Educ Inf Technol (2016) 21:1679–1697
DOI 10.1007/s10639-015-9409-1

VLEs, social stories and children with autism: A prototype implementation and evaluation

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Published online: 26 May 2015

Abstract Virtual Learning Environments (VLEs) have been successfully used in educational interventions for children with Autism Spectrum Conditions (ASC) for overcoming their persistent differences related to social communication and imagination. This paper investigates the potential of VLEs presenting Social Stories, as an advantageous pathway for the development of social problem skills in children with ASC. To this end, it presents the design and development of VLSS (Virtual Learning Environment with Social Stories), a prototype three-dimensional VLE for children with ASC. Overall, the evaluation of VLSS by 40 experts (special education teachers) was very positive, indicating that VLSS has the potential to be a beneficial and easy-to-use educational tool for enhancing social problem solving in children with ASC.

Keywords Virtual learning environments · Autism spectrum conditions · Social stories · Social problem solving

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1 Introduction

Autism is a lifelong and pervasive developmental disability characterized by core impairments in social communication and imagination (American Psychiatric Association 2013). Autism is conceptualized as a "spectrum" disorder because it covers a wide range of differences varying in level of severity (Wing 2002) and is evident from infancy or early childhood (from two or three years), depending on the type of the disorder (Rogers 2009).

Deficits in social communication have been interpreted as a consequence of an impaired "Theory of Mind" (ToM), which refers to one's ability to associate mental states (such as beliefs, intentions, desires and feelings) with behaviours (Baron-Cohen 1995; Wellman 1990). It is widely accepted that the awareness and understanding of the inter-relationships between others' affective/cognitive states and their actions are important for appropriate social responsiveness (Hala 1997). However, individuals with ASC, even those with higher level abilities, present notable and persisting differences in their ToM, as evident in their everyday life (Frith et al. 1994).

Virtual Reality (VR) has been widely used to support the educational process. Although there is no clear definition of VR, the term was used and popularized by Jaron Lanier in the late 80's ("Virtual Reality", 2013), to describe a three-dimensional (3D) computing environment in which users can be immersed and interact (Lanier et al. 1989). Similarly, 3D Virtual Learning Environment (VLE) is a special case of VR, where the emphasis is more on the education rather than on simulation (Bouras and Tsiatsos 2006). Therefore, VLE is characterised/defined as an interactive learning space facilitating innovative teaching and engaging learning activities (Collins and O'Brien 2011). More specifically, according to Dillenbourg (2000), any VLE should meet the following criteria:

a. The inclusion of designed information space(s).
b. The representation of a social space, derived from the educational interactions occurring in the environment that is, converting spaces into places.
c. The explicit representation of the information/social space.
d. The involvement of students as actors, and not only active users, meaning that they co-construct the virtual space.
e. The enrichment of classroom activities, without being restricted to distance education.
f. The integration of multiple tools, heterogeneous technologies and multiple pedagogical approaches.
g. The overlap with the physical environment.

The applications of VLEs have been also recommended as a useful teaching approach for children with ASC. In particular, VLEs have the following features, highlighting their beneficial value for this special group of learners:

- They provide a stable, secure and controlled environment, in the sense that children with ASC can make errors without facing the unexpected consequences of the real world (Bosseler and Massaro 2003; Dautenhahn 2000).
- They facilitate knowledge and skill generalization through easily made controlled adjustments/adaptations to enable real-life applications (Bosseler and Massaro 2003; Dautenhahn 2000; Schmidt and Schmidt 2008).

- They offer a quite realistic representation of reality, which promotes mental simulation and therefore contributes to the improvement of social problem solving (Parsons and Mitchell 2002).
- They present virtual agents which can be programmed to generate consistent and predictable responses, encouraging children when they make errors and reducing their stress (Milne et al. 2010). Furthermore, virtual agents versus humans have stable tone of voice and use constant expressions (Bernard-Opitz et al. 2001; Parsons et al. 2004), as well as they never get tired or frustrated (Milne et al. 2010).
- They allow the customization of the input stimuli (such as sound, colours, etc.), according to the preferences and needs of children with ASC, thereby serving the need for an individualized learning environment (Dautenhahn 2000).
- They increase users' task engagement (Parsons and Mitchell 2002).

