Vulnerable Viewers Of Valid Vistas? Assessing Student Performance When The Perception Of Presence Is Increased In A Virtual Learning Environments

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Abstract

This paper investigates some of the factors in virtual environments that promote an increased sense of presence. One of the advantages of building a virtual reality system is to allow students to enter different worlds which in this particular instance is the bottom of the Atlantic Ocean and to experience a real sense of "being there". However, does this enhanced sense of presence facilitate conceptual understanding? An experiment was undertaken where Sixth Form (Year 12) pupils interacted with a desk top system that took them to the bottom of the North Atlantic Ridge. The students who worked in an enhanced presence environment were able to navigate and

complete a number of tasks using the virtual reality environment more easily than those who did not use the enhanced presence version of the software. Interestingly the cognitive changes scores did not follow this pattern and students did not seem to learn as much with the enhanced presence environment. This study provides some benchmark data about theroles of presence with effect to cognitive processing tasks in virtual environments.

Introduction

Virtual reality systems have a track record as successful training environments. One good example is that of the British Aerospace virtual cockpit (Kalawsky, 1991a; Kalawsky, 1991b). Here the pilot sits in a flight simulator where all the controls are identical to those found in the real aeroplane. This means that if one rates the simulator in terms of presence, representational fidelity and immediacy of control, then all these factors are at a maximum of 1. These three dimensions have been chosen by Whitelock et al (1996) as a model for the empirical investigation of virtual environments in order to understand how their balance could affect student learning. These researchers argue that training systems require full presence, immediacy of control and representational fidelity but learning systems need not require such high quality systems.

In the case of the flight simulator, there is as true a sense of being in the real thing as is possible. This raises a set of questions. One of these is how can one maximise a sense of being there for students working with desktop virtual environments? Secondly, does this sense of being there or presence promote conceptual understanding? Since in education we are primarily concerned with teaching children to look beyond their senses to more scientific predictive models of the world. We also need to motivate them to enter this "theory world" by building teaching environments that are fun to use and where time seems to pass quickly. Understanding how to create this balance is one of the goals of educational media production. Together with providing "learning as fun" environments since Virtual reality systems offer students trips to wild and exciting areas of the world, for example, the ocean floor. In fact we have built a virtual reality program that invites students to explore the bottom of The North Atlantic Ridge in a submarine. They can visit different sites to discover the number of flora and fauna that are present in, what they believe to be, a barren world. The whole point of embarking on a field trip is to experience "being there" in some way. This paper investigates the factors that contribute to a sense of presence or being there and tries to discover how this effected the students actions together with their perceptions of these interactions with the environment

Presence

The notion of 'presence' is considered to be an important conceptual component of any Virtual Environment whether it is immersive or desktop. So what is presence? Presence is where we are immersed in a very high bandwidth stream of sensory input, organised by our perceiving systems, and out of this 'bath' of sensation emerges our sense of being in and of the world. This feeling is also engendered by our ability to affect the world through touch, gesture, voice etc.

According to Kalawsky (1993) both teleoperation and virtual environment systems convey a level of personal presence within the synthetic or remote environment. People feel immersed or present in the environments and seeing one's own body reinforces the feeling of presence. However, Edgar and Salem (1998) found that the interface can seem more of a hindrance than a help. They found that common problems focused on the speed at which the interface reacts to the movement of ones avatar (the representation of oneself) and objects. This may cause the individual to 'overshoot the mark'. What happens is that often too many pieces of information are available to the user, to be able to see them all at once.

Presence does not just refer to one's surrounding as they exist in the physical world, but to the perception of those surroundings (Steuer, 1992). Whereas Steuer refers to telepresence as the extent to which one feels present in the mediated environment, rather than the immediate physical environment. This means that the dependent variables of virtual reality must all be measures of individual experience. Providing an obvious means of applying knowledge about perceptual processes and individual differences in determining the nature of virtual reality (Steuer, 1992). The more an individual is aware of the interface then the harder it will be to achieve a high level of telepresence. To lessen the awareness of the interface, there needs to be increased level of presence.

