Do virtual environments promote self-directed activity? A study of students with severe learning difficulties learning Makaton sign language

P J Standen[1] & H L Low

Department of Learning Disabilities,
University of Nottingham Medical School,
Queen's Medical Centre,
Nottingham, NG7 2UH, England

[1]*mvzpjs@nottingham.ac.uk*

ABSTRACT

Eighteen students with severe learning difficulties and their teachers were videoed while using an educational virtual environment. Teachers' activity was coded into eight categories (e.g. instruction, suggestion, pointing) and the students' into three (e.g. moves in three dimensional space) and intra-rater reliability established. Significant ($p<0.0001$) decreases in rate over repeated sessions was found for all the teacher's categories with the more didactic (e.g. instruction and physical guidance) decreasing at a faster rate than suggestion and pointing. For the students' categories there was a significant increase ($p<0.05$) in rate between the first and last sessions for two of the three categories.

Keywords: self-directed activity, learning difficulties, special education, Makaton

1. INTRODUCTION

A principal claim for the value of virtual environments (VE) in education is that they encourage self-directed activity and give the student some control over the learning process (Pantelidis, 1993). Self-directed activity is given a high priority in the theories of Bruner (1968), Vygotsky (1978) and Piaget (see Wood 1988). Research on the development of perception (Held and Hein, 1963) also emphasised the essential contribution of self-directed activity.

The value of self-directed activity may be even greater for people with learning disabilities. As with all people with disabilities, children with learning difficulties have less control over things that other children take for granted and assume they will play a passive role all the time (Sims, 1994). They are often described as showing underdeveloped autonomy and self determination. This makes it difficult for them to make informed choices, for example where issues of health care are involved (Welsh Health Planning Forum, 1992). Around 20 people in every thousand have mild or moderate learning disabilities, and about three or four per thousand have severe learning disabilities and need frequent support with some aspect of daily living. With the continuing expansion of "care in the community" those currently in receipt of special education will need a set of skills to enable them to achieve some degree of independent living. The use of VE may be appropriate (Cromby et al., 1996).

Introduction of new technologies into the classroom has frequently led to predictions that they will revolutionise education. All too often these claims are not realised. According to Salem Darrow (1996), in order to avoid this happening with the introduction of VE, educators need to take a proactive planning stance in the growth of this important technology rather than the reactive stance many have taken with other educational technology developments up until now. "If educators want VE to meet learning needs especially of those students who have unusual learning needs, they must play an active role in the development of applications offering to developers their unique understanding of learning styles and good teaching practices" (Powers and Darrow, 1994).

While the media has portrayed VE as being experienced through the use of head-mounted displays, more suitable for educational use are desktop virtual environments, which can be run on ordinary computer monitors and use standard computer input devices such as a joystick, mouse, touch-screen or keyboard. They are just as able to generate a sense of "presence", i.e. the experience of feeling oneself to be present in the virtual environment and have the following advantages over the use of head-mounted displays or total immersion systems.

1. They avoid possible health and safety issues. Although currently under investigation in Nottingham, head-mounted displays have been reported to cause nausea and dizziness and produce short-term impairments in visual acuity.
2. They facilitate peer and tutor interaction due to the public nature of the display. By contrast, head-mounted displays make the user look and feel isolated. The social nature of learning and the role of instruction were emphasised by Vygotsky (1978) in his use of the concept of the "zone of proximal development". This is defined as the distance between a child's "actual developmental level as determined by independent problem solving" and the higher level of "potential development as determined through problem solving under adult guidance or in collaboration with more capable peers". Bruner (1968) has also drawn attention to the social context out of which skills develop, highlighting the value of elements such as joint attention, shared activities and sensitive and responsive adults prepared to assign meaning to the child's behaviour.
3. Desktop virtual environments can be run on an IBM-compatible computer costing less than £1,000, placing them within the budget of most schools and training centres. Although headmounted displays costing around £600 have recently become available in this country their image quality is poor. With total immersion system there are likely to be significant time lags in responding to the user's movements and tactile interaction with the computer images is clumsy and imprecise. A sufficiently robust system of good enough quality for use in training would currently costs upwards of £25,000

The present study set out to investigate the role of VE in special education from the educator's point of view. Specifically it looked at whether VE did promote self-directed activity, or whether teachers were using them in a more conventionally didactic manner.

2. METHOD

2.1 Participants

Eighteen teacher-student pairs took part. The students were all attending a large school for those with severe learning difficulties aged between three and nineteen years. Teachers volunteered to take part in the study after participating in a workshop on the use of virtual environments run by the research team. They were asked to nominate a student to work with who had sufficient motor skills and visual ability to be able to use the computer terminal, joystick and mouse and who had no experience of using virtual environments. Half of the students nominated were male. Seven were from the senior school and aged between 13 and 15 years, three were from the middle school aged from 11 to 13 years, five were from the junior school aged from six to eight years, and three were from the nursery and aged from three to five years. Before testing began, teachers completed the Vineland Adaptive Behaviour communication sub-domains of receptive and expressive behaviour. The expressive section assesses what the child says and includes items such as " says at least 50 recognisable words", "uses phrases containing a noun and a verb". The receptive section assesses what the child understands and contains items such as "demonstrates understanding of the meaning of 'no' ", "follows instructions requiring an action and an object". The students' mean scores were 14.4 for receptive and 21.2 for expressive communication. Compared with age-group norms this indicates levels of low to adequate communicative ability.

