The Vertex Project: Children creating and populating 3D virtual worlds

Fiona Bailey & Magnus Moar

Abstract

This paper outlines early investigations and initial outcomes of The Vertex Project, a school-based action research project currently underway at Middlesex University. The project aims to explore the potential of Shared 3D Virtual Environments as creative learning tools for children, and looks into the challenges facing their practical integration into the primary classroom. Working in partnership with three primary schools, the project sets out to investigate the teaching and learning possibilities offered by Internet based 3D virtual environments, placing particular emphasis on the opportunities provided by the active participation of children in the design and construction of their own virtual worlds, and in the creation of avatars with which to represent themselves within these spaces.

Introduction – what is a Virtual World?

A Virtual World is a kind of world that's different to our world – but in a way it is like our world – it's kind of like in the middle.
Maria, Oakthorpe Primary School

The Vertex Project is a school-based action research project which sets out to investigate the creative applications of three-dimensional shared virtual worlds technologies in primary education

Terms such as Virtual Worlds, and Virtual Community or Virtual Reality, although still relatively unfamiliar in the context of primary education, are nonetheless gradually creeping into the everyday vocabulary of both children and teachers alike, helped by the rapid expansion and increasing sophistication of the Internet over the past few years.

Only a few years ago, the Internet was itself still relatively unfamiliar and inaccessible in relation to primary schools in this country – even as recently as 1998, only 17 percent of primary schools were online [1]. The past few years have however, seen an extraordinary growth in Internet use in the education sector, and by September 2000, this figure had risen to 86 percent – representing 15,610 primary schools currently connected to the Internet [2].

The growth of the Internet has not only been in relation to network size and number of users, but there have also been significant technological advances which have affected the volume and type of content available. Since the launch of the Web in 1993, what was previously a small, exclusively text based communications system, has developed into a vast network supporting a diversity of interactive media including image, sound, animation, and video, enabling a range of new online activity to emerge, for example video conferencing, web-casts, and live chat rooms. Consequently, Internet based virtual environments and communities of all descriptions have evolved and continue to develop rapidly [3], and with the expansion of computers and computer networks in schools, virtual reality is likely to have an impact in the classroom in the not too distant future.

Virtual Reality as a field has broad applications, and developments in this area range from immersive gaming systems through to high-level research into medical and surgical simulation [4]. There is also growing recognition that as a media-rich, interactive communications medium, Virtual Reality holds enormous potential in relation to education, and research projects such as The NICE Project, (UIC) [5], and MIT's Zora [6] are innovative examples of how educationalists are approaching these new technologies.

But what is Virtual Reality, how accessible is it, and how can we approach its use in a classroom setting? Can Virtual Reality develop and enhance the learning experiences of young children, and if so, what are the practical challenges that face teachers in the light of these new technologies?

For the purposes of our research, we are focusing our investigations on the area of Virtual Reality known as multi-user, or shared 3D virtual worlds – virtual environments accessible on Internet. They are known as 'shared' virtual worlds by virtue of being on the Internet, enabling any number of users, from a number of remote locations to participate at the same time, in real time. Related to the now more familiar text-based or 2D chat rooms (for example The Palace or MSN Messenger), they distinguish themselves by incorporating a three-dimensional interface – a simulated space, or 'virtual world' into which the user can enter, move around in and interact within, using a 3D animated character called an avatar.

This 'avatar' represents you, the user. This is your on-screen persona, and has various actions (e.g. walk, run, wave, jump), gestures which you control using the keyboard and mouse, enabling direct visual interaction with the environment and with any other avatars you may meet in the space. Objects encountered in the environment may have simple interactive properties, which when triggered, activate sounds, animate sequences, shift your position or launch web pages. As with text-only chat-rooms, these spaces include a 'chat' facility, which allows real time conversation with the other participants using text input and (with

certain software) direct voice-to-voice communication. The overall effect of this audio-visual interface can be very engaging, resulting in an authentic experience of exploration, interaction, collaboration and exchange.

