Participatory design with children with autism

L Millen, S V G Cobb, H Patel

VIRART, Human Factors Research Group, University of Nottingham,
University Park, Nottingham, UK

{emxlm; sue.cobb; harshada.patel}@nottingham.ac.uk

www.virart.nottingham.ac.uk

ABSTRACT

The COSPATIAL (Communication and social participation: collaborative technologies for interaction and learning) project explores how we can develop effective and useful educational technologies in the form of shared active surfaces (SAS) and collaborative virtual environments (CVEs) to support the enhancement of social skills for children on the autism spectrum. The UK design team comprises technology developers, design engineers, educational psychologists as well as teachers from both mainstream and autism specialist schools. A user centred design approach is used to make decisions and review prototype development using CVE technology. The team is then involved in detailed specification of CVE scenarios and iterative review of prototypes. The involvement of teachers throughout the entire process is crucial, but in order to understand the primary user further and implement concepts optimally it is also desirable to involve the target end users directly in the design process. This paper describes the participatory design approach for elicitation of user requirements and CVE scenario design that is being used with typically developing children and how these methods have been adapted to facilitate involvement of children on the autism spectrum.

1. INTRODUCTION

Participatory design methods using a range of techniques have been successfully applied to workspace design and to the development of new technologies in industrial settings (Wilson et al., 2009). At the start of the participatory design process for new technologies in industrial settings, we have found it useful to generate participant enthusiasm and creativity through demonstrations of existing systems. This facilitates discussion, particularly amongst users who are unfamiliar with new technologies and their potential uses (Wilson et al., 2009). A variety of techniques are then used to provide information about user needs and requirements, and to generate and evaluate ideas for new technology design. Techniques used with adults in industrial settings include questionnaires, interviews, task analysis, observation, brainstorming, focus groups, storyboarding, technology demonstrations, exploratory user tests, and Wizard of Oz prototype review. In these contexts we have also found it useful to develop current practice scenarios and conceptual futuristic scenarios, use cases, and have produced detailed user requirements for prioritisation with the end users (Patel et al., 2006a; Patel et al., 2006b; Wilson et al., 2009). Our approach has always involved building close relations with the user partners, establishing who the stakeholders are and gaining an understanding of the contexts and skills to be investigated. The key has been to involve the users as much as is feasible, from concept design through to implementation of the technology.

In the context of education, there has been some discussion concerning the role that children are can take to inform design of instructional technology (Scaife and Rogers, 1999). Druin (2002) categorised the involvement of children in the design process of technology applications according to different roles, as: users, testers, informants or design partners and described how methods could be adapted to glean useful information from children of all ages to inform technology design (Druin et al, 1999). There are several examples of direct involvement of school children in the design process for development of new technologies (e.g. KIDSTORY: Druin et al., 2000) and these projects have made use of prototyping methods (such as building low tech mock-ups) to obtain children's design ideas and Wizard of Oz methods to facilitate review of potential design. Other researchers have moved from concentrating solely on children's involvement as design partners in the development of technology, to their role as 'experience design partners'. This considers the broader educational impact of the involvement of children in the design process. For example, the improvement in collaboration skills and goal orientated attitudes and critical thinking; and the transfer of skills and knowledge to new technological contexts (Garzotto, 2008).

The involvement of end-users directly in the design process can be useful to inform adequate design and it can be argued that it is more important for individuals with special needs to contribute to the product design process as advocates may not accurately represent their views (Fischer & Sullivan, 2002). However, this process can be difficult, particularly when the end-users have special needs that may affect their ability to communicate their views. The challenge of finding suitable methods for design input may be off-putting. Parsons and Mitchell (2002) note that individuals with autism are rarely involved in educational software development and this may be one reason why existing products are inadequate; '*User-centred design methodologies…address this concern somewhat because representative users are included in product design and development from the start*' (Parsons & Mitchell, 2002. P. 437).