One way which apparently evokes a greater level of presence appears is through the use of sound. Sound gives feedback to the user and offers greater levels of reality. Laurel (1993) refers to the use of sound to evoke emotional responses, whereas Rheingold (1991) refers to sound as valuable for feedback, particularly 3D acoustics. As he says: *"there's nothing like the sound of footsteps behind you to help convince you that you are in a dark alley late at night in a bad part of town - sounds have the ability to raise the hairs on the back of our neck"* p.151. One of the important components of presence stressed by a number of researchers appears to be good sound feedback. However, will the sound emphasis be important for conceptual learning?

In order to investigate the role of sound and a feeling of presence a study was undertaken with sixth form (Year 12) pupils who interacted with a program which took them to the bottom of the North Atlantic Ridge. The students worked in two conditions. One in an enhanced presence environment which had an increased audio feedback system, while the second group worked in the original environment which had a more silent atmosphere.

Investigating variables that increase a sense of presence in a virtual reality environment

The Virtual Environment: The North Atlantic Ridge

The North Atlantic Ridge software was a desktop virtual environment, developed in MTropolis. It allowed the students to explore the terrain of the North Atlantic Ridge. It did this by taking the students in a submarine down to the Ridge itself at the bottom of the ocean. Students could move around the Ridge in the submarine to explore the terrain for geological structures and biological life in seven major locations along the Ridge. This virtual environment introduced the student to an unfamiliar terrain and hence on the scale for representational fidelity would have a low rating. Students experienced high immediacy of control with a low to medium value for presence (as this was a desktop system). The submarine could move in all four major directions of the compass, North, South, East and West. Speed of travel varied in how quickly one moved the mouse across the screen and there were two views of the proceedings. One was the view from the submarine which filled most of the screen, while the other comprised of a plan view of the submarine itself and where it was located presently in the Ridge. The latter vista was designed to aid the navigation around the ridge - a terrain which was indeed interesting and compelling to understand, but very unfamiliar. The students were literally steering the submarine and could choose what to investigate and, when they found allocation, where to stop. This meant they could look more closely at the geology or the flora and fauna by viewing movies which were accompanied by a short written text. These video clips were taken by the Alvin Dive Team and illustrate the probes used to gain samples of geological material and shots of the flora and fauna that thrive on the different mounds.

Participants and Tasks

The empirical study involved Year 12 students, aged between 16 and 17 years. Parental permission was obtained as well as the co-operation of the school, so that all the sessions could be video recorded. Prior to the experimental session which took place in the school, students were asked to complete a brief questionnaire concerning their previous computing and game

playing experience. The students were then paired so that prior experience was controlled as a variable. The students were grouped under two different conditions, one group had audio feedback and the other had no audio feedback. At the outset, students were asked to complete a pre-test on their cognitive understanding of the geology of the ocean floor, then they were given a series of tasks to complete and a post-test was administered. The tasks involved using the virtual environment of the North Atlantic Ridge, where students explored the environment via a submersible. Students were requested to move around the environment to become acquainted with the location and the movements of the submersible. After a brief session of 'getting to know' the environment, students were presented with a printed list of locations and biological life which they had to look for and comment on. Their conversations were recorded for later transcription. It was felt that this was an important issue for our understanding of 'presence', because as Lombard & Ditton (1997) report, 'presence' is a psychological state that typically is best measured via subject self-report (although observation of involved media users might also be a useful indicator).

Results

The main objective of this study was to test whether audio feedback enhanced the students feeling of presence in a virtual learning environment. We found this to be the case from their subjective ratings of presence in the sound and no sound conditions (see Table 1 below). This enhanced sense of presence contributed to notions of engagement and time passing quickly when using the environment. It also contributed to a better on task performance .For a fuller discussion of this point see These are all important considerations which impinge upon the design of virtual learning environments. But what other factors could have affected this enhanced sense of presence?

In order to understand the mediating influence of context on perceptions of presence, students were also asked about their previous experiences with computer games. The study therefore set out to investigate whether those with game playing experience would feel more present in the North Atlantic Ridge program. For example, if students were used to navigating and interacting with virtual games and were more familiar with these types of virtual environments, would they experience a greater sense of presence? Hence trying to discover whether there is a learned component to a sense of Presence. Our findings suggest that whether the students were game players or not, this variable did not affect their ranking of Presence, while using the North Atlantic Ridge environment.