Additionally, one of the most interesting features of these technologies in relation to our research is the built-in facility which allows the user to design and construct personalised environments on-line, which can subsequently be added to, edited, reconfigured and extended. An informal survey of the virtual environments currently available reveals 'worlds' created by groups and individuals ranging from distant planets to underwater cities, from glittering shopping malls to rolling, wide open spaces. This creative capability opens up a range of unique applications when approaching the use of this technology in an educational context, as it provides access to a range of new tools which enable children to become designers and makers and not simply passive users of these media.

It is the combination of these communicative, collaborative, interactive and creative, facilities that makes these media technologies so rich in potential in relation to teaching and learning, and these are the key areas of investigation within The Vertex Project – and it is the idea that children can design and create spaces themselves, and populate these worlds with their own virtual characters, which forms the starting point for the project.

ActiveWorlds

Our pilot studies for the project began in schools in September 1999, but before embarking on any work with the children, the core technologies needed to be clearly identified. From a wide range of possible software (for example Blaxxun, OnLive Traveller and Superscape) [7], we eventually selected one called ActiveWorlds [8] – the biggest criteria in this choice having been ease of use, and the ability to edit and construct easily within the environment (Figure 1)

It was important that the interface was as

Above:

Figure 1
The ActiveWorlds Interface, here showing an avatar in the world A'tuin, (centre), gesture and navigation buttons (top) list of available worlds (left), text-chat area (bottom) and a linked web page (right).

accessible as possible for the age range (7 to 11 year olds), in that they should be able to create their own objects and spaces with a minimum of training. Although not as sophisticated in appearance as some of its competitors, the ActiveWorlds interface appeared to fulfil these criteria, not least because it has a very game-like quality and appearance, and there was a possibility therefore of a certain amount of familiarity and skill transference by some children from their use of game consoles.

We were also attracted to ActiveWorlds by the fact that it had a large and active community of users, linked not only through meeting in the shared worlds themselves, but also via a number of newsgroups which could potentially be helpful to the project. Even more interesting was the fact that they had recently launched a virtual community dedicated to developing educational uses of shared virtual world technologies, the Eduverse [9]. We felt this initiative would be very useful in bringing together like-minded educators and researchers, and it would be particularly useful for the schools to have access to an established, and growing, network of educational users. This would also mean that schools could work in a secure environment not accessible to the general Internet public.

Another desirable feature of ActiveWorlds is that it has a web browser integrated into the interface, (by default Microsoft's Internet Explorer), which means that children would be able to access web sites containing supportive information, and would also offer the creative possibility for children to create their own web pages which can be linked to their world.

Crucially however, the software included tools that would enable children to create their own virtual spaces using either on-line galleries of virtual clip-art, and by creating and uploading their own original three-dimensional objects and artwork.

Having identified the software, we were ready to introduce the project into the classroom. We did this bearing in mind that the children's responses may result in the need to adapt, modify or even exchange this software according to their needs, and to ensure the most appropriate tools were being used to pursue the pedagogic aims of the project.

Pilot Studies – What the children have done so far

The over-arching aim of The Vertex Project is to explore the teaching and learning applications of these new technologies in a primary setting, and to investigate the possibilities of developing creative cross-curricula approaches for their use in the classroom. In order to do this effectively however, we needed to identify a much more focused area of investigation and map out a clear set of research questions.

Our approach to the project builds directly on our own previous research in the area of children's creative uses of multimedia [10] and draws upon experience gained from projects developing children's interest and abilities in communicating over networks [11]. Central to our approach therefore, is creating opportunities for children to use technologies creatively, expressively and collaboratively – an emphasis being on the importance of children experiencing learning through making, together with the development of peer-to-peer communication and collaboration via the networks of the Internet.

In order to examine the range of possibilities, over the past year we have worked in partnership with three schools – Soho Parish Primary and Oakthorpe Primary in London, and Firth Primary in Orkney. These schools were selected not only for their enthusiasm and ability to participate, but also because we felt that the very different geographic locations (urban and rural) and the diversity of cultures between these locations, could create a strong basis for partnership and offer a wide range of possibilities for exchange and interaction between the children. Working closely with teaching staff, over the year regular workshops were carried out in the two London schools, with Firth Primary's imput being co-ordinated in Orkney by the Headteacher in consultation with ourselves.

