Exploring the role of virtual environments in the special needs classroom

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ABSTRACT

A series of Virtual Environments (VEs), specifically designed to allow adolescents and adults with high-functioning autism and Asperger Syndrome to practice social skills, have been trialled in a school for students with autistic spectrum disorders. We have taken a qualitative approach to exploring how these programmes might be used to augment traditional teaching practices in a real school. By configuring the VR hardware in different ways and using the programs with various student-teacher combinations we have been able to observe how the VEs are used and to make recommendations as to how they may be modified so they better support teachers and students needs.

1. INTRODUCTION

The AS Interactive project has developed a series of Virtual Environments (VEs) with an ultimate aim of using them to support social skills teaching for people with autistic spectrum disorders (ASDs) (Parsons et al., 2000). We are primarily focusing on adolescents and adults at the high-functioning end of this spectrum, with high-functioning autism (HFA) and Asperger Syndrome (AS) who have the core autistic deficits in their social, communicative and imaginative abilities (Wing, 1996), yet have no additional learning disabilities. Although they may manage to cope well with many aspects of everyday life, significant impairments in social understanding may lead to exclusion from many aspects of society.

Difficulties are faced in trying to *teach* social skills, something that the rest of us pick up from our everyday real world experiences and generalise from one situation to another, meaning that there are few existing materials available for teaching these skills. As VEs have been shown to be successful for teaching spatial skills (Stanton, 1998) and procedural skills (Cobb, Neale, & Reynolds, 1998; Mendozzi et al., 2000) the AS Interactive project aims to explore what role VEs may take in social skills training.

VR is considered to have great potential as an educational tool and has been judged to be an excellent medium for implicit experiential learning, yet caution has been expressed as to how this style of learning might impact on the conceptual understanding and memory of its users (Machamer & Osbeck, 2000). This has led to the recommendation that VEs should be designed to include breaks of presence, so that the learner might reflect on what they have just learnt (Fencott, 1999; Waterworth & Waterworth, 2000; Whitelock & Jelfs, 1999) or that VEs should be implemented alongside more traditional methods to facilitate the conceptual learning (Bowman, Hodges, Allison, & Wineman, 1999; Crosier, 2000).

We agree with this view, and believe that VEs will only foster learning if used in combination with existing teaching methods, drawing on the strengths of both; it is therefore necessary to examine how these environments can be used in real training situations. We can then use data gathered from these settings to modify VEs so that they better meet user needs.

We suspect that the effectiveness of VEs in teaching people with ASDs will be as a tool to engage the user in a realistic active learning environment and as a motivating visual prop used to focus the attentions of a group of users on a specific social skills issue. The following sections describe our approach to introducing VEs for teaching social skills into a special needs school, our observations from this, and recommendations for VE design modifications to address the needs arising from real training situations.

2. OBSERVING VE USE IN SCHOOLS

2.1 Aims and objectives

We have examined the use of two VEs in a school for students with ASDs. The overall objective was to enable the teachers to use the VEs in different ways, with various hardware and software configurations, in order to examine how teachers may support VE use and conceptual understanding and to identify how the VE might be improved to better support these reflective practices. Alongside this was the ongoing collection of information about the utility and usability of the programs, which allowed regular modifications and improvements to be made.

2.2 Learning environments

Our intended end-user group are adolescents and adults and we understand that these VEs would be primarily used in 'social groups', schools and colleges. To ensure that the VEs developed are appropriate for these user populations an iterative process of 'user-centred design' is being conducted. This approach has been careful to consider user characteristics and requirements as well as the needs of teachers and autism-training professionals (Neale, Cobb, & Wilson, 2002).

VEs have been developed that allow the practise of social skills in a café and a bus, both of which have various levels of social difficulty. In both the Café and Bus VEs (see figure 1) the user needs to find an appropriate place to sit. A more detailed description of these environments can be found elsewhere (Cobb et al., 2002).