In the last decade, VLEs has been used successfully in applied educational research with individuals with ASC (Cobb et al. 2010; Moore et al. 2005). Drawing from this theoretical and empirical trend in the literature, this paper focuses on a 3D VLE for children with ASC, which is based on the use of Social Stories (SS) to help children with ASC learn to solve social problems.

This paper is organised in three parts, reflecting its purpose to evaluate both the usability of the proposed environment as well as its educational content. The next section outlines related research on the use of VLEs for students with ASC. The following section describes the design and development of the prototype VLE application. The procedure and the findings of the empirical evaluation of the application are presented and discussed in the final section.

2 The use of VLEs with individuals with ASC

There is an increasing number of studies examining the potential benefits of VLEs for the education of children with ASC. VLEs are considered to be particularly effective with these children, because they provide an ideal method for social skills training (Beardon et al. 2001).

VLEs have been successfully applied in social skills instruction, such as the development of AS Interactive, which is a Single-User Virtual Café (Mitchell et al. 2007; Parsons et al. 2000, 2005) and the COSPATIAL project, which incorporated both social skills and collaborative problem solving (Cobb et al. 2010; Millen et al. 2010b). Furthermore, the JeStiMulE was developed to simulate different social situations by teaching emotion recognition (Serret et al. 2014) and the iSocial, a virtual learning environment was implemented for a social competence intervention (Stichter et al. 2014). Milne and her colleagues (2010) developed the application "Thinking Head", which realistically depicted a tutor – virtual agent so that children with ASC could learn to recognize facial expressions. Other researchers used virtual agents in the educational process such as "Baldi" (Bosseler and Massaro 2003) and "Sam" (Tartaro and Cassell 2006), which facilitated language and social skills in children with ASC. Also, humanoid avatars have been employed to examine if children with ASC could develop their empathy (Cheng et al. 2010), as well as enhance their communication skills (i.e., verbal and text-communication) (Cheng and Ye 2010; Grynszpan et al. 2011, 2012).

Further research, demonstrating the potential value of the VLE, aimed at teaching multi-tasking (Rajendran et al. 2011), as well as life skills (Charitos et al. 2000).

Evidently, VLEs seem to motivate children with ASC to participate with enthusiasm and pleasure in the educational process (Cheng and Ye 2010; Milne et al. 2010; Weiss et al. 2011). In addition, the use of VLEs has been found to improve children's performance during the educational intervention, leading to more efficient learning (Mitchell et al. 2007; Tartaro and Cassell 2006) as well as generalization of knowledge (Bosseler and Massaro 2003).

Moreover, there are a few multimedia tools presenting personalized SS for children with ASC that have been implemented with success (Doyle and Arnedillo-Sánchez 2011). Despite the extent of the aforementioned literature, there is very limited research, which combines VLEs and SS for developing social problem solving skills in children with ASC. Considering the merits of VLEs, it can be proposed that educational interventions based on exploiting both VLE and SS, could offer valuable support to the learning of children with ASC. Following other researchers (Cobb et al. 2002) in the area of collaborative virtual environments (CVEs) in the autism spectrum, we decided to seek the evaluation of this VLE application by professionals in the first stage of the development of this application. It has been found that evaluations from teachers can offer valuable help to the refinement of the design characteristics of VR applications. In this respect, this paper reports the findings of the empirical evaluation of a prototype 3D VLE especially developed for persons (9–17 years) with ASC by professional special education teachers. The added value of this environment is the exploitation of SS, which provides a prototype 3D VLE supporting a scenario for these individuals. For the empirical evaluation of this application, the following hypotheses were formulated and special education teachers were asked to express their views on the following research questions:

RQ1. How do special education teachers evaluate the usability of the environment based on VLE and SS for children with ASC?

H1. Our prediction was that the level of the environment's usability for students with ASC would be evaluated as high.

RQ1.1. How do special education teachers evaluate the role of avatars in the educational process for children with ASC?

H1.1. Our prediction was that special education teachers would ascribe a high evaluation to the level of importance referring to avatars for the students with ASC.

RQ2. How do special education teachers view the suitability and usefulness of the specific SS for teaching social problem skills to students with ASC?

H2. Our prediction was that special education teachers would assign a high rating to the level of suitability and usefulness of the specific SS for students with ASC.