This first phase has essentially therefore been an experiment – an exploratory period for researchers, teachers and children alike. Focusing on Key Stage

2, we have introduced virtual environments into various classroom and group settings, run workshops with children and developed a range of ideas and curriculum links with key teaching staff.

Working in small mixed ability and mixed age groups of between four to eight children, as well as a whole class, children have familiarised themselves with the software, learned to control and navigate using their avatars, communicated with their partner schools, and learned to build their own structures.

The software was initially introduced to children in small groups (Figure 2) with little or no instruction or background information in order to find out how they responded to the interface itself and the related navigation, control and construction tools, how they responded to using avatars, and also to gain some insight into their understandings of the concept of virtual reality.

Following these initial sessions, the children were introduced to their partner schools within the virtual world, having regular meetings with each other over the year, exchanging information about each other and where they live. Children also began learning to use the building tools and working together to create their own simple structures using online libraries of 3D clip-art, and began visualising and making preliminary designs for creating their own avatar characters.

Observations and documentation were ongoing throughout this period, and a range of interesting issues and possibilities have emerged as a result. A number of key questions and potential areas of development have arisen from these initial studies, and these will form the basis for the second phase of the project.

Initial observations and outcomes

From observations during the pilot year, we found that the children were immediately drawn to the technology, responding with excitement and enthusiasm and remaining highly motivated and engaged throughout the process. Children and teachers alike found the interface accessible, quickly becoming familiar with the controls, navigating the space intuitively and with relative ease.

It became apparent through early observation and questioning that all the children involved already had considerable experience with computers, and a majority had access to computers at home. All of them used the Internet regularly – mainly for homework (or so they claimed!), and all either had a Playstation or played computer games regularly.

Above:

Figure 2
Children at Soho Parish Primary exploring the Vertex world

About half the children had heard of virtual reality, and several could describe it in some way, for example:

A Virtual World is something that you imagine. It's not real life – you think it up.

or alternatively:

Virtual Reality is … say if like everything all around you is different and there's chips everywhere and that, and it's all very confusing and stuff. [12]

Some had experienced virtual reality in some shape or form, (for example one child had taken a Virtual tour of London on the PC, and another had taken a ride on a virtual roller-coaster in Skegness). There was therefore a certain awareness, if not full understanding of the concept. No children had, however come across Internet based virtual worlds, so for all of them this was a first time experience.

Almost without exception, the children initially approached the environment as if it were a game, and continued to refer to the activities as 'playing' throughout the pilot phase. Regardless of its game-like appearance however, within a very short space of time it became apparent to them it was not the same as a game. It would not do what computer games do – you could not kill or be killed for example (something most children were preoccupied with at first). Also there is no identifiable structure as such that you would find in a game – for example a quest, a puzzle, or a stated goal. Neither do you win or lose.

Interestingly however, once they realised what it would not do, rather than becoming bored and discarding it (which was an initial concern), they very quickly and eagerly moved on to find out what it would do – and for the majority of them the fascination was firmly rooted in the fact that they could talk to other people:

It was really, really, really good. It was like a computer game but much better really because you can control it and you can talk to other people, live.

and, they could make things:

The best thing about it is you can make things – and I really like making things [13]

Communicating and interacting

The exploration of various 'worlds' although initially intriguing for the children, proved to have limited appeal. There was certainly a novelty value in this to begin with, but it quickly became apparent that children spent most of their time searching for other people. Exploring was only of interest if there was someone to explore with, or someone to find. Consequently, children looked forward far more to sessions when they knew they would meet up with other people, most especially with the children from the other schools.

They found using text-chat a little difficult at first, not getting far beyond asking each other's name and age, but with the introduction of a clearly identified topic and a little advance preparation, children quickly grew in confidence and exchanges became purposeful and more fluent.