Cobb et al (2002) describe the benefit of involving user representatives and professionals in the early conceptualisation stages of virtual environment development and recognised that different stakeholders inform different aspects of technology design; professionals (teachers) can help to define the purpose of the application and specification of learning objectives whereas end-user representatives provide an understanding of specific needs and requirements of the user group. Review of contribution to final prototype indicated that, although end users may be involved in idea-generation, they have less influence over final decisions for content of educational software (Neale, Cobb and Wilson, 2001). Users can, however, be directly involved in usability design decisions influencing interface design, content layout and interaction with a virtual environment learning scenario (Neale, Cobb and Wilson, 2002), Techniques for design input from different stakeholders are different at each stage of development and may need to be adapted to best elicit information from the end-user group. The 'inclusive design toolbox' for development of educational virtual environments describes different prototyping techniques and how these may be applied with different user groups to inform different aspects of software design (Neale, Cobb and Kerr, 2003).

Brown et al. (in press) involved stakeholders and user representatives during the analysis phase of their project which aimed to design location-based learning experiences for people with intellectual disabilities and additional sensory impairments. The design requirements derived from this early user participation were presented as conceptual storyboards displayed on an interactive whiteboard; groups of users provided feedback on these storyboards and initial prototypes were evaluated in facilitated user group sessions. At a later stage, a co-discovery method was employed with pairs of users to test the prototype system; this method collects information in real-time and may be suited to users with cognitive disabilities who may feel more comfortable working with a peer (Brown et al., in press).

Lalji and Good (2008) designed mobile phone interfaces for illiterate populations through a continuous partnership with the end user population, investigating their worlds, relationships and concerns and the context of the technology use. Non-typical users may have different interaction requirements and expectations of the technology, therefore it is important for their inclusion in the design process. User needs were elicited through the use of questionnaires, interviews, an exploration exercise (they were asked to make a dummy call using a landline), and participatory design sessions (participants were asked to draw menu icons). Lalji and Good adopted an iterative design and testing process by employing the use of questioning and probing, participatory design and testing of hardboard model prototypes which included the use of the 'think aloud' technique.

This paper presents the participatory design approach used for design and review of the COSPATIAL CVE scenarios. In particular, this paper focuses on methods used for participatory design with typically developing children and adaptations to these methods for children with autism spectrum conditions (ASC).