The enhanced audio condition did not affect the students' perception of control since this was rated as 5.8 and 5.9 respectively. However what is interesting, is a change in representational fidelity which was noted in the two conditions. It is apparent that without sound the visual representation appeared more realistic when in fact the model terrain was not an exact replica but an academic representation of the ocean floor of the North Atlantic Ridge. The visual representation appeared more real and exact when it was a silent one, but the variable of

Presence was enhanced by sound. It is questionable as to whether the value of representational fidelity needs to be very high for conceptual learning. But what is apparent from this study is that the visual input is dominant when audio feedback is low.

Table I: Mean ratings of Presence, Control and Representational Fidelity by students in the sound and no sound conditions.

	Sound	**No Sound**
Presence	6.3	4.9
Control	5.8	5.9
Representational Fidelity	6.4	7.5

As Rutherford et al (1999) say ‘sound is an essential part of everyday life for humans’, and without it we have feelings of ‘unconnectedness’ with out surroundings (Gilkey & Weisberger 1995). Other findings from our work suggest that a high level of Presence provides a motivating environment in which students can explore conceptual notions. It is certainly a primary aim for educational technologists to provide stimulating and motivating materials for students, especially for those who work alone at home, as is the case with the undergraduates at the Open University. However, it is still important to check whether students are learning with these programs. Therefore students' on task performance measures were recorded.

Assessment of student performance while using the two different versions of the Virtual Environment

The students reported less difficulty in finding the different active sites when an audio track was present. In fact more students stated it was neither easy or difficult to locate various regions when an audio track was played when they used the program. What is more surprising is that students experienced more difficulty understanding the conceptual content in the different areas when an audio track is present. Further substantiating our suggestions is a comment made by one student that she preferred computer games such as Sim city:

‘I like the Sim-City games where you have a lot of involvement in building cities and using your head’

However when asked if Sim City had a background track or background noises, she remained unsure about whether there was one or not.

One inference could be that ‘being there’ is very motivating but could well take up too much of the users attention and produce a cognitive overload when it comes to understanding conceptual

notions. Hence we need to obtain more data about the balance of these salient variables that facilitate conceptual learning.

Student Understanding

A pre- and post-test was administered to ascertain what the students had learned. The mean score on a five point scale for the pre-test was 3.3 for the enhanced audio condition and 2.9 for the normal audio condition. These students were not familiar with the flora and fauna of the North Atlantic Ridge and were approximately all at the same starting point with respect to prior knowledge of this domain. There was however more of an improvement in the post-test scores for the normal audio group, improvement of 8 points than for the enhanced audio condition with an improvement of 5 points.

In trying to discover why this difference could have occurred we analysed how easy it was for the students to understand the sites they visited.