Figure 1. *Screen-shots of the Café and Bus VEs. The user must find somewhere to sit.*

2.3 Participants

We worked with a group of 16-19 year olds and their teachers and teaching assistants at a school for students with ASDs. All 8 students in the class have ASDs, and we included all of them in group activities, but worked mainly with the 3 higher functioning students for individual activities. As we had worked periodically with the class over 18 months and more intensively over 2 months, the students knew the researchers well and were used to us being in class and using video cameras, taking very little notice of this.

2.4 Methodological approach

An ethnographic style of enquiry was adopted as we wanted to capture a realistic picture of how VEs might be used in real school contexts. VEs were introduced within the classroom and the teachers were given free reign as to how to use them. Researchers were on hand to provide technical assistance only. We wanted to see how professional educators would utilise the technical tools provided in order for the VE developers to tailor the specific VEs so that they better met the teachers' needs. We also wanted to gain a greater general understanding of the potential of these technologies for teaching. The physical setup of the equipment as well as classroom management practices, were of real interest to us, in terms of how they impacted on technology use and learning. All of the sessions described were video recorded and analysed qualitatively. When possible, this information was supplemented by teacher interviews. More structured studies, focusing on effectiveness were also carried out within the project and are described within these proceedings (Leonard, Mitchell, & Parsons, 2002).

In order for the VEs to be applied most effectively in the classroom we have found from previous studies that it is important to familiarise teachers with the technology and research objectives (Cobb, Neale, Crosier, & Wilson, 2001). This was done by holding a teacher meeting where the aims of this evaluation were explained, VEs were demonstrated and used by the teachers, then informally reviewed. Individual teachers

who agreed to participate in the evaluation were then offered additional time to practise using the VEs whilst supported by one of the researchers.

3. OUTCOMES

3.1 Observation of VE use

We found that the VEs could support teaching in different ways within the classroom depending on the computer hardware used, familiarity with the VE program, the teacher present, and the number of students present. We observed three main approaches to VE supported learning and have categorised them as: individual tuition, group exploration and group reflection. Descriptions of VE use within each of these categories are below.

Individual Tuition: The first couple of times that the VEs were used in school was on a single PC where a student would work alongside their teacher who provided assistance and guidance as necessary. This more 'traditional' form of computer use assisted in gauging the suitability of the program for individual students, and identifying their level of understanding. Three students with HFA/AS used the VE.

We observed that the Café VE seemed to be pitched at a suitable level of difficulty for the students, as they could all complete the lower level tasks without assistance (e.g. 'find a seat in an empty café') but when it came to the more socially challenging tasks they required more help. Level 3 of the program presents the user with a café at which every table has some people sat at it and the task is to find somewhere to sit down. The students had been taught not to sit down next to someone they don't know if there is somewhere else to sit, yet they had not discussed with their teachers what the most appropriate course of action might be if there are no alternative places to sit. This meant that they often had to discuss with their teacher the most appropriate strategy for finding a seat. 'J' searched thoroughly through the café trying to find an empty table. At a number of tables the computer asked *"Sat at the table is someone you don't know. What should you do?"* and he responded by backing away, verbalising *"No"* and searching for a better place to sit. Only with further explanation and prompting from his teacher did 'J' attempt to 'speak' to one of the people sat at a table to ask if he could sit there.

The session outlined a number of ways in which the Café VE could be re-structured to better support learning. One such suggestion, made after observing the students struggle with the most difficult levels of the program, was to introduce an intermediate level that would allow the user to be more gradually introduced to the task of asking a question in the VE. In the program used, when the user first attempts to ask a question (to ask if they can sit down), a negative answer is always given (such as "someone is already sitting there") and they have to ask a question again before they are successful (this was intended to show the users why it is important that they ask before sitting down). Receiving a negative response to a new action appeared to make some students anxious. An intermediate level may state explicitly that all of the tables in the café had people sat at them, and the task itself could be made marginally easier, if they took the correct approach to solving this problem (i.e. by asking a question) then their attempts would be immediately rewarded.