2. PARTICIPATORY DESIGN WITH CHILDREN

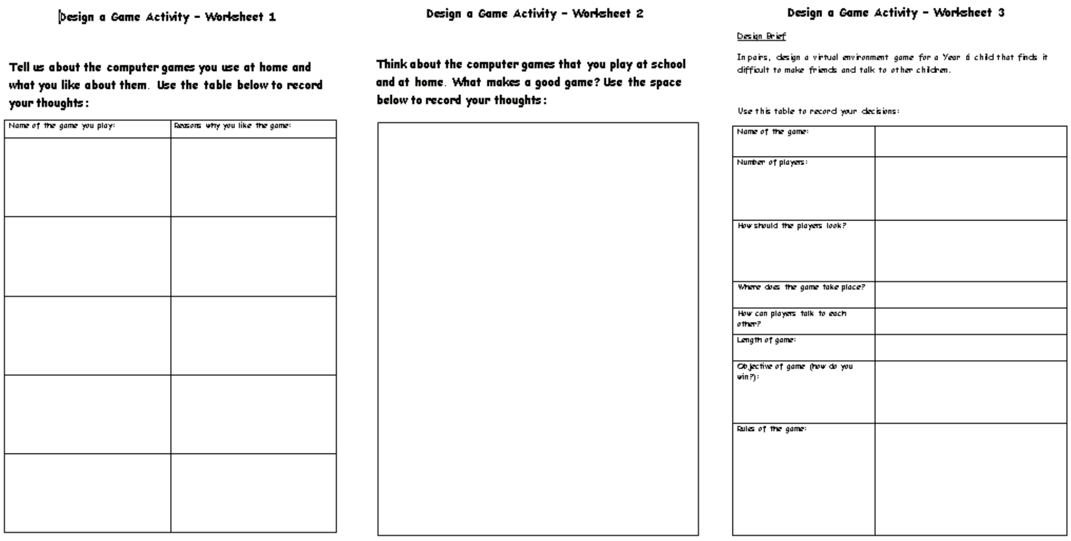
2.1 Introduction

As part of the COSPATIAL project we are developing a suite of programs using for collaborative interaction using CVE technology. The first in this series is a serious game called Block Party; a joint problem-solving, block building activity where each player has different but interdependent objectives to achieve. To complete the activity, children are paired with a peer and both access the same virtual environment from different laptops. The users are able to communicate with each other via their avatars. The Block Party task involves the children building a tower together out of blocks in the virtual environment. Each block is divided down the centre into two colours and child has a different target colour pattern that they have to achieve. In order to complete the task they therefore need to communicate with each other in order to jointly select a block with the colour combination that suits both of their needs.

In order to evaluate both the learning potential and usability of the scenario a number of prototype review and scenario design sessions were arranged with typically developing children at a mainstream school. Six Primary School children (2 x 10 year olds, 4 x 11 year olds) took part in a 3-hour design workshop. This process would help us evaluate the usability of the prototype and enable us to trial and evaluate prototype review and scenario design methods try to understand implications for use with students with autism.

2.2 Critical review of prototype software

During these workshop sessions the students were encouraged to become critical testers and evaluators and they were briefed on the nature of design and prototyping. This discussion focused on the imperfections associated with prototypes and our requirement for, and the importance of, their critical feedback. In these situations, researchers and teachers must emphasise that children can be honest and should not tell us what they think we want to hear.



Design a Game Activity – Worksheet 1

Tell us about the computer games you use at home and what you like about them. Use the table below to record your thoughts:

Name of the game you play:	Reasons why you like the game:

Design a Game Activity – Worksheet 2

Think about the computer games that you play at school and at home. What makes a good game? Use the space below to record your thoughts:

Design a Game Activity – Worksheet 3

Design Brief

In pairs, design a virtual environment game for a Year 6 child that finds it difficult to make friends and talk to other children.

Use this table to record your decisions:

Name of the game:	
Number of players:	
How should the players look?	
Where does the game take place?	
How can players talk to each other?	
Length of game:	
Objective of game (how do you win?):	
Rules of the game:	

Figure 1. *Worksheets used in design workshop with typically developing children.*

The first task was to discuss in groups the computer games they use at home and what they like about them. The students were asked to record their responses on 'Worksheet 1' (Fig. 1). There were a variety of responses, e.g. "competing against friends", "never know what's going to happen next", "makes you think", "you get to design your own character". The discussion then moved on to 'Worksheet 2' (Fig. 1) and focused on what makes a good game Some responses to this included the use of colours, levels, rewards, tool bars, having a save button and many more ideas.

In order for the children to understand the type of technology the COSPATIAL project is using, a demonstration of the Block Party prototype was given. The children were encouraged to interact with the prototype and discuss positive and negative aspects of the game as they proceeded. The whole group then had a discussion to feedback their ideas and thoughts on the prototype. The teacher recorded their responses under the headings 'Like', 'Dislike' and 'Change'.

2.3 Scenario design

In the final stage of the session the students were set the task of developing their own ideas to design a computer game (Fig. 1 – worksheet 3). The students were provided with a design brief in which they were informed that they would be designing a game that would encourage a 12 year old child who finds it difficult to make friends to communicate with other children. To do this the students worked in small groups and completed a worksheet that detailed aspects of the game such as the aim, number of players and the rules. The students then went on to draw their game ideas on to large sheets of blank paper. The students were instructed to draw any part of their game ideas on the paper – this could be individual aspects such as how the avatars look or the whole game environment.

2.4 Observations and outcomes

The workshop activity session provided some fruitful discussion about what the students liked and disliked about various games. The children were actively engaged with each aspect of the afternoon and the ideas generated were many and varied. However, it became clear during the session that the scenario design task was fairly open-ended, the spectrum of ideas was vast. Students often had to be reminded of the overall aim of the computer game as their imaginations took them in many different directions. In some areas the activity was not constrained enough to gain information that could be directly fed back into concept elaboration.

