The Magic Cottage: A Virtual Reality Environment for Stimulating Children's Imaginative Writing

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Abstract

This paper presents an exploratory study that investigates the impact of using a Virtual Reality Environment (VRE) on enhancing creativity in imaginative writing at primary school level. The intervention was to present the pupils with an interactive 3D environment, using Virtual Reality (VR) technology, that provided the setting in which their stories could take place. Numerous interactive features were incorporated into the VRE, giving a sense of adventure, but no human or other animated characters were portrayed. The main aim of the study was to investigate if a VRE could increase motivation and stimulate pupils' imagination in the context of a writing task that is part of normal school practice and of the National Curriculum (not a special research task). This paper provides a description of the graphical environment and the technology used in the trials, presents the methodology and discusses the outcomes and future work.

1. Introduction

The study presented here is part of an extended study to develop an "Art and Science" pedagogy programme and to evaluate the use of 3D digital technologies for enhancing teaching and learning and promoting creativity. The ASII-3D (Art & Science Interactive Initiative 3D) was funded by NESTA and Scottish Enterprise and was conducted by the Digital Design Studio (DDS) of the Glasgow School of Art. The Education Department of West Dunbartonshire Council, near Glasgow, Scotland, supported a series of two trials to be conducted with two primary and one secondary school within its region. This paper relates to the primary school study.

The study was defined in close collaboration with the head teachers and teachers of the primary school to ensure that the implementation of the VRE fitted the needs of the curriculum. It was also vital to choose an educational subject which existing learning and teaching methods can be problematic or inadequate for its instruction/delivery and identify how such technology can help to overcome problems or augment current teaching techniques (Draper, 1998). Imaginative/descriptive writing was selected as the subject matter for the study under the hypothesis that a graphically rich VRE could increase motivation and stimulate pupils' creativity. The impact of the VRE on the educational activity was evaluated based on our observations and on comparison to previous schoolwork.

2. Creating a VRE for Imaginative Writing

2.1 VREs in Primary School Education

Immersive and semi-immersive VREs use high-end equipment, large immersive projection systems such as a CAVE (Cruz-Neira et al., 1993), head-mounted displays, haptic technology and surround sound systems. Datagloves and datasuits allow users to interact with the environment by tracking their motion and providing tactile feedback. Recent and on-going developments in the technology of VR have substantially reduced its cost resulting in a wider exploitation of its abilities as a training tool and educational medium (at primary, secondary and tertiary levels).

Most of the educational VR projects have been developed for high school pupils and university students with only a few relating to primary school education. Here we review a number of VREs that have been created specifically for primary school subjects. The Electronic Visualisation Laboratory at the University of Illinois at Chicago, developed NICE, an immersive, multi-user learning environment for exploring complex ecological interrelationships (Johnson et al., 1998; Roussou and Gillingham, 1998). Pupils can create their own virtual garden and control weather conditions and time. The same research lab created a VRE called "Round Earth Project" to transform younger children's mental model of the shape of the Earth (Johnson et al., 1999). The Human Interface Technology Lab at the University of Washington, designed "Virtual Puget Sound" to simulate the processes of the ocean such as tides, currents and salinity (Winn, 2002). A more recent study, the "Virtual Playground", allows children to design and build their own virtual playground while solving mathematical fraction problems (Roussou and Slater, 2005).

Evaluation of various educational VREs has demonstrated that 3D visualisation can help in situations in which concepts are inherently spatial (i.e. ecosystems, photosynthesis, tides and fractions). Other studies have used VR to conduct science labs for situations that can not be experienced physically. Youngblut, in her extended review of educational VREs (Youngblut, 1998), reports that the majority of these have been designed for science education rather than the arts. Moreover, research in this area is still experimental and most of the projects were not designed to suit the needs of the curriculum.

Unlike previous studies, this project examines the impact of a VRE on a non-science area such as English language and more specifically on imaginative writing. It is also important that this VRE has been developed to address the needs of the current school curriculum. This research does not intend to evaluate the technology nor the individual properties of VR (i.e. presence, interactivity and navigation).