A week after this session, the Café VE was again used in the same manner, however, many different issues arose from the use of the VEs. By the end of session 1 the students had all successfully completed the highest level of achievement within the Café VE. During session 2 their behaviours were noticeably different. All three of these users had learnt, from the previous session, *exactly* what they needed to do in the VE in order to reach a successful outcome. In this session they displayed repeated behaviours at each of the levels, for example, by visiting the same tables in the same order on each visit to the café, and always making the same choices when they needed to ask a question. It was clear that for each level of difficulty in the Café VE they had visually memorised the environment. For example, in level 2 there is an empty table in the corner of the room where the user may sit and in level 3 there are no empty tables. In level 3, many of the users did not even look around the room to see if they could find an empty table as they had remembered from the week before that in this level there were none.

During this session the users completed tasks within the Café VE much more quickly than they had the week before, and there were far fewer examples of dialogue about the social aspects of the decisions made between them and their teacher. In fact it seemed that most of the decisions that were made were copied from their successful actions made the week before and the social implications of these were not reflected upon.

The behaviours observed during this session have highlighted to us just how adept individuals with ASDs are at learning the 'correct' answer to a problem and then repeating it again and again. The importance of programming flexibility within an educational VE has also been exemplified in our observations of the users rote repetition of responses to situations within the VE. Although we made a concerted attempt to introduce flexibility into the VEs throughout the design process we tended to focus on developing a VE that allowed each user to behave differently within it each time it was used. For example there are a number of distinct paths a user may take that would lead to a 'successful' or an 'unsuccessful' outcome. However, what we did not explicitly consider was the need to force the user to behave differently each time they use the Café VE, or each time they visit the same difficulty level in the VE. Our observations from this session indicated a need to introduce much more randomness within the system, perhaps by presenting the user with a number of VEs that are at least different in some superficial way. For example, changing the look of the café and the people within it, and changing the location of the tables with free spaces should ensure that on each visit the user will be forced to have a look around the café to find the most socially appropriate place to sit. Another approach might be to change the manner in which questions are chosen. When asking a question within the current Café VE it is possible (and quicker) if the user does not re-select a different question each time, but leaves the question selected upon the question that was asked the last time the VE was used. Ensuring that the user has to actively select a question each time one needs to be asked, and changing the questions that are available to them should mean that they have to think about which choice would be the most socially appropriate on each occasion this function is used.

Group exploration: The third session aimed to find out how the VEs might be used in a group situation and how teachers may structure this experience. We wanted to explore group use of the VEs, as many of the existing teaching methods used with this class are group-based and the 16+ classroom is arranged so that sofas and chairs face the corner of the room, where a flip chart is usually placed. For this session a laptop was used to run the VEs and they were displayed on a projection screen which replaced the flip chart. One teacher and three classroom assistants were present with eight students. This set up is shown in Figure 2.

Figure 2. *Classroom setup for group use of VEs.*

At first the teacher navigated around the VE and the decisions he took were informed by the suggestions offered by members of the group. An excerpt of dialogue is shown in Table 1, showing that the teacher used the VE to focus on specific social issues and the students could engage in this.

Another example of class discussion of VE use is shown in table 2. It seems clear from the dialogue that class discussion around the interaction with the VE adds richness and meaning to the scene and enables the teachers to explain if something is not clear (for example when the man in the VE says that "someone is sitting there" when no one is literally sitting in the seat).

Each of the students then took turns in using the VE. When students experienced difficulties, for example, when "tricky decisions" needed to be made, these were discussed and influenced by the class as a whole. However, when the students knew what to do in the VE the situation was much different. This type of VE use was characterised by individuals working quickly through the VE making their decisions immediately and leaving little time for the rest of the group to contribute or comment. The teacher tried to involve other members of the group in decisions but the student in control often carried on with what they

were doing and were not influenced by the group discussion that might have been taking place around their actions.

Table 1. *Dialogue between teachers and students whilst using the Cafe VE in a group.*

Person	Dialogue	Actions
T	Right over in the corner	Navigating towards a table
T	Careful with that tray	
T		Reaches the table
T	Oh in the corner there	
S	Not that one	
T	Which one?	Navigates round to the side
S	There	Pointing
T	Right, that one. You want that table do you?	Navigates up close to the table
VE	Sat at the table is someone you don't know. What should you do?	
S1	Ignore him	
S2	Click on the speech bubble	
S3	Ignore him	
C1	That man is already sitting at the table so it is like his table	
C2	Hang on, S2 is telling us	
S2	Click on that button on the right, T.	