3. ADAPTATION OF PARTICIPATORY DESIGN METHODS FOR CHILDREN WITH ASC

As one of the primary end users of the COSPATIAL technology, we want to also gain the input of students with autism spectrum conditions. The nature of autism presents particular difficulties with regard to idea generation and communication that could prohibit direct involvement of these children in the participatory design process. Taking into account specific characteristics of autism, and with advice from autism teachers, we adapted the participatory design workshop method described in the previous section to see if we could successfully involve children with autism in design and critical evaluation of the CVE scenarios.

3.1 Understanding user needs

Children with autism have a number of cognitive characteristics which may have implications when seeking to achieve user involvement with the design process (Hardy *et al*., 2002; Wing & Gould, 1979; Wing, 1996; Siegel, 2003; Baron-Cohen, 1996). These are summarised below (extracted from Millen et al, 2010. P. 153-154):-

- *limited language or communication skills* – this characteristic requires a considered approach when trying to involve the user in the process, particularly when attempting to generate and evaluate design ideas and eliciting user opinion;
- *poor imaginative skills* – this could cause potential difficulties, for example, when using low fidelity prototyping which requires the user to use their imagination skills to envisage the final product;
- *rigidity of thought processes* - People with autism find it difficult to be flexible in their thought processes and thus any changes to their environment or routine can prove difficult for them to understand or adapt to. This has implications for arranging sessions and disrupting routines;
- *"Theory of Mind" impairment*: the idea that people with autism often find it difficult or impossible to imagine another person's mental state and perspective – this poses the issue of whether a child with autism would be able to offer opinions based on their knowledge of their peers;
- *learning difficulties* – IQ or general level of ability or understanding may not be sufficient when dealing with the concepts required.

3.2 Adaptation of method

The freedom given to the typically developing students in the 'design a game' activity meant that they often forgot that the purpose of the game should be to encourage children to make friends. Observations of the mainstream school workshop, together with our prior knowledge about autism, led us to realise that this format would be far from ideal for students on the autism spectrum. The task should be more constrained and focused in order to encourage students with autism to participate, engage and benefit from the activity. Children with autism benefit from structured environments and activities. When presented with too many open-ended options the child may feel anxious or frustrated and becoming unwilling to participate in the activity. Clearly then, presenting a child with autism with a blank sheet of A2 paper and asking them to come up with computer game ideas is not an option.

In order to adapt the methodology to achieve this, the researcher met with an ICT specialist teacher with many years of experience of working with students with autism. This teacher also played an important role in developing a prototype feedback system to be used with students with autism. The format was later discussed further with a nurture teacher with numerous years of experience of working with children with communication difficulties and an autism specialist teacher from a mainstream school.

3.3 Prototype review with ASC

A Block Party review session was carried out with five students (16 and 17 years old) with autism spectrum conditions. This took place during the students' weekly ICT class and was facilitated by their ICT teacher. It was decided that the review of the prototype should be carried out as a group activity and would focus only on the initial training stage of the activity.

The Block Party training scenario was projected via the interactive whiteboard in the classroom so that the whole group could see it. A keyboard and a mouse were connected to the laptop with an extension cable so that all students could have a turn to interact with the CVE from their seats. Each student was provided a feedback sheet that contained screenshots of various stages of the Block Party activity alongside columns that were headed 'Like', 'Dislike' and 'Not sure'. Feedback posters were placed on the wall next to the whiteboard – these were enlarged replicas of the individual feedback sheets (Fig. 3). These posters were used to collect the feedback from the whole group and were annotated by one student at a time with everyone's responses.