3 Design and Development of the application

The VLSS environment has been designed and implemented using the OpenSimulator (http://opensimulator.org) open source platform. Firestorm Viewer (http://www.firestormviewer.org/) was also used to enable the user to connect with the VLE. The

virtual environment included the best possible realistic representation of school premises in Greece (Fig. 1a) and a typical classroom with an interactive whiteboard (Fig. 1b and 2).

Considering the dominant and explicit role of VLE's design, several challenges emerged in relation to the design of this application, because children with ASC present significant problems in communication, emotion recognition and social skills (Happé 1994; Wing 1990). The basic design elements of a 3D VLE are presented in Table 1.

This set of design elements is the output of a careful analysis of Dillenbourg's interpretation of VLE (Dillenbourg 2000) as well as the principles aring from the literature review, which highlight the value of a 3D VLE, especially for children with ASC. As is shown in Table 1, even if the use of VLE is not considered as required feature for children with ASC beforehand, it seems that the use of a 3D VLE, and avatars along with SS would fit well as a combined solution.

Based on the above analysis, it seems that our prototype VLE fulfils the majority of the design elements. The proposed VLSS meets the criteria of a 3D VLE, except the one which refers to "students being not only active, but actors", as it can be quite difficult for this special group of learners to take initiatives from the beginning of their familiarization with the application. However, the OpenSimulator platform affords this option, i.e., teachers can enable the possibility of creating objects that are referred to each SS. As a result, the proposed prototype allows teachers to customize and individualize the learning environment to the needs of children with ASC. Next, the basic elements of the proposed VLSS has used, will be described.

Firstly, multimodal constructive feedback (Bernard-Opitz et al. 2001; Parsons et al. 2004) is given with the purpose to inform the user about a correct or incorrect choice. According to this principle, the feedback was provided to the users in two different modes, image and sound (Mitchell et al. 2007).

Secondly, the information was presented to the users on an interactive whiteboard exploiting both text and images (Grynszpan et al. 2008), and following Chen et al. (2005) findings, who reported that this combination brought the optimal performance of text comprehension by children with ASC. Besides, clear and explanatory images were shown on the whiteboard to represent what the virtual teacher said (Milne et al. 2010). Also special consideration was given so that all text information, displayed on the whiteboard, would not convey any complex or confusing messages (Milne et al. 2010) (Fig. 2).

The virtual space was comfortable and spacious (Fig. 3a) for greater easiness, less navigation problems and fewer bumps into objects or walls (Cobb et al. 2002). In the VLEs all objects have been chosen to represent familiar objects and were placed in visible places (Parsons et al. 2004) (Fig. 3b).

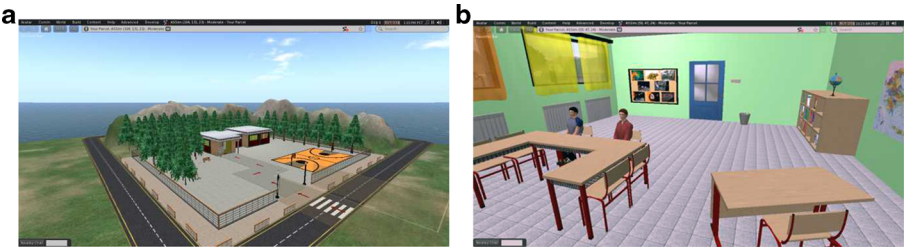

Fig. 1 **a** The typical school **b** The classroom

Fig. 2 The interactive whiteboard

Table 1 Design elements, which are satisfied, according to SoA (✓ satisfies the design elements, – doesn't satisfy them)

	State of the Art (SoA)											
Design Elements	**AS Interactive** (Mitchell, Parsons & Leonard, 2007; Parsons et al., 2000; Parsons, Mitchell & Leonard, 2004; Parsons, Mitchell & Leonard, 2005)	**COSPATIAL** (Cobb et al., 2010; Millen, Cobb & Patel, 2010)	**JeStiMulE** (Serret et al., 2014)	**iSocial** (Stichter, Laffey, Galyen& Herzog, 2014)	**Thinking Head** (Milne et al. 2010)	**Baldi** (Bosseler & Massaro, 2003)	**Sam** (Tartaro & Cassell, 2006)	**Empathy** (Cheng, Chiang, Ye & Cheng, 2010)	**Communication skills** (Cheng & Ye, 2010; Grynszpan et al., 2011; Grynszpan et al., 2012)	**Multi-tasking** (Rajendran et al., 2011)	**Life skills** (Charitos et al., 2000)	**Prototype VLSS**
Designed information space	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Social space	✓	✓	✓	✓	✓	✓	✓	✓	✓	–	–	✓
Explicitly represented information	✓	✓	✓	✓	–	–	–	✓	✓	✓	✓	✓
Students are actors	–	–	–	–	–	–	–	–	–	–	–	–
Enrich classroom activities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Integrate multiple tools	✓	✓	✓	✓	✓	✓	–	✓	✓	✓	✓	✓
Overlapping with the physical environment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Stable, secure and controlled environment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Knowledge and skill generalization	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Realistic representation of reality	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Use of virtual agents	✓	✓	✓	✓	✓	✓	✓	✓	✓	–	✓	✓
Individualized learning environment	–	–	✓	✓	✓	–	–	–	✓	–	–	✓
Engaging environment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Fig. 3 **a** The school corridor **b** The entrance with signposts

