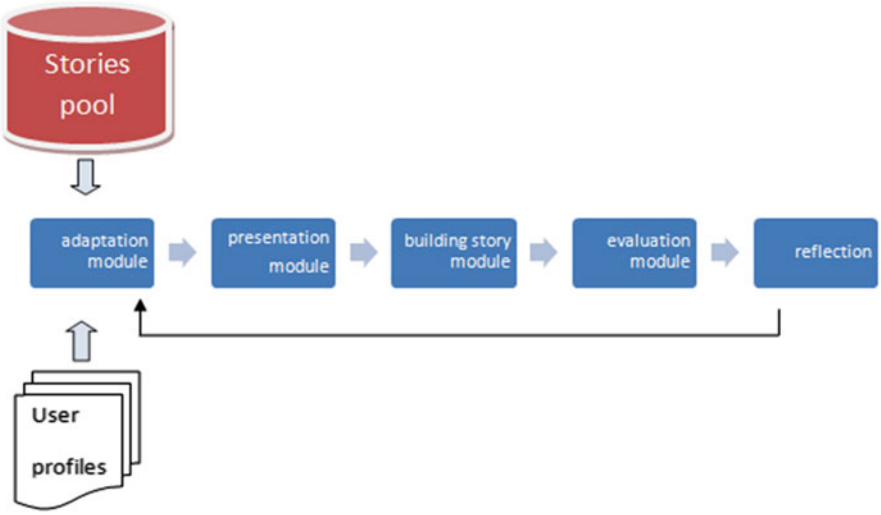

Fig. 1 The design of Di.S.S.A.

Stages of the Application

The system is adaptive to cater for different levels of ASD and evaluates user's tasks in order to provide feedback for user's performance. The architecture is based on experiential learning (Kolb, 1984) and follows the basic steps of experiential learning; namely, experience—reflective observation—conceptualization, and active experimentation.

When the application launches for the first time, a questionnaire is presented that is filled by an adult, such as the parent or the special education teacher. The questions of this instrument refer to the student's skills and preferences, the level of ASD, the use of text, movements, sound, or text messages, the number of pictures used and the visibility of the evaluation model. The relevant story is picked up from the stories pool (Figs. 1 and 2). The story is adapted to suit user's special characteristics and preferences. The system decides how information is presented to users (adaptive approach) with respect to the adaptivity dimensions of user and content. This is not an intelligent system as the system follows a series of production rules (if …then).

The user logs into the system by inserting his/her name. The system "remembers" him/her next time he or she logs in and automatically starts from the last point he or she left the application. This function is accommodated, considering that students with ASD might give up trying while using the application. As repetition helps them comprehend the task, the system "remembers" them so that they can continue their trials from the point they stopped last time. Users (teachers, parents, or students with ASD) choose a social skill to learn.

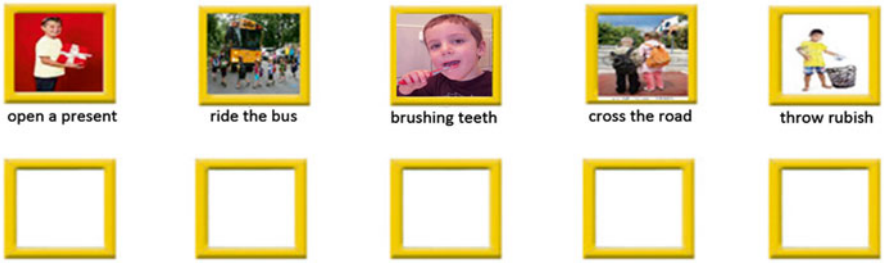

Fig. 2 Screenshot from Di.S.S.A. showing how the user can pick up a story

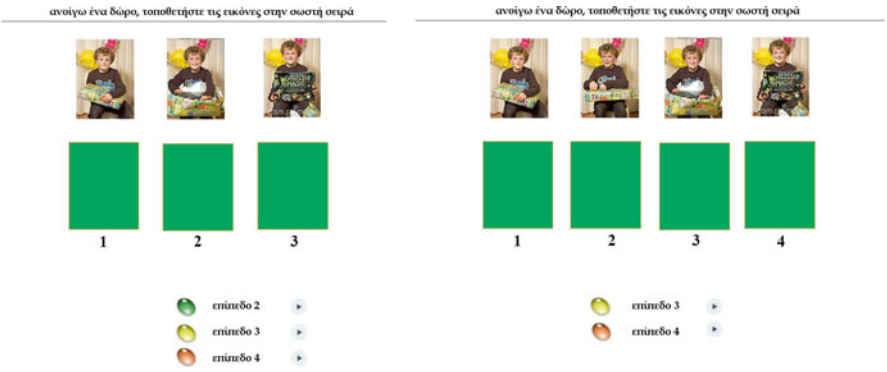

Fig. 3 Screenshot of the Di.S.S.A. showing the selection of level of difficulty for users

The user is presented with four levels of graduated difficulty for constructing a story (Fig. 3). That is, he or she can choose the length of the story by selecting either three, four, six, or eight images as breaking an activity into distinct steps has been proved to be an effective method for achieving task mastery and independence in special education (Swanson & Hoskyn, 1998). In the case of the system being used by the student without supervision he or she can choose the desired level independently. In all other cases, a professional or a parent will select the appropriate level of difficulty for the student with ASD, considering the student's ability level and the severity of autism.