Figure 1

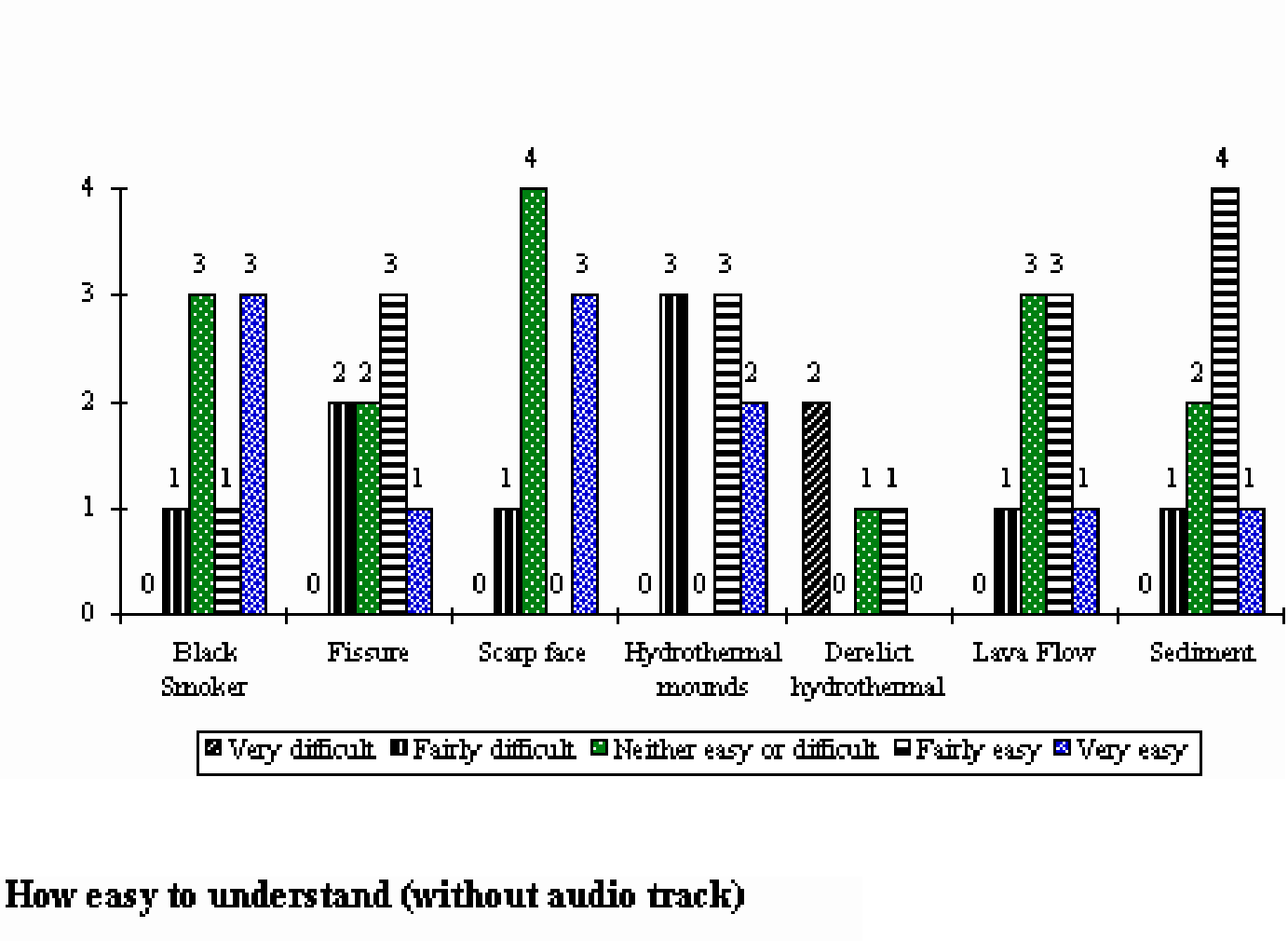
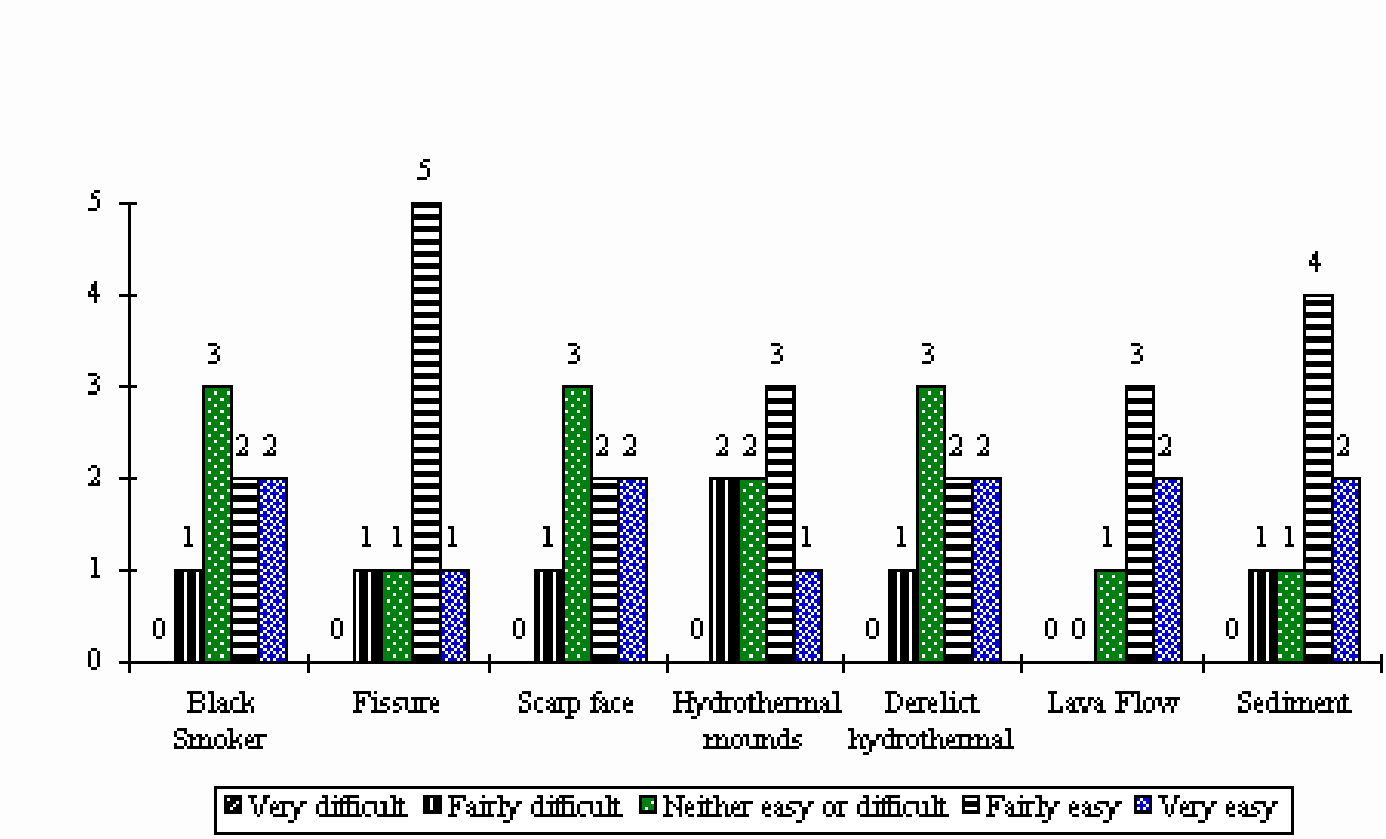