Moreover, non-significant sounds, images and animations, which may cause annoyance or distraction to the children with ASC, have been purposefully avoided (Milne et al. 2010; Millen et al. 2010a). However, some visual stimuli, such as audible rewarding messages or images, have been used to highlight what is important and where children with ASC should focus on during their interaction with the VLE (Doyle and Arnedillo-Sánchez 2011). Last, the virtual avatar, representing the teacher, whose voice and appearance was chosen to be female, used a stable voice tone for interacting with the children with ASC. A video presenting the VLSS environment, a part of the SS as well as the activities/functionalities, can be found here: http://155.207.113.25/video/VLSS_video.mp4.

4 Instructional design– social stories

According to Jonassen (1994), constructivism views learning as occuring through realistic experience and is focused on realistic approaches to solve real world problems, by providing multiple representations or perspectives of the problem. Following the constructivist approach, it seems that the VLSS is well grounded on evidence-based educational approaches. To this end, Social Stories (SS) were considered as an appropriate method for teaching social problem solving, because they include a brief description of a specific social situation, with an emphasis on the social expectations accompanying social situations (Gray 1994). SS are developed in a way which emphasizes a smooth transition from a generic to a specific presentation of a subject (Moore et al. 2000). Moreover, SS have an escalating degree of difficulty and gradual reduction of support (Parsons et al. 2004). Prior to this evaluation, a part of the SS included in this study had been used in a single subject intervention for teaching social problem solving and ToM skills to three children with ASC (Chronopoulou 2012). This subset of SS was developed according to the guidelines proposed by Gray (1994). Therefore this evaluation does not attempt to measure their effectiveness. However, SS have been adapted and modified to meet the requirements of the VLEs so that the usability of the application would be assessed by special education teachers.

In particular, four (out of nine) SS were selected and appropriate adaptations were made (see Table 2). These specific SS were chosen because their scenarios described familiar/naturalistic social situations occurring at home and school. Moreover, all scenarios illustrating social problems in everyday life were associated with basic positive and negative feelings (such as happiness, anger and sadness). The first SS included an incident taking place at home: a vase was broken by the wind and the parents accused their child, who became angry with them, because he did not have the chance to explain what happened. The second SS presented an event taking place in a school: a boy who liked maths had

Table 2 Design of the structure and the content of social stories

No.	Learning targets	No. of sentences	Images	Responses
1	Children with ASC learn to solve social problems at **home**: how to handle a situation, which is not their own fault	10	Yes	a) stay calm b) explain to the parent what happened c) help parent to pick up the pieces of the broken vase
2	Children with ASC learn to solve social problems at **school**: how to handle a situation which is not their own fault	7	Yes	a) stay calm b) talk to teacher and inform her that he has difficulties with maths problems c) ask her to help him with maths problems
3	Children with ASC learn to solve social problems at **home**: how to handle a dilemma	8	Yes	a) stay calm b) tide up room c) go for a ride with his bike
4	Children with ASC learn to solve social problems at **school**: how to handle a situation in which they feel anger from their classmates	7	Yes	a) stay calm b) pick up the pieces of the broken pencils c) show extra care in keeping his pencils in his pencil case

difficulties with math problems. The boy had a math test and his teacher commented that his efforts were not enough. So the boy became angry. In the third SS, a child was faced with a dilemma: to do what his parents asked him to do (i.e., to tide up his room) or to follow his own desire/wish (i.e., to go for a ride with his bike). The last SS presented a school scenario, where a classmate accidentally broke down another child's favourite object (i.e., pencils) and as a consequence that child became angry and wanted to take revenge from his classmate. The solution to each social problem was presented in the same format of SS and included three steps: a) to stay calm, b) to explain to the other person, what he wanted to do or what is the right thing to do and c) to carry out the solution.