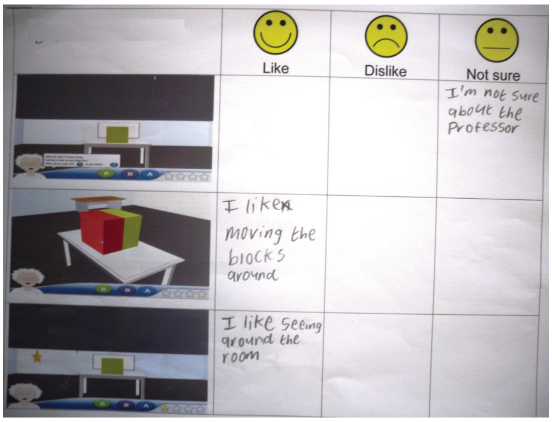


Figure 2. *Individual feedback worksheets used in prototype review with students with ASCs.*

The group played the training program by taking it in turns to take control or by suggesting to the teacher what action they should do next. At various stages the teacher paused the program and asked the group what they thought of the stage that they had just completed. These pauses corresponded to the screen shots on the feedback sheets. The students recorded their answers on their individual feedback sheets initially. The students were encouraged to provide both positive and negative comments down and were reassured that there was "no right answer". Some students may not have included comments but were not penalised for this as, for students with ASCs, a task requiring them to provide opinions and feedback is one that can be very difficult. Having said that, all of the students engaged very well with the activity and provided us with some interesting feedback. One student was then asked if they would record the group's comments on the posters.

3.4 Observations and outcomes

Overall the method used in this session was very successful. The session was sufficiently structured and supported by the teacher to meet the needs of students with ASCs. In fact, this method may be useful in gaining structured feedback from students in mainstream schools. The teacher stated that he thought the session documented here was successful due to the support provided in the previous introductory session. On the whole, the students navigated the virtual environment with ease and all of the students also said that they enjoyed the session and would like to play Block Party again.

One student struggled with a slight inconsistency between the screenshot on the worksheet and the actual view that the program had been paused at. In terms of method, it is important that worksheets and learning materials are consistent and accurate as students with autism are likely to pick up on the minor inconsistencies and struggle with them.

Although the session did highlight the fact that children with autism often pick up on very small inconsistencies that could cause problems, with the help and support of an experienced teacher these occurrences can be effectively managed and explained to the student. Time was spent in explaining to the students that the program was not finished and the person making the technology at the university wanted to know what they thought of it. Of course, ideally there would be no inconsistencies or problems within the program when demonstrating / using with students with ASCs. However, this session does suggest that holding these sessions with early, unfinished prototypes can be carefully and effectively managed.

3.5 Scenario design with ASC

The overall concept was the same as that used in the mainstream school 'design a game' activity. The activity was designed to be used by a researcher and a small number of students (two or three) with a teacher present. To aid understanding we hoped to support a progressive pattern of thinking that reflects the core components

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of the task. The activity was divided into six main sections (presented in Table 1). This structure encourages children to first think about the types of computer games that are available to them. They then proceed to consider what aspects of these games they like and dislike and subsequently they are asked to start generating computer game design ideas. The children and researcher talk together about what friends are and what makes a good friend, finishing the section by talking about why we might want to play computer games with our friends. The final two sections focus on designing a game. The children are asked to generate ideas for different aspects of game play and are then encouraged to draw some of these ideas.

The importance of flexibility is often highlighted when working with students with autism and is certainly a common theme in previous work that the authors have carried out on development of technology for children with autism. Consequently, although it is imperative that researchers approach these sessions organised and well prepared, there should always be an awareness that the method may need to change at short notice. For example, a session may need to be cut short due to the needs and attention span of the child or simply because the child may have experienced something upsetting that day and therefore unwilling to cooperate. Additionally, as the autism condition is a spectrum, the abilities of children with ASCs varies a vast amount and therefore the methods presented here may not be ability appropriate. The optimal way to respond to this is to always discuss and adapt plans with the school contact prior to the visit. The teacher should be able to indicate whether the activity is appropriate for the student and if it is not, how it can be made appropriate. Clearly, if a method is not working on the day the researcher must try to facilitate this process. This can be supported effectively if the student's teacher is present and active in the session.

