# The Vertex Project: Exploring the Creative Use of Shared 3D Virtual Worlds in the Primary (K-12) Classroom

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## Abstract

Children invent imaginary worlds and enact scenarios within them on a daily basis as part of their imaginative play. Given the opportunity and the tools, what kind of worlds would children create for themselves within a virtual space, and what kind of learning can emerge within these playful, child-centered spaces?

In VERTEX, young children inhabit an imaginary virtual world that they have designed and created using 3D modeling tools and net-based virtual worlds software. Crossing traditional subject disciplines and involving local and remote collaboration, the project demonstrates children's design and communication abilities above and beyond the expectations of the curriculum.

## 1 Introduction

There is a growing body of research demonstrating that shared virtual worlds can be powerful educational tools with the potential for transforming the learning experience. Recent studies carried out by researchers at the Electronic Visualization Lab at UIC [Roussos et al. 1997; Johnson et al. 1999] using immersive virtual reality have indicated a range of positive effects on learning, as has work underway at MIT's Media Lab [Bers 1999] using desktop virtual environments. They can present engaging interactive environments for learners to explore, can encourage active participation collaboration and exchange, and can be highly effective tools in teaching complex concepts and ideas.

In the UK, however, where many primary schools are still struggling towards the effective integration of the Web into classroom activity, there have as yet been few concrete opportunities for teachers to explore the potential of these technologies. Working within the demands of a highly structured National Curriculum, where the use of computers is often assigned to the subject area of Information Communication Technology (ICT), few teachers have been able to experiment with more creative, cross-curricula methods in relation to new technology.

The aim of VERTEX is therefore to work with teachers and children to investigate the creative teaching and learning possibilities of shared 3D virtual worlds and to develop and disseminate innovative yet practical strategies for their use across the primary (K-12) curriculum.

For the purposes of this study, we have used net-based virtual worlds. Immersive systems are currently large, costly and their use still requires a high level of technical expertise. For many schools operating within limited budgets and with few resources, there are obvious practical difficulties in relation to implementing their use in the classroom at this time. Net-based virtual worlds, on the other hand, are increasingly accessible. They are inexpensive and run easily on a standard PC with a dial-up connection. As most UK primary (elementary) schools now have at least one classroom-based computer, and over 90 percent of schools are now online, this presents us with a realistic opportunity to introduce and develop the use of this technology in a working classroom.

## 2 The VERTEX Project

The starting point for VERTEX is the importance of learning through making. Taking the constructionist idea that learning can occur deeply and effectively through the making of personally meaningful artifacts and projects [Papert 1980] and the belief that imagination and play are fundamental factors in learning [Vygotsky, 1978], VERTEX places children in the role of designers and producers, as well as users, of these media. In doing so, the project aims to monitor and evaluate the learning that arises through children's direct participation in these processes.

Based in three UK primary schools, VERTEX has involved over one hundred 9 to 11 year olds and their teachers in a three-year program of activities toward creating and populating a small network of virtual worlds. These schools are in very different geographic and cultural locations–Soho Parish Primary is at the very heart of London's West End, Oakthorpe Primary located in suburban outer London, and Firth Primary is situated in a small coastal town on the island of Orkney, off the north coast of Scotland. Each school has a diverse social and cultural mix, including children learning English as a second language and children with a variety of special educational needs. They also have varying levels of access, skills and experience in uses of new technologies, amongst the teachers and children.

In order to establish the project effectively within each unique situation, considerable time was spent in the schools during the initial stages. Working closely with teachers, time was spent devising strategies to integrate the project into the class timetable in ways that ensured the full involvement of all children, in all aspects of project work. Working in the context of a classroom of 32 children and having limited access to computers, the best way to achieve this was to develop methods that did not rely solely on computer-based activity.

While the hub of activity centered on the avatar-based virtual world software ActiveWorlds, the project incorporated both digital and non-digital approaches to developing ideas, progressing designs, and 3D object making. Children used new media in combination with traditional activities, ranging from story writing, collage and drawing to the use of software tools including Adobe Photoshop and 3D Studio Max. In each school they worked together as a class, in small groups, and through online teaching sessions towards imagining, planning, designing, and making their own virtual world and a unique set of avatar characters.

From the outset, embedding the project into a working classroom established a sense of ownership within the schools and amongst children and teachers, allowing a clear direction to emerge based on the different character of each school. It also established confidence and an aptitude amongst teachers in handling new tools and managing the project in their classroom.