2.2 Imaginative writing

Imaginative writing is part of the English language subject. This activity is typically conducted once or twice a fortnight in the classroom, taking about 40 minutes after a briefing or other introduction by the teacher. According to the Scottish National Curriculum, there are three types of writing: Functional (Letter, Leaflet, Report, News Article), Personal (Account, Report, Letter) and Imaginative (Poem, Story, Imagined personal response to a given topic/context). In addition, as appeared from this study, there are learning aims focusing initially on technical language skills and secondly on expressive skills to do with creativity.

Recent educational agendas have attempted to give more prominence to content and structure and rather less to grammar, spelling and handwriting. Thus, teachers have devised a number of methods and mechanisms to engage pupils' interest and challenge their thinking. Storytelling has been used to stimulate the imagination, and drama and role-play have been introduced to create inspired contexts. The government is also encouraging the use of media and ICT. Consequently, in order for all the suggested strategies to be deployed, careful planning, ICT knowledge and occasionally further training to acquire certain skills is demanded from teachers.

There are several online resources for helping teachers to find interesting ideas for their English classes[1]. Similarly, educational researchers are constantly developing interactive virtual environments for augmenting learning and teaching and engaging pupils' interest. Most of these are desktop computer applications running either from a CD or DVD or online. "Teatrix" for example is a graphical virtual environment designed to support story creation through role-play (Prada et al., 2000). "Ghostwriter" is another research project that aims at promoting educational drama as a preparatory activity prior to the actual writing task (Robertson and Oberlander, 2002). While no applications have been found involving VREs for supporting writing at primary school level, several experimental projects have produced mixed reality environments by combining physical rooms with big-scale 2D projections for immersing children in virtual story spaces (Watson et al., 2004; Bodick et al., 1999).

This paper presents a graphical, semi-immersive collaborative VRE, not designed to tell a story but to inspire pupils to write their own stories by using it as a reference or starting point. Since it not based on any existing computer or video game, pupils have the freedom to explore the 3D model without completing any specific tasks (unlike "puzzle games", failing to activate or find an object does not influence the flow of the exploration). Nevertheless, some unusual and "out of place" objects have been introduced, with the view to make the environment more interesting, to rise questions and to generate imaginative interpretations which could potentially find a place in the written stories. Thus, the Magic Cottage offers a space for free exploration and interaction with virtual objects, whereas the stories depend on the pupils' minds. This has similarities to video or computer games where the environment is defined but the player dictates the actions.

3. Methodology

3.1 Participants

Two primary schools took part in this study: Clydemuir Primary School (7th year) and Christie Park Primary School (6th year). The trials were arranged in the first instance through the West Dunbartonshire education authority in Scotland, within whose area the primary schools are.

3.2 The technology

A semi-immersive projection system was used to present the virtual environment. The children were standing in front of a 1.8x1.3m wide projection screen with an active stereo CRT projector behind, wearing Crystal Eyes stereo goggles to provide a separate

[1] www.teachingideas.co.uk/, www.primaryresources.co.uk/index.htm, www.bbc.co.uk/schools/

image for left/right eyes for depth perception. The system was driven by a standard high-performance PC.

The children used a joystick to navigate within the environment. Although more sophisticated input devices were available, we chose the joystick because many children are already familiar with the concept from previous gaming experience. Even though the environment supports multi-user experience and collaboration, the navigation can be controlled by only one user at a time. Pupils can guide the person who has the joystick, which supports the sense of being a member of an exploration team set for a 3D journey.

The virtual environment was modelled using a standard 3D design package (Maya) and displayed using an existing virtual reality toolkit (blue-c API) to enable rapid application development (Naef et al. 2004). The application is configurable to suit a large range of presentation systems, from a laptop computer up to fully immersive environments such as a CAVE and could easily be deployed to schools for further experiments using a portable projection system.