3.6 Observations and outcomes

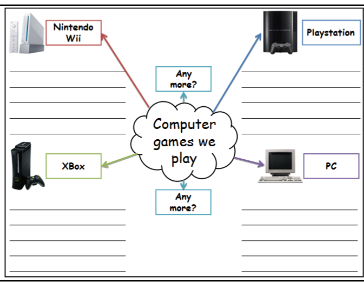
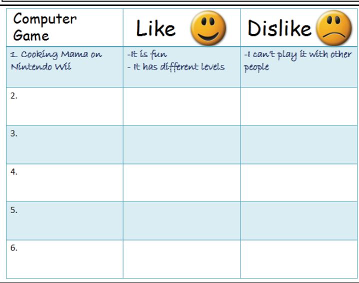
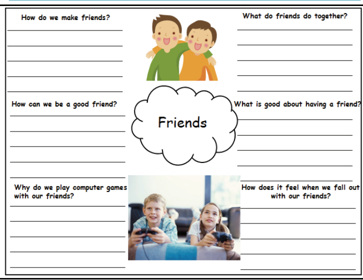
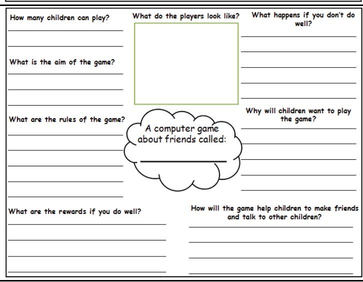
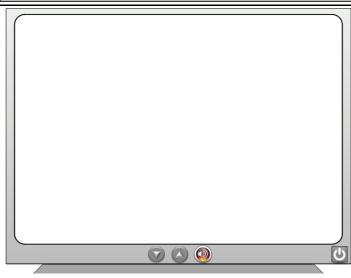
The scenario design method was trialled with three students with autism aged 13 and 14 years who are based at a mainstream secondary school. The activity was well received by the students who engaged in the session for approximately two hours. The session followed the pre-planned activity progression, however, the students had trialled our Block Party scenario during the previous day but did not have time to complete our student feedback form so this was completed at the start of the design a game session. It was originally anticipated that the activity would last only one hour but as the students were enjoying the activity the supervising teacher asked if we could continue on.

Although the teacher was close by and intermittently came to check on progress, the session was run by the researcher. The researcher had only met the students once the day before but this did not result in any problems and the students were happy to work and interact with the researcher. This is a huge advantage as in 'real world' research, and especially when working within the constraints of the school environment, there is often a shortage of time available for researcher acceptance and familiarity. Overall, the teacher was very impressed by the work carried out by the students. Initially, discussion was a little hard to generate but when presented with the drawing task the students became much more involved. One student in particular who is usually reluctant to engage in conversation was voicing extremely interesting ideas towards the end of the session.

The use of personas had mixed results. Their presentation and content generated some discussion on who the characters were and the issues they struggled with and therefore proved beneficial in this sense. It is not clear whether the students held the personas in mind when engaging in the design task as the students did not refer to them. There was a little confusion regarding what the personas represented. When informed that the group would be designing the game for these fictional children, one student commented such 'But why? They're just on paper'. This is clearly an imagination related obstacle that needs more consideration. Another student commented 'Are they real people? Are we going to meet them?'. At this stage the teacher was present to help to clarify the concept and explained that these children were not real, but examples, however there are many children in the world who are like the examples that we are designing for. The use of this tool needs further consideration.

The researcher began this activity by asking the students to complete the 'Design a Game' mind map. Although this was a structured activity that focused on specific aspects of a game, the decision space for the students was still too vast and relied heavily on the use of imagination. With the students struggling to complete this work, the group took a break and returned to complete the final interface design drawing activity. Upon return, and as somewhat expected, the students were a little unsure about what they should draw on their blank paper. During the break the researcher sketched an example of a completed activity, a 'here's one I made earlier' prompt (as advocated for children with autism by Worth, 2005) in anticipation of this. This sketch was shown to the students along with an early prototype sketch of the Block Party game that they had played the previous day. The researcher explained the design process and that the group needed to draw their ideas so that the developer at the university could see them and use them for the new game (although, see section below on managing expectations). Although this seemed to clarify the task for the students there was still a reluctance to put pen to paper. For this reason the researcher offered to start the drawing off for them and was met with enthusiastic nods. The students requested that the game be set in a city and therefore the researcher sketched an outline of some tall buildings. This process engaged the students and they soon became happy to take over the drawing. Sometimes a student would complain that they could not draw something they way they wanted to and the researcher would step in. The students stayed on task for a full two hours and only needed gentle reminders of who the game was to be designed for a why. This is in contrast to the typically developing students at the mainstream school who needed many reminders of this.