Working in this cross-disciplinary way, the project specifically aimed to identify the ways in which involvement in the process of virtual world design and construction can develop children's creative expression and imaginative abilities. In addition, we are examining how working in multi-user spaces

could develop their language skills, communication skills and how working with their peers locally and remotely might encourage collaborative learning between young children.

## 3 Developing the Project in School

Work began in January 2000 and following familiarization with the basic functions of the ActiveWorlds interface, children were introduced to their remote partners through the VERTEX world – a secure space separate from the public network. As their skills and confidence grew, children were taught how to construct their own virtual buildings using the duplication and editing tools built into the browser. They also worked together to create structures using lists of downloadable building objects. In the initial sessions, a remote researcher guided children, but as they became proficient, children would meet, explore and experiment together.

Once these skills were acquired, partnerships between schools had become established and children had been instilled with a sense of purpose for creating their environments—the task of developing their creative input could begin. This involved the children collectively devising the overall concept for their virtual world and its various component parts, designing and making their own objects and models that would shape these landscapes, and creating their own avatar characters to inhabit their new worlds.

Initially, children were encouraged to develop their design ideas through activities such as group discussion, creative writing, and role-play. Once a collective plan had been formed, they progressed their ideas through illustrated maps and elaborate drawings. These images formed a working blueprint for the design of the virtual world. During this time, children were also creating their avatar characters. This activity usually began using a 'hot-seating' exercise, through which they described their personality and appearance in role. Following this, the children then created designs for their characters in the form of elaborately collaged, movable puppets or as detailed drawings in their workbooks. All these procedures happened as whole class activities directed by the teacher and were linked to various curriculum areas such as literacy and art, as well as ICT, establishing cross-curricular ways of working.

Once the overall picture of each world and its inhabitants emerged, the next stage was to transfer their designs into the computer. In order to do this, they would be using digital photography and 3D modeling tools, namely Adobe Photoshop and 3D Studio Max. Bearing in mind the primary geometric shapes used for building in ActiveWorlds, children mapped out the designs of individual building blocks and objects needed to realize their ideas.

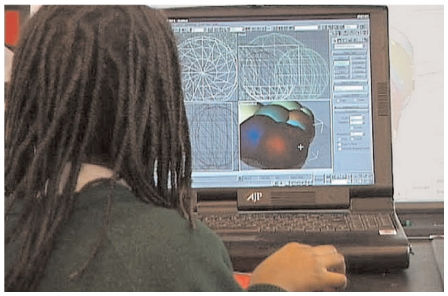

**Figure 1: Shanni creating a cloud in 3D Studio Max.**

3D Studio Max was introduced to whole class groups using a projector and this first demonstration was used as an opportunity to show children how their puppets were to be transformed into avatars. This involved scanning them into Photoshop, creating a path and exporting it to 3D Studio Max where it was extruded into a 3D figure. While illustrating this step-by-step procedure, time was spent taking children through the aspects of the program they would need to learn in order to create their building objects. Following these sessions, children were all given the opportunity to play informally with the program. For several weeks following this introduction, children participated in concentrated teaching sessions with the program, as shown in figure 1. To gain the level of competency necessary to create their objects, they needed to learn several basic functions of the program–how to create, combine, and modify simple 3D objects using standard and extended primitives, as well as how to create and map textures onto the objects using the Materials Editor. In order to facilitate this, each child was given the task of creating a tree, made from two or more textured 3D shapes. In preparation for this process, children began creating libraries of images to use as Texture Maps. They did this by participating in 'Texture Hunts,' using a digital camera to collect interesting and unusual patterns, shapes and colors from in and around their schools.

As we had anticipated, once working in 3D Studio Max most children understandably struggled with the interface, finding it cumbersome and difficult to manage. They also had difficulty organizing their work spatially. However, it was particularly interesting to observe that the level of excitement associated with creating a 'real' virtual object to add to their world created a powerful motivation and impetus for them persist and ultimately overcome these difficulties. With much repetition, practice, and reinforcement over several weeks, children became more confident and skilled, and began to experiment–making clouds, creatures, furniture, robots, flowers, abstract sculptures, and building blocks to make houses, palaces, and playgrounds. Once completed, their objects were placed on the ActiveWorlds server, where the children could download them and begin the process of constructing their own imaginative shared 3D virtual worlds. Figure 2 shows one such example.