Figure 2



How easy to understand (with audio track)

The students enjoyed working with the enhanced audio software and were able to navigate better and to complete the tasks set more smoothly. Yet they did not seem to understand what they were doing so well as the other group, as their test scores indicate. Although game playing experience did not enhance the sense of presence it could well have set up a game like approach to tasks set i.e. achieving targets in a minimalist way. They did not extract the maximum information from the sites as establishing where they were was easier. The other side to this argument is that they could not delve as deeply into the conceptual content as being there, which is very motivating in itself, could well take up too much of the users attention and produce a cognitive overload when it comes to understanding conceptual notions.

Conclusions

A feeling of enhanced presence was induced by an augmented sound system. This was experienced by the students as a greater sense of "being there" at the bottom of the North Atlantic Ridge, exploring the terrain in their own submersible. Enhanced sound made navigation around the environment easier but, more importantly, the students thought the time passed more

quickly using this version of the software. They were very motivated and wanted to complete the tasks which some of them felt were fun as they drew analogies to game playing scenarios. The subjects worked in pairs and appeared to argue less in this environment. This was because they could complete the tasks easier and a joint strategy did not need to be agreed to solve a problem. Altogether the enhanced sound version appeared to be a more motivating venue for exploration.

On the other hand the more superficial visual clues of the terrain did not give the students enough information to complete the tasks. They had to explore the individual sites in more detail to understand and construct "mental maps" of what they were doing. This could have contributed to their increased cognitive change scores.

To summarise, our findings suggest that the sound does contribute to a greater sense of presence for the user, but it interferes with the cognitive processing tasks. Hence, being there is very motivating but could well take up too much of the users attention and produce a cognitive overload when it comes to understanding conceptual notions. This study provides some benchmark data about these issues which require further investigation if we are to design effective virtual environments for conceptual learning and not just straight forward training. Hence we are still left with probing more deeply the important question of whether being there is enough for conceptual learning to be facilitated in virtual reality environments.

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