Table 1. *Structure of workshop activities with ASC students.*

Activity	Worksheet	Description
1. Introduction to session	Visual timetable of activities	The researcher described the activities that would be conducted during the session. The timetable was displayed on the wall and activities were crossed off as each one was completed.
2. What computer games do we play?		A group discussion about the computer games that the children play at home and at school. Mind maps were used as part of this methodology as children with ASCs are often visual thinkers. A pre-prepared template was used to help the student understand what was expected of them – how much to write, where to write it and what to write about.
3. What do we like and dislike about the games we play?		The students were asked to choose five games from the previous activity and to think about their likes and dislikes for each game. To facilitate and prompt this, an example completed row has been provided. To end this activity, the researcher reviewed the answers with the students and prompted a discussion on what makes a good or bad game.
4. Friends		This activity focuses on friends and friendship as this is what we would like the students to base their ideas for a new game on. To facilitate this, a series of photographs were shown to the participants and they were asked to discuss whether the children in the photographs were friends or not, and why they thought this.
5. Design a game		The students were asked to design a computer game for other children to play. To do this they had to consider who the game was for, why someone would want to play it, what the game rules would be etc. To support this activity, simplified personas were used.
6. Interface design		In the final activity the students were asked to draw some of their game ideas from the previous stage. The students then drew their ideas directly on to the screen so that it represents how they would like the game to look. Students with ASCs may feel somewhat distressed by being presented with a completely blank sheet of paper (Worth, 2005) and therefore the outline of the computer screen is an attempt to place boundaries on the task.

A number of interesting interface ideas were proposed by the group and after the drawing activity was complete the students were able to return to the previous, part-completed mind map and fill in the blanks. The researcher observed that, once started, the students were motivated by their own drawings and this created a domino-like effect of ideas. This meant that questions such as 'Why would children want to play the game?' and 'What happens if you do well?' were easy to answer subsequent to drawing activity. Perhaps this could be attributed to the tendency of children with ASCs to be much more visual learners and thinkers (Grandin, 2002).

In brief, this method is considered a success for a number of reasons including the depth of understanding of the task at hand, the quality of ideas generated by the students and the length of time spent on-task. However, issues such as the use of personas, the length of the activity and the large design-decision space presented need further consideration. These issues will be discussed further with the design team including teachers involved with the project. An alternative method could require students to design a specific and constrained aspect of the new CVE scenario e.g. what the avatars should look like, or how to present specific menus and toolbars. This will be investigated in upcoming sessions.

4. CONCLUSIONS

Involving users throughout the technology design process is important and useful. However few projects have involved children with ASCs. There are a number of established methods for involving adult users in the design process but there is little in the way of guidance for including users with such specific needs. The work reported here demonstrates that achieving the involvement of children with ASCs requires careful consideration and adaptation of techniques. Children with autism should not be excluded from the design process because of this and the early trials of our methods show positive results. The users are able to offer valuable insights into the design and evaluation of CVE technology. Not only is this process beneficial for us as a design team but it is also an important opportunity for the children where they are encouraged to voice their opinions, a skill that many children with autism struggle with. Many of the teachers who have been involved in COSPATIAL work have commented that the design sessions held have been hugely beneficial for the children.

Early work indicates that some of the methods used have potential when including children with ASCs in the design process. However, the methods are far from perfect and one of the biggest challenges for the involvement of users with autism in design their poor imagination skills. Future work will therefore aim to refine these methods. Other methods such as storyboarding and 3D low fidelity prototyping will also be investigated and evaluated for use with this user group.

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