Next, a sequence of images making a story is presented (Fig. 4a). Following this presentation, the images are placed randomly in the screen (Fig. 4b) and users are asked to rearrange the pictures in the correct order to create the story. An example of a story (i.e., "opening up a present") is presented in Fig. 4. For a realistic representation, the images used are photographs. A step-by-step procedure is followed. At this point, Di.S.S.A. has been designed following structured teaching which

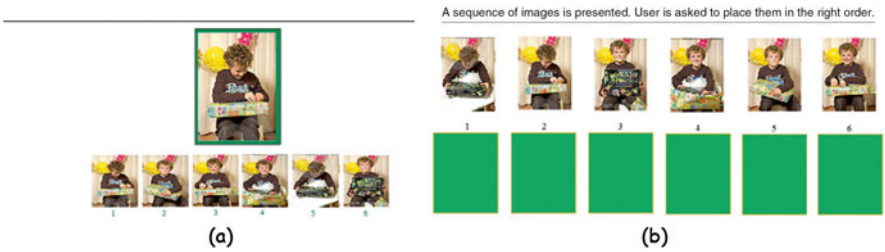

Fig. 4 Screenshot of the Di.S.S.A. for making a sequence of images for the story

places a strong emphasis on the execution of a sequence visually presented (Mesibov et al., 2005; Stromer et al., 2006). Therefore, the user can move to the next step only if he or she is correct in selecting the first picture of the sequence.

Feedback/Evaluation

The system provides sound messages to reflect user's actions such as messages that inform the user for the correct or false completion of tasks. The messages "lead" users to the right direction in order to make the correct decision. The system tells the users orally and through text messages what they have to do and what the outcome will be at all stages of performance. Text messages are presented too, in order to build a relationship between images and words. For the evaluation of use, their performance is recorded, stored, and compared with past trials for the same story by the same user. Depending on the outcome of the evaluation, the system executes a reflective function by selecting the same story theme, but with different images. This is necessary given the need for skill generalization. Therefore, a new story is presented to make sure the learner has acquired the social skill being practiced independently of the particular sequence of images.

A "present" is given every time the user places an image in the correct place. Persons with ASD are very fond of animals (O'Haire, McKenzie, Beck, & Slaughter, 2013). So the system is designed to include an animated animal that places itself in a different area in the screen other than the user's working space, to prevent any distractions (Fig. 5). The user is given a different present for every story to avoid boredom. In the end of the session the user can save a collection of all animated animals in the system.

Following task completion, a result log is presented that contains the number of errors of the user and the duration of engagement in each task. This is a useful tool for comparing data to check for improvements between different trials of the same user (Fig. 6).