2.2 Equipment

The VE used in this study were built to teach Makaton, a vocabulary developed for learning disabled hearing impaired adults which has since been adapted for children who have little or no expressive speech and poor comprehension. They were displayed on a desktop system, with movement controlled by a joystick and interaction by a mouse. They consisted of a series of rooms, each devoted to the learning of one symbol (e.g. telephone). Each room contained four examples of the relevant object (e.g. four different types of telephone). When the user investigated the objects they activated the appearance of the relevant written symbol, and the signing of that symbol by a mannikin at one side of the screen. For each set of four rooms, a fifth room was available where the learner could test their knowledge of the signs and symbols demonstrated in the other four rooms.

2.3 Procedure

Each pair had between four and ten twice-weekly sessions using the Makaton programme. It was not always possible to keep the same teacher with each student but 11 students remained with the same teacher throughout. The order in which the student proceeded through the programme, the number of rooms that they explored, the number of times each room was explored and the length of session (up to a maximum of 20 minutes) were left entirely to the student or teacher. Each session was recorded on videotape. Each student's knowledge of Makaton was assessed at the beginning of the study and after their last session using 16 Makaton symbol cards which corresponded with those that were in the

Proc. 1st Euro. Conf. Disability, Virtual Reality & Assoc. Tech., Maidenhead, UK, 1996

software. Any form of recognition of the symbol in terms of speech, signing or pointing to the physical object in the room was taken as positive.

2.4 Analysis

After repeated viewing of the tapes, teachers' activity was coded into eight categories:

1. Non 3D Instruction: any verbal instruction given by the teacher to direct child's attention back to the screen or to make a movement which was not through three-dimensional space, e.g. move the arrow to the phone, click the mouse, look at the screen, press this button.
2. Non 3D Suggestion: any verbal suggestion (can be in the form of question) given by the teacher to make a movement which was not through three-dimensional space. Unlike point one above, it does not tell the student how to accomplish a task but simply prompts the student, e.g. let's see what the man does, would you like to turn the pages of this book? what do you think the doors can do? shall we have a look at another room?
3. 3D Instruction: any verbal instruction given by the teacher to make a movement through three-dimensional space, e.g. find the pencils, move to the right, press this button on the joystick to bring yourself up.
4. 3D Suggestion: any verbal suggestion (can be in the form of a question) by the teacher to make a movement through three-dimensional space, e.g. would you like to move closer? Would you like to see what else is in the room?
5. Pointing: this is when the teacher points to the screen to direct the student's attention or to instruct the student to move the arrow from one place to another. It often accompanies other behaviours (e.g. a question) but will be scored as a separate category.
6. Physical Guidance: teacher physically guides the student in using the joystick, mouse or keyboard, e.g. puts hand over student's hand to move mouse. As with pointing often accompanied by suggestion or instruction.
7. Teaching Questions: questions and comments made by teacher that give meaning to student's experience. Could include comments made to put student's actions into context, e.g. everyone's gone out, maybe that's why the doors are shut; what is that? what colour are the pencils?
8. Teacher's Move: teacher moves mouse or joystick or uses keyboard.

Students' activity was coded into three categories:

9. Spontaneous 3D Movement: any movement made by student using joystick.
10. Spontaneous Non 3D Movement: any movement made by student using mouse or keyboard.
11. Student's Initiative Completed by Teacher: student starts an action which is completed by teacher.

Behaviour was recorded from the videotape as frequencies, i.e. duration was not taken into account, purely the number of times each category occurred. As sessions differed in length, frequencies of behaviour categories were converted to rates (frequency of category divided by duration of session).

3. RESULTS

Intra-rater reliability was assessed by the same rater repeating the coding of ten randomly chosen sessions after an interval of one week. All eleven categories were significantly correlated (Spearman's rank correlation) between the two sessions but category seven (teaching questions) was significantly different on the t-test so this was omitted from further analysis. As very few pairs completed more than seven sessions, analysis was carried out on these only.

3.1 Teachers' Behaviours

Using regression analysis, significant decreases in rate over repeated sessions was found for all of the teacher's behaviours with the more didactic categories (e.g. instruction and physical guidance) decreasing at a faster rate than suggestion and pointing (see Table 1).