T = teacher; C1 & C2 = classroom assistants; S1, S2, & S3 = students; VE = pre-programmed responses from the VE.

Table 2. *Discussions around actions in VE.*

Person	Dialogue	Actions
T	R: Right, we've chosen that one look, we've chosen that one, 'is this seat available?', 'OK'.	Clicks on OK
VE	No, sorry. Someone is sitting there.	
S1	They're wrong.	
C1	What does that mean then?	
T	Well there is nobody sat there, is there?	Points to screen
C1	Well perhaps, somebody must have gone to the toilet, or...	
C2	Yes, or perhaps that man's sitting at the table, and they've gone to get the food.	
C1	Find another table	
T	Right, OK then, so we wont hang about. We'll go and find another table. Do you think?	
C1	I think that's an excellent idea because that man obviously doesn't want us to sit there.	

T = teacher; C1 & C2 = classroom assistants; S1 = student; VE = pre-programmed responses from the VE.

When discussing this session with the teachers they commented that so much was going on and so many issues were being presented that it was difficult to be able to reflect on them and perhaps discuss why they may have occurred. We observed that this was particularly difficult when a student was in control of the VE as they would interact with the VE at their own pace and find it difficult to inhibit their responses (i.e. stop interacting with the VE) to join in a discussion about what had just happened.

Group reflection: The third session of VE use also involved a group working around a projected display, but a different teacher led the activity and a distinctive style of interaction was observed.

At the start of the session, before using the VE, the teacher initiated a group discussion about visiting a café and finding a table - an activity that some of the students had carried out that morning in a real café. The students then took turns to use the Café and Bus VEs. At many points during the session the teacher would

reflect on the behaviours that had taken place in the VE and asked the students questions about this. An example can be seen in table 2 where student 1 is trying to find somewhere to sit in the Café VE.

Table 3. *Dialogue between teacher and students, reflecting on VE use.*

Person	Dialogue	Actions
S1		Needs to sit down, and uses the question "is this seat free?" to ask if he can sit at a particular table.
T	Well done S1	
S1	That's a bit of a funny thing to say "is this seat free?" What does that mean?	
S2	Available	
T	Ohh so it doesn't mean that this seat is not going to cost me any money then. Does it?	
S1,2,3 &4	No!	
T	Well I thought if something was free it meant that you didn't have to pay for it. What does it mean S2? Tell me again what it means.	
S2	Is this seat available?	
T	Right, so it means you can sit on it.	

T = teacher; S1, S2, S3 & S4 = students.

It is clear that the teacher makes a lot of effort to reflect on what has just happened in the VE and discuss the task to clarify some of the issues that are more difficult to understand. It is best if the VE is not being used when this discussion is happening and the teacher usually managed this by moving the student who has just used the VE away from the computer and back to their seat. This limited when discussions could take place as they occurred most successfully at the end of each student's 'turn' on the VE.

On a number of occasions the teacher used the VE to provoke a discussion about other social or behavioural issues relevant to that context that were not directly covered by tasks within the VE. For example, not bumping into people in the café when carrying your tray (see example in table 3) and what to do on the bus if there are no seats at all to choose from. This demonstrates the potential of this technology to support direct and indirect learning aims by providing a set of scenarios or contexts around which the teacher can promote discussion of many social issues.

Table 4 *Teacher promotes discussion about related social issues in a cafe*

Person	Dialogue
T	Can I just ask everybody, because student 5, you need a little bit of help with this. If you are trying to find somewhere to sit and you're carrying your tray and there are lots of people around, what have you got to be careful about? What not to do?
S5	Not to bump into people
T	Not to bump into people, that's right. So you have to be thinking about where everybody else is in the café don' you.
Class	Yes

T = teacher; S5 = student; Class = all students

We observed the students frequently trying to sit on the back seat of the Bus VE. As we had not anticipated this behaviour, the levels that we presumed would be difficult to complete were easily completed, as any socially challenging situations had been pre-programmed into the front seats of the bus. This observation highlights the need for the VE to be tailored to the needs of individual students.