With respect/regard to the usage scenario, it refers to the support of problem solving through the projection of educational material. The educational intervention procedure is that in each session, a child with ASC will connect to the system from his/her own computer, and through his/her avatar will interact with the environment. A virtual teacher giving verbal instructions to him/her is also included in the application.

After logging into the virtual world, the child with ASC is instructed to follow a series of steps (Millen et al. 2010a) to complete the educational intervention. Specifically, s/he has to follow a route to enter the school premises/building, following the auxiliary arrows, in order to familiarize him/herself with the navigation arrows of the keyboard. The child also has to click on two doors to enter the school and the classroom respectively. At the end of this route, there is a realistic representation of a classroom with desks, chairs and an interactive whiteboard. S/he is asked to choose the chair with his/her name written on it and sit, using the mouse. Additionally, the virtual teacher gives precise verbal instructions about what s/he has to do and written signs are also displayed in the interactive whiteboard. A SS is presented on the interactive whiteboard followed by the sequence of steps

for solving the social problem. Next, the child listens to a similar SS, where s/he is asked to solve the problem by choosing the appropriate response amongst those displayed in random order. If the chosen response is the correct one, a rewarding (visual and auditory) message appears, otherwise a "help" message is displayed. This process is repeated until the child chooses the correct response for solving the social problem.

Moreover, the VLSS includes two levels of representation. The first level, targeting the familiarization with the functionalities of the application, includes an abstract representation of a typical school, showing only the items necessary for the children to focus on the demands and the process of the intervention. The second level is used during the training phase, where the school building remains the same but the exterior space has been properly designed to depict the best possible realistic representation of a school. The goal of this level is to facilitate children's understanding of the various social problems and extend their training in problem solving.

5 Method

5.1 Experimental design

The initial phase of the VLSS evaluation was conducted through expert users (43 special education teachers), so as to have an initial feedback before testing the system with specific users (children and adolescents with ASC) in specific educational settings. According to the literature review, expert-based and user-based evaluations are the most commonly applied methodologies. Expert-based evaluation is an inexpensive, quick and efficient formative evaluation method, which is mainly used on system prototypes. Similarly, user-based evaluation unveils problems of real users but is a costly method requiring representative users. The latter is quite difficult, as the proposed VLE was developed to support a special group of users (Karoulis et al. 2006). In the area of ASC and VLE, recent research has disclosed the tensions arising from the effort to integrate teachers' and children's views about the decision-making process for technology (Parsons and Cobb 2014). As a consequence, the pilot evaluation of the finished product was conducted by experts (in this case, professional special education teachers). All participants had long teaching experience with children with ASC, preferably with children with Asperger Syndrome or high functioning autism. High functioning autism and AS share similar cognitive characteristics, such normal IQ (>70), and therefore can benefit from similar educational approaches (Ozonoff et al. 2000). The reason why we targeted the VLSS at children with AS or high functioning autism was that it is oriented to enhance social problem solving skills in children with ASC. As a result, the application is more appropriate for these children who have the cognitive and motor skills to engage in social interaction with greater independence.

For the purposes of the study, the researcher arranged face to face meetings with the special education teachers. Through these meetings, special education teachers had the opportunity to practice using the application and discuss their queries with the researcher. For reasons of procedural reliability, the same procedure was followed with each participant: s/he had to use the VLE with all the functionalities such as chairs, doors and the interactive whiteboard. S/he also watched/heard the four SS and in the end, s/he chose the steps to solve the problem. This procedure lasted about 30–40′.

5.2 Instrument

A combination of qualitative and quantitative data was collected. In specific, a semi-structured interview was carried out with all participants, who also completed a questionnaire, tapping on their general views on the use and the effectiveness of VLSS.