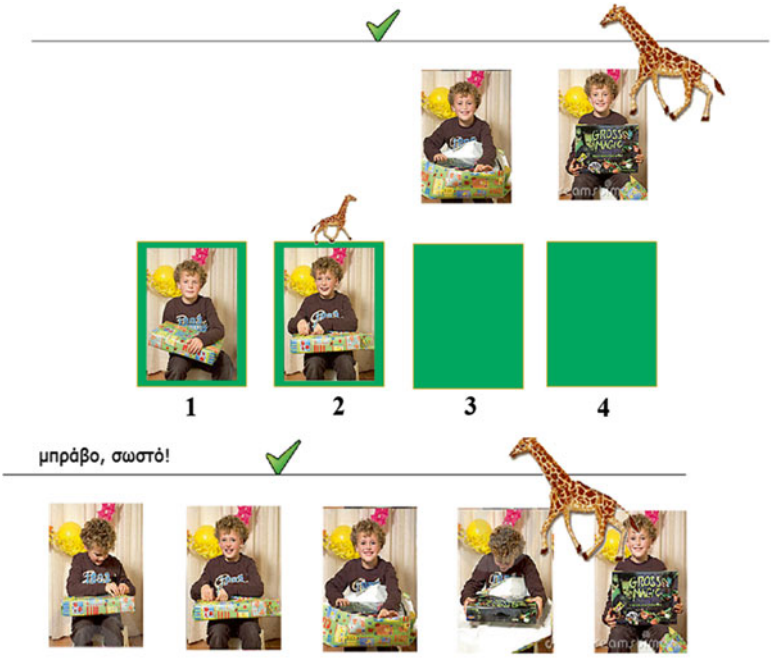

Fig. 5 A "present" is given every time user puts an image

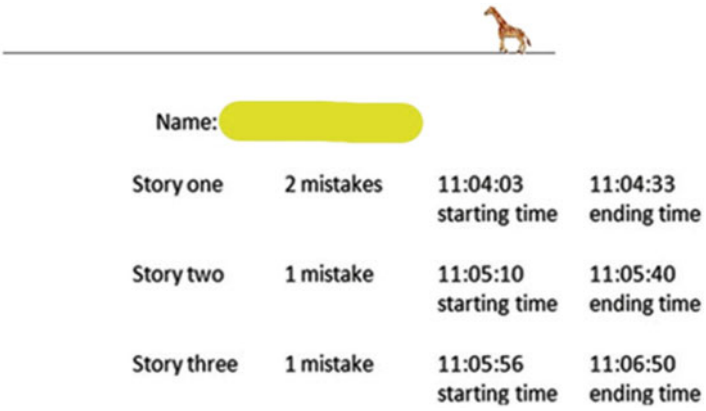

Fig. 6 Sample evaluation log with data about task performance

Pilot Application of Di.S.S.A.

A pilot application of Di.S.S.A. was carried out with four pupils (7–11 years) with a formal diagnosis of mild autism. Two aspects of the application were evaluated: user's satisfaction and user's task accomplishment. The evaluation was conducted in collaboration with the parents of the children and took place in their homes.

The researcher met with the parents to demonstrate the application and explain to them how to operate it. Each child used the system on their own with instructions and supervision by their parents, who had chosen the level of difficulty that was suitable for their own child. Each child learned three social skills by using DiSSA and three social skills with DS software for typically developing children. The software used is Photo Story by Microsoft that doesn't use steps when operated and its interface design is "busy" as it is addressing typically developing children. It is used to create a story but it does not accommodate features as correct sequence of images and subsequently a module of informing the user for the correct completion of tasks. The stories were aimed to teach them: (a) to cross a road, (b) to open a present, and (c) to wash their teeth.

Interviews with the parents were carried out by the first author of this chapter. In general, the findings were positive for both aspects of the application and all children with ASD reported that they enjoyed using the application. Their parents emphasized that their child had learned the sequence—stressing that story was easier than using printed images or other educational tools. They mentioned that their children showed a strong motivation to operate the application and seemed highly concentrated on the tasks. Also, they repeated patiently the whole procedure as often as it was required. In contrast, when they were asked to repeat the task with the DS software not specific for ASD, their parents had to spend more time to convince them to practice the repetition. Parents reported that their children appeared to view Di.S.S.A. much more like a game than as a learning tool. They particularly liked the animated "presents" and this function (to collect as many animals) motivated their engagement with the application.

One of the parents described user's experience as an enjoyable activity: "My son didn't want to leave the application. He liked using it."

The same parent added: "My son wanted to use it even after he did all three stories. He asked for more stories. I think he thought it is a game, maybe because he was getting the animated animal as presents when he was finishing a task and he wanted to get more presents."

Another parent reported that his son learned the sequence of images very easily comparing tasks with printed images that he had tried before. Also, he reported that his son considered the application as a game and not as a lesson. He said: "I think that my son wanted to get as many more animals as possible, I am not sure but I think that this is one of the reason he liked using DiSSA."

Another comment was the following: "My son got confused with the other software and I needed to stand by him all the time he was operating it. I needed to tell him every time he was placing an image if he used the right one. When I left him alone for a while he got upset."

In summary, the main findings of the pilot application were the following: (a) children with ASD liked more using Di.S.S.A. than the DS software nonspecific for ASD, (b) the structured style of presentation helped them maintain their attention on the task, (c) they could operate Di.S.S.A. almost independently, and (d) they learned the tasks given faster using Di.S.S.A comparing to the DS software nonspecific for ASD. The above are important findings for children with ASD as they address

crucial elements in their learning process as these children have different learning characteristics than their typical peers. The special needs that complicate their learning are difficulties with verbal expression, difficulties with remembering verbal instructions, their short attention span, the lack of organizational skills, the difficulties to generalize the skills taught and to make transitions from one task to the other. Since Di.SS.A. utilizes greatly visual processing and presents information in a structured way through computer systems it carries the potential to be an appropriate method for teaching social skills to this special group of learners.

Following the positive outcomes of the pilot application, an intervention with more participants has been scheduled to take place, including persons with differing levels of autism severity.

Conclusions

Despite the changes of the format of narrative storytelling over the years, its purpose remains the same. Digital storytelling serves the same principles as the inclusion of new media using computer technology. The number of available DS systems is indicative of their importance for teaching academic and leisure skills. Their use, for learners in the autistic spectrum, has been introduced in the last decade and systems appropriate for this special group of learners need to be designed and evaluated.

Di.S.S.A is our first attempt to design DS software specifically for users with ASD. It utilizes components of Structured Teaching, such as minimal use of written messages and extensive use of images, for the instruction of social skills to persons with ASD which have been recommended as appropriate for students with ASD. Another useful feature for professionals and parents is the continuous evaluation which allows them to record user's competence in the learning task.

It is anticipated that the use of DS is a promising method for making learning more appealing, raising students' productivity and positive affect during individual or collaborative activities. Future work includes testing the application to a large number of people with AS, in different settings, targeting not only social skills but other skills too such as safety and hygiene skills and other learning subjects such as mathematics and history.

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