Table 1. *Results of regression analysis for teachers' behaviours*

Behaviour category	**R2**	**probability**
non 3D instruction	0.17	p<0.0001
non 3D suggestion	0.15	p<0.00001
3D instruction	0.03	p<0.00001
3D suggestion	0.19	p<0.0001
pointing	0.11	p<0.0001
physical guidance	0.16	p<0.00001
teacher's move	0.13	p<0.00001

3.2 Students' Behaviours

Regression analysis could not be used for the students' results because the data were slightly skewed and so rates for the first and last sessions were compared using a Wilcoxon one tail test. A significant increase in rate was found for spontaneous 3D movement ($p<0.03$) and spontaneous non 3D movement ($p<0.04$) but rates remained the same over sessions for Student's Initiative Completed by Teacher.

If a composite score is formed for all teacher categories and then all student categories and these figures are plotted against session, teacher activity can be seen to decrease as student activity increases (Fig 1).

Figure 1. *Graph of medians of behaviour rates against sessions*
Comparison between teachers and children's behaviours

3.3 Knowledge of Makaton

Using a Wilcoxon test, a significant ($p<0.03$) increase was found in the number of Makaton symbols the students knew at the end of the sessions when compared with their baseline scores.

4. DISCUSSION

These results showed that students made more self-initiated actions as sessions progressed. The only student category which showed no increase was Student's Initiative Completed by Teacher for which there were low rates throughout. This supports the often made claim for virtual environments in education: that they promote self-directed learning (Pantelidis, 1993). The increase in student activity was in 3 dimensional moves as well as non 3 dimensional moves showing that they are taking advantage of the characteristic of virtual environments that distinguishes them from other interactive packages.

©1996 ECDVRAT and University of Reading, UK ; ISBN 0 7049 1140 X

Teachers contributed less as sessions progressed as shown by the composite score formed from all the teacher behaviour categories. However this drop was not as great as the increase in rates of student behaviour. This is because some behaviours (both categories of instruction, teacher's move, physical guidance), dropped at a faster rate whereas others (suggestion, pointing) hardly changed. The interpretation of this could be that teachers are not just becoming fatigued but selectively dropping the more didactic and controlling behaviours.

This can be explained with reference to the term "scaffolding" identified by Wood (1976) as one of the functions of tutoring. When a beginner starts to learn a task help (a scaffold) is provided to enable the beginner to make progress by controlling those elements of the task that are initially beyond the beginner's capability. As the beginner becomes more familiar with elements of the task and develops the ability to carry it out independently the tutor intervenes less, i.e. the scaffolding or training support is removed little by little. Another function of the tutor according to Wood (1976) is to maintain the learner's interest and motivation, marking relevant features of the task and interpreting discrepancies between the child's productions and correct solutions and controlling the level of frustration experienced by the learner. This is represented in the present study by the categories of pointing and suggestion which decreased at a slower rate.

To be able to interpret more accurately the role of the teachers' behaviour a sequential analysis would need to be carried out to demonstrate what happened after a teacher made a particular action. This would throw more light on whether teachers reduced their rate of behaviour in response to increasing initiative on the part of the student or whether the increase in student activity occurred after the teachers deliberately reduced their own. Although more informative, this approach is obviously more time consuming. However the method used in the present study is simple enough to be usefully employed to evaluate other educational virtual environments.

5. REFERENCES

J S Bruner (1968) Processes of Cognitive Growth: Infancy, Clark University Press, U.S.A.

J J Cromby, P J Standen and D J Brown (1996) The potentials of virtual environments in the education and training of people with learning disabilities, J. Intell. Disab. Res. (in press).

R Held and A V Hein (1963) Movement-produced stimulation in the development of visually guided behaviour. J. Comp. Physiol. Psychol, 56, pp. 872-876.

V S Pantelidis (1993) Virtual reality in the classroom, Educ. Technol, April, pp. 23-27.

D A Powers and M Darrow (1994) Special education and virtual reality: challenges and possibilities, J. Res. Comp. Educ, 27, pp 111-121.

M Salem-Darrow (1996) Virtual reality's increasing potential for meeting needs of persons with disabilities: what about cognitive impairments? Proc. Third Intl. Conf. Virtual Reality and Persons with Disabilities (H J Murphy, Ed), Northridge CA: California State University Center on Disabilities (in press)

D Sims (1994) Multimedia camp empowers disabled kids, IEEE Computer Graphics and Applications, January, pp. 13-14.

L S Vygotsky (1978) Mind in Society: the Development of Higher Mental Processes Harvard University Press, Cambridge, Mass.

Welsh Health Planning Forum (1992) Protocol for Investment in Health Gain: Mental Handicap, Welsh Office, Cardiff.

D J Wood (1976) cited in: J D Day, L A Cordon and M L Kerwin (1989) Informal instruction and development of cognitive skills: a review and critique of research Cognitive Strategy Research: From Basic to Educational Applications (C B McCormick, G E Miller & M Pressley, Eds), Springer-Verlag, New York, pp. 84-85.

D J Wood (1988) How Children Think and Learn, Blackwells, Oxford, U.K.

©1996 ECDVRAT and University of Reading, UK ; ISBN 0 7049 1140 X