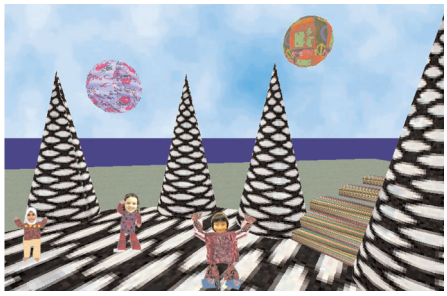

**Figure 2: Children dancing in the Astronomic Space Disco.**

## 4 Emerging Issues

As we move into the final stages of the project, a number of issues have begun to emerge that we will be investigating more closely. These notably include:

- *Based on work carried out so far, there are strong indications that virtual worlds can be used to great effect as a hub of activity for whole class project work.*

Working in this way can act as a catalyst or an imaginative bridge for children, enabling them to make meaningful links between ICT and other subject areas in the curriculum. An example of this emerged through science topic work while assessing children's understanding of how animals adapt to their environment. Normally where children would be asked to write about an animal such as the Desert Rat, teacher Judi Hammill

assigned children to design a virtual animal and to describe how this imaginary creature developed its characteristics to suit its unusual habitat. The extensive work produced by the children demonstrated how learning can become more creative when connected to something meaningful and significant to the child's experience.

- *Storytelling and imaginative writing provided a starting point for children to think creatively about their project.*

As work progressed, their activities and encounters in the virtual space began to act as a stimulus for further writing and storytelling in other areas of classroom activity. Teachers working with the project noted that boys in particular, who in general underachieve in literacy at this age (most especially in imaginative writing), showed considerable improvement in their imaginative writing skills when relating work to their virtual world activities. Additionally, teachers have identified the potential benefit for children learning English as a Second Language.

- *Working together in the virtual world demonstrated the potential to significantly develop children's collaborative and communicative skills.*

Through participation in an online project, children learned to skill share and problem solve and worked collectively to develop a sense of joint authorship and ownership. Several children working at one computer has its drawbacks, but there are also advantages as it stimulates conversation about the task. Children by necessity learn to cooperate. In addition, there is potential to form partnerships between significantly different locations. This presents a valuable opportunity for children to explore ideas of difference through sharing stories about each others lives, cultures and experiences

- *There have been strong indicators that children with Special Educational Needs can benefit from working with virtual worlds.*

All children have been highly motivated by working with these technologies, but this has been especially noticeable among children with learning difficulties and children who are otherwise under-motivated or disruptive. This can be attributed to a child-centered approach that involves small group work, but also to the game-like quality of virtual worlds, which engages children playfully and encourages them to keep trying where they may otherwise give up. Teachers have noted a significant increase in the confidence and self-esteem of some children and their achievements in areas such as ICT are developing beyond expectations in relation to the primary curriculum.

## 5 Conclusions

Although there have been many positive outcomes so far, there are still a number of areas in relation to technical implementation that need further investigation and adaptation. Currently, the means by which children build their avatars and objects is through the use of professional authoring tools such as 3D Studio Max and Adobe Photoshop. Whereas there are learning benefits from using such software, there are also several problems:

- There is a considerable time and cost—both for the children in becoming competent with these complex tools and also for the educators in teaching the relevant skills, once they themselves have acquired them.
- The tools are not integrated with the ActiveWorlds browser, which means that children lose engagement with the focal environment that they are building.
- The process currently involves a lengthy delay between children making artifacts, and those objects subsequently appearing in their 3D world. This lack of immediacy can affect the children's enthusiasm and also unnecessarily prolong this aspect of their VERTEX work. This delay is partly a result of the modeling being done outside the browser and also because technical support is required to process the children's models and place them on the ActiveWorlds server.
- The professional authoring tools can be expensive. The ability of most schools to afford them is questionable.

To address these issues, it is proposed that new tools need to be developed. These tools should be fully integrated with the 3D browser, allow direct construction of objects within the 3D world and whilst having simple interfaces, have sufficient functionality to enable children to build their worlds. There are currently no proprietary tools available to do this. Several solutions to this problem are currently being investigated including using ActiveWorlds Bot technology to develop object construction assistants and using Macromedia Director 8.5's 3D authoring capabilities.

During the past two years the children working on VERTEX have achieved a remarkable amount, individually and collectively, with the software and hardware at hand. It is their work, very often beyond our expectations, which has allowed us to plan for the future developments and challenges of this project.

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