The questionnaire (see Appendix) included thirty (n=30) statements/questions grouped into the following two thematic areas: a) usability of the VLSS and b) adequacy of the educational content for children with ASC. The development of the instrument was based on the Questionnaire for User Interface Satisfaction (Lund 2001). This instrument included all the statements apart from statements with the following numbers: 4,8,12,17,24,27,28,29 (http://hcibib.org/perlman/question.cgi?form=USE). In addition, some of its statements were drawn from a questionnaire, designed for the evaluation of educational content for individuals with ASC (Staikou 2008) and another instrument evaluating virtual metaphors and features within a 3D virtual world as well as measuring the important role of avatars (Terzidou 2009).

A range of response formats (5-point Likert type scale ranging from "1" for "Strongly Disagree" to "5" for "Strongly Agree", multiple choice and yes/no response format) was used in the instrument of the present study. All responses to the questionnaire were analysed using the Statistical Package for Social Sciences (SPSS, Version 20.0). Descriptive statistical analysis was applied to the responses of all statements/questions of this instrument. The reliability of the questionnaire was estimated as high (a=0.94).

5.3 Participants

In total, forty-three (n=43) special education teachers participated in the empirical evaluation of the application, which was carried out through the completion of an online questionnaire. The online questionnaires were fully completed by 40 (out of 43) experts. The sample was comprised of 11 men and 29 women. Also, 45 % (n=18) of the respondents had taught or worked with children with ASC for over 3 school years, while the remaining 55 % (n=22) had taught for less than 3 years. Besides, 45 % (n=18) of them had previous experience with virtual environments.

6 Results

The results for each statement are presented in the following Tables. More specifically, the statements referring to the usability of the VLSS are categorized into four groups: a) usefulness, b) ease of use, c) ease of learning and d) satisfaction (Lund 2001). End-users of the application are both teachers and students with ASC. For this reason, special education teachers were asked to answer the specific usability statements from their own point of view as users, but also from the point of view of students with ASC as potential users of the application (Table 3).

Table 4 presents the means and standard deviations for the statements, which referred to the important role that avatars play in the educational process (Terzidou 2009).

Table 5 contains statements which referred to the suitability and usefulness of specific SS (Staikou 2008).

Table 3 Usability of VLSS

	Teachers (n=40)							
	Own point of view				Their point of view for students' with ASC			
	Min	Max	M	SD	Min	Max	M	SD
Usefulness (**S1-S6**)	2	5	3.78	0.586	2	5	3.85	0.542
Ease of use (**S7-S15**)	2	5	4.02	0.633	2	5	3.66	0.706
Ease of learning (**S16-S19**)	3	5	4.39	0.513	3	5	3.92	0.653
Satisfaction (**S20-S22**)	2	5	4.08	0.643	2	5	3.94	0.667

The analysis of responses to the semi-structured interview revealed some significant and positive statements, such as "*the instructions were very comprehensible as they are implemented in both verbal and non-verbal way*" and that "*the VLSS was a very user-friendly environment*". Additionally, a special education teacher stated that "*I believe that the procedure for solving social problems presented on the whiteboard entails simple and small steps*".

However, participants mentioned some negative aspects of the VLSS. In specific, they mentioned that this version of the application provides only a limited number of SS (a sample of four SS) to teachers and children with ASC. A special education teacher elaborated on her reply by saying that "*I would prefer the VLSS to offer a rich database with SS, from which I could select SS, according to the child's needs*". Finally, another expert emphasised that "*The development of prerequisite skills, such as repeated practice, is very important and valuable. In order to achieve that, it would be necessary to perform many repetitions and frequent practice with SS in a variety of topics and graduated levels of difficulty*".

7 Discussion

The purpose of the present study was to examine whether VLSS has the potential to be a useful and easy-to-use educational tool for teaching social problem solving to children with ASC. The specific questions are presented below:

RQ1. How do special education teachers evaluate the usability of the environment based on VLE and SS for children with ASC?

Table 4 Avatars' importance

	Teachers (n=40)			
	Min	Max	M	SD
S23. The realistic representation of students with ASC through an avatar is very important	3	5	4.08	0.656
S24. The presence of avatars motivates the participation in activity	3	5	4.13	0.563

Table 5 Adequacy of the SS' educational content

	Teachers (n=40)			
	Min	Max	M	SD
S25. SS provide logical sequence and an escalating degree of difficulty in a helpful format for students with ASC	2	5	3.63	0.705
S26. The interaction is suitable with the motor and cognitive level of students with ASC	2	5	3.73	0.599
S27. The feedback is constructive and appropriate to the students with ASC	2	5	4.05	0.597
S28. The design and the presentation of SS should attract the attention of students with ASC	2	5	3.73	0.716
S29. The design of SS would overload the memory of students with ASC	2	4	2.73	0.847
S30. The presentation of SS is "simple" in the sense that it displays only the required information	2	5	3.78	0.660