3.3 The design of the environment

The theme of the VRE had been selected after a brainstorming session that involved the head teachers of both primary schools. After explaining how imaginative writing is taught in the classroom as part of the curriculum, they gave some very constructive suggestions regarding the atmosphere and interactions to be incorporated in the VRE. For example, the use of sound effects was considered as very important for conveying the feeling of presence. It was decided that two exposures to the VRE would provide clearer evaluation results, since the first exposure might show mainly effects of novelty or unfamiliarity. The first session should also serve as an introductory demonstration of the technology and the navigation controls; therefore it should not involve difficult manoeuvres and many interactive objects. The pupils saw two different scenes in the VRE: in the first session the outside of a cottage and its surroundings, and in the second session the interior.

First Session – Outside the Magic Cottage: In the first session, the pupils find themselves outside a Cottage (Fig. 1). They are prompted to explore the "Magic Cottage". A dreamy and mysterious track had been chosen for background music, along

Figure 1. a) The exterior of the Magic Cottage b) Various interactive objects in the woodshed

with realistic sound effects of wind, birds and water stream (near the well). Since they are not able to open the cottage's main door and get inside, the pupils start searching for keys and clues. They can open the woodshed door, explore all the objects, read the labels on the vials and boxes, open a book, and pick up a key. After careful exploration they can find a bottle of poison underneath a tree.

Second Session – Inside the Magic Cottage: The second session takes place in the interior of the cottage (Fig. 2). This was designed to be graphically richer, including more interactive objects and sound effects. The crackling fireplace, the boiling greenish liquid inside the cauldron, the noise of lizards, the snoring coming from the bedroom, the creepy laughter and the background music are all contributing to making the atmosphere more dramatic and "spooky".

Figure 2. This image shows the interior of the Magic Cottage.

3.4 The experiment

This study compared three groups of pupils: the *digital group* (six pupils from each school) who travelled twice to the DDS and experienced the virtual model; the *non-digital group* (another six pupils from each school) who also travelled twice to the DDS but did not see the virtual environment before writing (thus offering a control for the excitement, attention and sense of being involved, yet without in fact using the technology); and a *stay-behind group* (12 pupils from each school, of which 6 were selected for detailed comparison of their work) who did not leave the school.

This allowed us to compare two schools, three different intervention groups (*digital, non-digital, stay-behind*) and three writing exercises (two associated with visits to the DDS and a comparison drawn from a previous piece of imaginative writing). The group members were chosen by the head teachers to achieve a similar mix of high, medium and low ability children, and similar numbers of boys and girls, to each group, thus using a form of stratified random sampling.

After the arrival of the groups at the DDS, the *digital group* was taken to the Virtual Reality room. When the group of pupils first entered the VR room, they were given a short introduction of what they were about to see. Then they were given the 3D glasses and advice about where they should stand in order to see the environment in 3D. The *non-digital group* was taken to the meeting room (desks and chairs had been rearranged to recreate the classroom environment). Each session lasted for 20 minutes. During that time the teacher was conducting the usual writing lesson with the *non-digital group*. After the VR session, the *digital group* joined the group discussion. Then the writing exercise lasted for approximately 50 minutes. The pupils who had seen the VRE were told not to mention or describe it to the other children.

For evaluation purposes, the stories were formally assessed by an external marker, and qualitative data such as video recordings, observation notes and interviews were collected.

4. Results

Both groups that visited the DDS enjoyed the outing and especially the digital group got very engaged in exploring the VRE. The variables that this study was aiming to measure and evaluate were *motivation* and *creativity*. Motivation was gauged qualitatively from the video recordings, observation data and teachers' comments, while creativity was analysed based on a comparison between previous schoolwork and the stories submitted.

4.1 Motivation

The hypothesis that pupils would be more motivated to write after exposure to the VRE was tested based on observations by the researchers and the teachers accompanying the visits. On one occasion, it was noticed that two of the six pupils (one of high and one of low previous writing ability) who had had the VR exposure settled into the writing task much faster than the others - they had covered about 3/4 of a page in 10 minutes, when the rest had only written about 1/4 or 1/3 of a page in that time. This could be consistent with the notion that the VRE had primed their imagination with plenty to say, and that that had previously been a bottleneck for them.