One proposal is to modify the virtual bus to make it a more challenging social environment by allowing the teacher to select which seats in the bus are to be occupied and which empty before it is used by an individual. This may allow the VE to train the individual to inhibit a rigid and potentially socially inappropriate behaviour that the teacher is aware of by exploring the consequences of this behaviour in a number of similar situations.

When discussing the use of VEs for social skills teaching the teacher emphasised the difficulty she faces in getting the students to understand the perspectives of others. She identified the potential of VEs in allowing the students to take others perspectives, by role taking within VEs and playing out different scenarios.

3.2 Recommendations for VE changes

During this period of observation a number of recommendations were made for changes to be made to the VEs, based on issues that had arisen from VE use in a real school context. These recommendations are listed below:

- The stages needed to progress more gradually as complexity increases and new concepts are introduced. This should reduce anxiety of users who are unsure of what action to take or who carry out an incorrect action in the VE

- The scenarios should be presented in a visually distinctive manner each time the VE is used to decrease rote learning based on the visual presentation of the environment.

- Ensure that each time a new question is asked the user must actively select it and not rely on a default selection, which allows the student to use the same question each time. Different question options would also make this activity more flexible.

- Allow the teacher to tailor the VE to cater for individuals, for example, the teachers could pre-select where people are sat on the bus.

- To enable more effective reflection on group use of VEs facilitate a 'pause' button to be operated by the teacher. This can be used to stop the VE at relevant moments to enable discussion around the social issues encountered.

- Understanding of social understanding involves the consideration of other people's perspectives. Enable the user to find out 'what the other person is *thinking*' in the VE if socially inappropriate actions are taken.

These changes will be incorporated into the VEs and subject to further school based reviews.

4. CONCLUSIONS

Our observations from working with these groups have emphasised the need for the designers of education/training VEs to work closely with the 'experts' in this field, be they teachers, training practitioners or classroom assistants. This approach to evaluation has been an effective way to explore the potential of VR as a teaching tool, and a resource to inform the design process so that VR based materials support and supplement existing teaching methods. By working over a series of months with the same school the teachers became familiar with the technologies and were encouraged to direct the way in which the VEs were used. As they grew more confident with using the technologies, they could better identify how the VEs may support teaching and learning. They came up with increasing numbers of suggestions and put them into practice in the classroom.

This holistic style of enquiry is essential when designing and evaluating educational technologies. We believe that VEs for social skills education will be most effective if used alongside other methods. It is therefore necessary to examine how VEs may be used in conjunction with existing teaching practice and tailor their design so that they complement these techniques.

The study identified a series of design modifications which need to be made to improve the suitability of these VEs for use in schools. They include changing the structure of the learning task presented (by making more gradual the presentation of increasingly complex tasks) and designing VEs that enable the teachers to individualise them to address specific learning needs (deciding which seats on the bus are full and allowing them to pause the VE to promote discussion and reflection). The changes should also force the users to make more socially based decisions, rather than replicating their previous actions (i.e. they have to actively select a new question each time and are presented with a different visual representation of the scenario on each visit to the Café VE). We also hope that, by including a function that allows users to visualise other people's thoughts and feelings, we can increase levels of social understanding amongst users.

In addition, this study has highlighted the potential of VEs in setting the scene for teaching a wider array of social scenarios than have been pre-programmed into the environment. In one of the group sessions

observed the teacher would set the scene using the VE and then pose her own additional social scenarios. This may be an especially useful feature of VEs for teaching people with autism as they classically have a very poor imagination and VEs may help users to visualise themselves in a situation.

Further work is continuing with the cyclical process of review and re-development of the VEs. We are also involving the teachers in the production of an activity manual (containing computer-based and classroom-based tasks) to be provided as a resource guide with the final virtual environment training program.

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