In general, our findings indicated that the level of the environment's usability was evaluated as high. The usefulness referring to teachers (M=3.78, SD=0.586) and to experts' opinion on whether students with ASC could use the VLSS (M=3.85, SD=0.586) were quite high. For example, the majority of special education teachers supported that VLE could help teachers (77.5 %, n=31) and students with ASC (82.5 %, n=33) to be more efficient. This finding is consistent with previous research (Mitchell et al. 2007; Tartaro and Cassell 2006), which indicated that VLE can contribute to the effectiveness of learning of students with ASC.

With respect to the easiness of use, the values were also high for both end-users; teachers' views of themselves (M=4.02, SD=0.633) and as experts presenting their point of view of students with ASC (M=3.66, SD=0.706). In other words, most of the teachers considered that the VLSS is easy to use for teachers (97.5 %, n=39) and for students with ASC (75 %, n=30). This is further reinforced by the instructional design which was followed, according to the literature review, by providing spacious virtual space for ease of navigation (Cobb et al. 2002) and realistic representations of objects (Parsons et al. 2004). Moreover, auxiliary arrows, audio messages, written signs, etc. were used to attract students' attention and to provide them with sufficient guidance (Doyle and Arnedillo-Sánchez 2011). Special education teachers agreed that teachers (72.5 %, n=29) and students with ASC (52.5 %, n=21) could correct quickly and easily their mistakes. Finally, teachers considered that both themselves (97.5 %, n=39) and students with ASC as other potential users (90 %, n=36) could use the VLE successfully every time.

The easiness of learning was found at high level for teachers (M=4.39, SD=0.513) and students with ASC (M=3.92, SD=0.653), according to experts' opinion. Teachers supported that teachers (97.5 %, n=39) and students with ASC (77.5 %, n=31) could learn to use the VLE quickly and that teachers (100 %, n=40) and students with ASC (67.5 %, n=27) could easily remember how to use it.

Finally, the level of satisfaction was also quite high for teachers (M=4.08, SD=0.643) and from their point of view for students with ASC (M=3.94, SD=0.667).

Teachers considered that the VLE could be pleasant to use for teachers (85 %, n=34) and for students with ASC (77.5 %, n=31).

The aforementioned findings, confirmed that students with ASC can make errors with the VLSS without confronting the unforeseen results and as a result VLSS can provide a stable and secure environment for them (Bosseler and Massaro 2003; Dautenhahn 2000; Strickland 1997).

RQ1.1. How do special education teachers evaluate the role of avatars in the educational process for children with ASC?

According to relevant research (Cheng and Ye 2010; Grynszpan et al. 2011, 2012), the avatars' representation can play an important role to children with ASC. For this reason, this study further examines the use and the importance of the avatars. The majority of teachers (82.5 %, n=33) supported that the realistic representation of children with ASC through an avatar is very important as well as that the presence of avatars could motivate the participation in an activity (90 %, n=36). Moreover, virtual agents can play a vital role in VLE, as they can respond consistently and predictably, encouraging children when they make mistakes and reducing their stress (Milne et al. 2010).

RQ2. What is the view of special education teachers about the suitability and usefulness of the specific SS for teaching social problem skills to students with ASC?

In general, the levels of suitability and usefulness of specific SS have been also evaluated as quite high. The majority of teachers (70 %, n=28) considered that SS provide a smooth transition of a general to a specific presentation of a subject (Moore et al. 2000) with an escalating degree of difficulty (Parsons et al. 2004), which is helpful for children with ASC. Teachers (90 %, n=36) agreed that the feedback was constructive and appropriate for the children with ASC. Furthermore, teachers (67.5 %, n=27) supported that the design and the presentation of SS could attract the attention of children with ASC as well as (80 %, n=32) that the presentation of SS is "simple" in the sense that it displays only the required information. However, only a small proportion of teachers (25.5 %, n=10) agreed that the design of SS would be overloading for the memory of children with ASC. This can be explained by the fact that the presentation did not convey any difficult or confusing messages (Milne et al. 2010).