According to the teachers, pupils' behaviour was different. The ones who had the VR exposure were contributing more in the discussion. The 3D experience had a stronger effect on boys who are more difficult to engage into writing than girls. Boys often write less than girls and do not get easily motivated, as most topics do not interest them. It appeared that the VRE boosted their motivation, increased their participation in the discussion and settled them into writing faster than usual.

An interesting observation was that most pupils were lively and talkative during the discussion session with the teacher (after the VRE exposure), yet a few found it hard to put their ideas on paper and took them longer than the non-digital children to complete their stories. A possible explanation for this is that the VRE gave this subset of pupils plenty of stimuli but this also made it harder to choose where to begin and what to include or exclude. While the VRE obviously sparked their interest, this did not get successfully expressed in their writing task.

4.2 Creativity

A qualitative examination of the written work was used to test whether the exposure to the VRE actually inspired creativity. On three of the four occasions, the teachers gave a much more considerable introduction to the writing task (to both digital and non-digital groups), not only describing the task but going into some details of topics they might describe and generating a list of key words they might use, which were written up on the white board (Fig. 3). This discussion appeared to aid the digital group by providing them with words to attach to the imagery and sounds of the VRE. A possible explanation is that creative writing requires two different kinds of input: one is the visual image of something worth describing and the other is the verbal means for producing a description. The results demonstrate that this VRE has the potential to stimulate creativity, but that lessons directed at this should perhaps be separate from those directed at improving other aspects of writing.