Interest in these exchanges was certainly enhanced by the use of avatars (Figure 3). As a means of facilitating interaction between children these characters proved enormously successful, each child trying on numerous different avatars before moving further into the world. Dressed as their favourite avatar, the children would then actively seek out other avatars, engaging them in conversation and using the gesture buttons to wave, dance, fight, turn cart-wheels and play 'it' with each other.

For some children the experience of using an avatar was particularly powerful and they identified strongly with their character, describing the experience as:

You feel like you're there and you are the avatar … like you're looking through the avatar's eyes not your own eyes, because you can see everything so clearly [14].

Some viewed the avatar more as a character which they controlled (much like a character in a

computer game), but it was still used nonetheless as the primary vehicle for initiating contact and conversation with others in the space.

All the children expressed an interest in making their own avatars. Even though they enjoyed using the avatars, they were not entirely happy with the off-the-peg choice available to them, primarily because they did not resemble them (interestingly, all the available avatar characters are adult). Ultimately, most children wanted to make their avatar look like themselves (give or take a monster or two!):

Because if you, like, design your own one, the person that you meet would kind of get an idea of what you look like instead of just seeing an avatar there [15]

There was often uncertainty about the status of the various avatars they met, as they often were unsure whether the other character was real or was simply a computer-generated character.

I don't notice at first that there was actually someone else in it working with us I thought the computer just put him there … but when we were asking him things he was responding in a person's way [16]

For most children, they felt that the experience of meeting others in the world would be more genuine if they could appear as themselves, and they would be more engaged by the experience if they could see what the other children looked like – confirming they were human, as well as satisfying their curiosity. Looking like themselves would in the same way confirm their existence to others they met. There was also a strong feeling on the part of the children that voice-to-voice communication would further enhance the experience for them, not only because typing was quite a slow process, but also because they wanted to hear the other children's voices.

Building

Once the children had become familiar and confident with the interface, finding their way around and communicating in the environment, we introduced the idea of building. For them, the idea of being able to create their own structures and spaces held a particular appeal. They immediately had ideas about creating their own entire planet, and ideas for everything from worlds made from sweets with midget gems trees, to outdoor adventure centres with rock climbing and bungee jumping emerged.

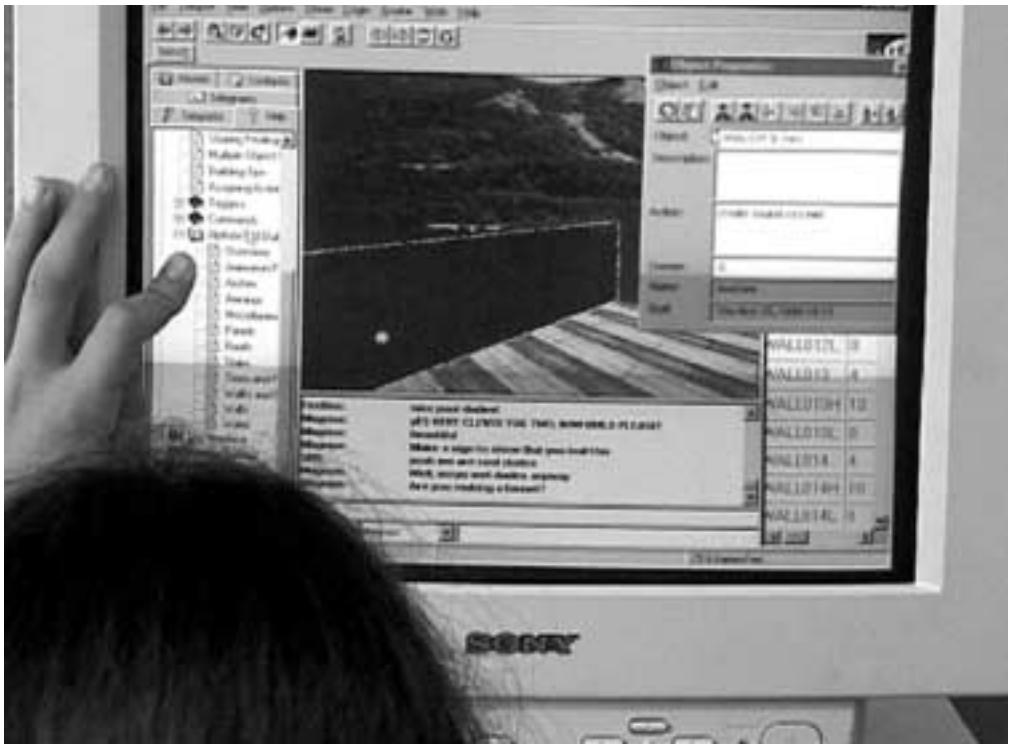
Building in ActiveWorlds is however quite an involved and complicated process, so we had to begin with a little more restraint.