8 Conclusions and future work

This paper investigates the use of Social Stories through VLEs for assisting students with ASC in social problem solving tasks through the use of special education teachers as one group of expert users. Our decision to examine teachers' views was informed by the reflections of other researchers (Parsons and Cobb 2014), who emphasized the

important challenges raised by the engagement of different groups of users (such as professional teachers and children with ASC) in the design and development of a collaborative VE, as a means for achieving ethical and epistemological objectives related with collaboration and empowered decision-making. Our project has been research-driven, in the sense that we aimed to evaluate a research outcome through a group of expert users, in alignment with our agenda for a strong social justice agenda. Our project has not been a research exercise, but rather a project to create a VLE which would be useable and available for schools, with the expectation that it would help students with ASC and their teachers to attain social problem solving goals. With this thinking framework, the initial expert-based evaluation was aimed at professional teachers and it is very positive that it generated optimistic results. The VLSS prototype n is perceived as appropriate by professional teachers, who agreed that the Social Stories followed a logical sequence and provided appropriate feedback to students. Moreover, they perceived that VLSS can motivate students with ASC to participate with enthusiasm and enjoyment, especially when appropriate avatars are used. These findings are encouraging that the participation of students with ASC, as another group of experts, to the evaluation of this research outcome will yield interesting insights before its final application in classrooms. This line of enquiry would contribute to the emerging discussion on the inclusivity of users in the development of collaborative virtual technology for children with ASC. This area is relatively new and it is not yet clear who could/should advise on the use of this type of technology or the timing for seeking these views (Parsons and Cobb 2014).

In conclusion, our findings hold promise for the use of Social Stories in VLEs for teaching social problem solving to students with ASC. If a VLE is designed after consultation with special education teachers, the flexibility and adaptability offered by VLEs can increasingly benefit children with ASC (Cobb et al. 2002). Furthermore, our project can assist researchers in the integration of evidence-based strategies (such as Social Stories) into VLE applications for the development of social communication skills. Considering that researchers so far continue to adapt and develop the VLEs with greater sophistication for students with ASC, while also recommending the use of VLEs in combination with other teacher methodologies, our project attempts to address these issues offering empirical evidence for the novel combination of SS and VLEs. It became evident that exploring the views of teachers, as primary facilitators in the use of VLEs by children with ASC, has served well the purpose of improving the design features of this application before its pilot application with real users.

Our future work involves the in situ evaluation of VLSS with students with ASC in real educational settings. Our first attempt falls in the area of science education, and is currently under evaluation with two adolescents with ASC. We are also planning a follow up and longitudinal intervention, which would generate valuable insights into the learning gains of children with ASC with respect to VLSS over time (Irish 2013).

Acknowledgments We wish to thank all special education teachers who took part in this study. This study would not have been made possible without their valuable contribution.

Appendix

		Teachers' own point of view					Teachers' point of view for students' with ASC				
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	Usefulness										
S1.	It helps user be more effective										
S2.	It helps user be more productive										
S3.	It is useful										
S4.	It makes the things user wants to accomplish easier to get done										
S5.	It saves user's time when he use it										
S6.	It meets user's needs										
	Ease of use										
S7.	It is easy to use										
S8.	It is simple to use										
S9.	It is user friendly										
S10.	It is flexible										
S11.	Using it is effortless										
S12.	User can use it without written instructions										
S13.	User doesn't notice any inconsistencies as he uses it										
S14.	User can recover from mistakes quickly and easily										
S15.	User can use it successfully every time										
	Ease of learning										
S16.	User learned to use it quickly										
S17.	User easily remembers how to use it										

	Teachers' own point of view					Teachers' point of view for students' with ASC				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
S18. It is easy to learn to use it										
S19. User quickly became skilful with it										
Satisfaction										
S20. User would recommend it to a friend.										
S21. It is fun to use										
S22. It is pleasant to use										
S23. The realistic representation of students with ASC through an avatar is very important										
S24. The presence of avatars motivates the user's participation in activity										
S25. SS provide logical sequence and an escalating degree of difficulty in a helpful format for students with ASC										
S26. The interaction is suitable with the motor and cognitive level of students with ASC										
S27. The feedback is constructive and appropriate to the students with ASC										
S28. The design and the presentation of SS should attract the attention of students with ASC										
S29. The design of SS would overload the memory of students with ASC										
S30. The presentation of SS is "simple" in the sense that it displays only the required information										

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