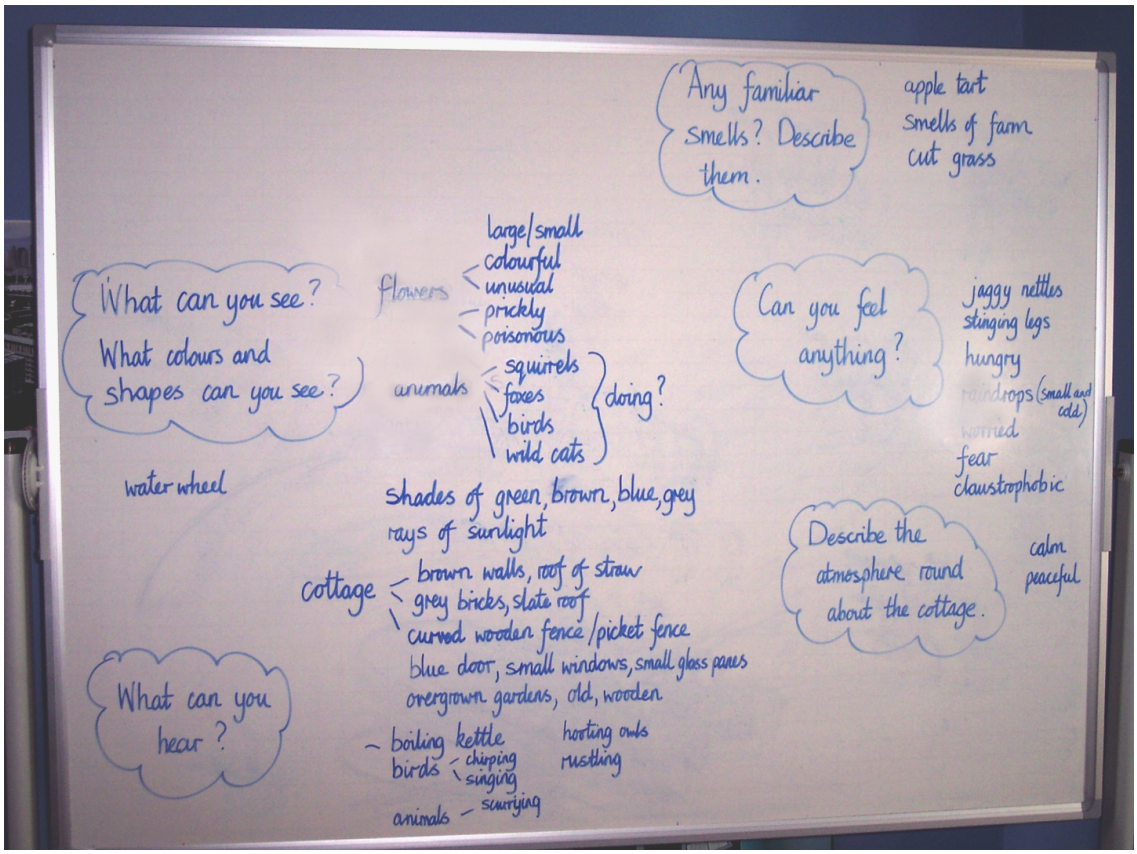

Figure 3. During the group discussion the teacher writes some keywords on the white board

Those who had experienced the VRE had described accurately all the objects they had seen and all the sounds they had heard thus these stories were very similar in style and words. This can be attributed to the fact that the purpose of the activity was not properly assigned. Initially, the written tasks were not meant to be descriptive but imaginative. However, the teachers asked the pupils to describe the Magic Cottage while a different question could have prompted them to use the VRE as a reference and not as the main topic (e.g. “Who lives in the Magic Cottage?” or “ While you are exploring the cottage suddenly the front door bursts open and… What happens next?”). The pupils believed that if their descriptions were accurate they would have completed the activity successfully. This was a shortcoming, and indicates something that needs to be better controlled in future work.

4.3 Formal Assessment

An external teacher was selected to mark the work of all pupils involved using national assessment criteria: two schools, three occasions, three groups each, 108 stories in total. No significant patterns were discernible. The marking scheme, because of its focus on spelling, grammar and sentence structure rather than imagination or story content, did not show systematic differences between groups, whereas a different assessment approach might have provided more evidence regarding the creative aspects of the stories. Pupils are also conscious that assessment of their stories is usually primarily based on the grammar, spelling, punctuation and sentence structure, and much less on the imaginative aspect. Therefore, inevitably, they tend to write a less complicated and intriguing story that allows them to focus more on formal criteria instead of imagination.

Even though the project had focused on designing and building a VRE to suit the needs of the curriculum, the formal assessment criteria were not flexible enough to allow measurement of more ambiguous and less technical aspects of writing. Whereas the recent educational guidelines are emphasising the importance of creativity in schools, the marking scheme does not seem to reflect that. This becomes more apparent when informal learning environments are introduced into the formal educational setting. In such cases, new evaluation methods have to be deployed to gauge the potential educational benefits.

5. Conclusions and Future Work

The trials reported here are small (in terms of numbers of pupils and duration of exposure) and highly exploratory, representing something like a "first contact" between VR technology and school learning. On the other hand, and unlike many studies published in the literature related to educational technology, this was not a laboratory demonstration but a trial involving real schools, and the learning aims and tasks were not chosen to suit the technology nor research purposes, but pre-existing ones already part of the curriculum.

While our conclusions are based on observations and discussions with the participants, it is important to emphasise how far we are from proving anything. The trials are first attempts and what was mainly being sought was clues to possible educational benefits of the technology in actual school teaching. The study threw up hints of educational effectiveness of VRE, but the main overall lesson was that a more detailed consideration of the interaction between technology and writing classes is needed. The computer model used in this trial did not directly support story structure nor of course language. Multiple skills are important: linguistic, imaginative, creative, and descriptive. It is likely that large effects will be seen only if one of these is selected. This divergence of aims stems from the national guidelines for assessment, which are more explicit about technical aims such as spelling, and grammar than they are about imagination and self-expression, even though the teachers, and the National Curriculum, see the latter as an important high-level aim.

The best evidence of potential value for the use of the VRE in this application is that both schools involved and their education authority wish to repeat the study and are funding the second round of trials. Discussions are pending on the form and particular aims for this. For instance, an alternative application of this technology could be to base the 3D

computer models upon the pupils' stories anddescriptions, thus providing a method for giving vivid feedback to the children about the meaning and effect of their writing.

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