Unfortunately, the tools for building are not very intuitive, involving the duplication of existing objects in the environment, and then the editing of that object's properties. This process however, once mastered, enables children to build using what could be described as 3D virtual clip-art – piecing together ready-made walls, floors, doors, roofs, trees, flowers and the occasional water feature to create their own virtual spaces.

In order to achieve this, children have to select an object by clicking on it using the right mouse button, which activates a window containing several property fields. They must then bring up an appropriate 'building help' web page by selecting the relevant item from the 'Help' menu. After perusing long textual lists of the available objects (there are no visual clues as to the objects appearance), they can select an object and then type its code into the appropriate property field in the activated window (Figure 4). If completed success-

Above left:

Figure 3
Children at Oakthorpe Primary communicating with an avatar



fully, the chosen object will appear in the environment, but will still need orientating and positioning, a difficult process only achieved by using a combination of cursor keys and on-screen arrows buttons – quite a feat in simulated 3D space.

Initially we were very worried that children (especially the younger ones) would find this process too cumbersome, if not impossible, and would understandably tire of it very quickly. However, regardless of the difficulties, without exception, children were absolutely determined to create something of their own, and as a consequence were each able to build some very imaginative and even quite complex structures after only 20 to 30 minutes tuition. All the children needed reminding of this process at the start of each subsequent session, and every time the process was reinforced, many children have become consequently quite accomplished builders, stretching the creative limitations set by the clip-art list to produce a range of weird and wonderful constructions, including a giant pizza, a multi-story swimming pool and a forest of fir. The children subsequently enjoyed visiting and exploring each other's structures, and giving guided tours around theirs' – showing a marked preference for this activity over exploring other, perhaps more sophisticated and ready-made worlds.

Working in pairs or small groups for these activities, another significant aspect of the process which emerged was the discussion and collaboration these tasks generated. Children worked remarkably well together at the computer, discussing, planning and negotiating the direction of the activity. There was also a significant development of children working together over the network, helping each other to build, and directing less experienced users how to navigate and use the controls. As one teacher commented:

The collaborative elements have come out very strongly. They are working well as a team in a way that sometimes you can't get them to do in other subjects say Maths, literacy. Even though you

encourage group work, they often retreat back into their own agenda. On the computer (in Vertex) they have to work as a team, they can't do it on their own – it doesn't work like that. [17]

A major achievement in this respect was the construction of an interactive maze, which was built collaboratively by eight children working together across the network (Figure 5).

Regardless of the children's successes in this area, 'building' remains a laborious process which needs further technical attention as the project progresses. The children felt that it would be much easier if they could 'drag and drop' objects into position using the mouse, and felt that the addition of a simple visual rather than textual list of objects would make the process more manageable. There is also the issue of creating original objects, as the library objects, although useful for developing the children's skills, quickly become limiting, and the children need the opportunity to develop their ideas and create their own objects.

Based upon these initial observations, the project has secured funding for a further three years from Middlesex University. As we are nearing the completion of the pilot studies, all these issues and responses are now informing us as to the way forward for this next phase, and it is during this time that the project will build upon and further investigate the potential of these technologies.

The Next Phase – Where to now?

The pilot studies have shown that children respond very positively to these technologies. Teachers have also all responded with great enthusiasm and have together with researchers begun to identify a number of areas for potential further exploration and development within the curriculum.

The main areas which emerged as holding significant potential for further study were the communicative, collaborative, and creative possibilities embodied in this technology. The initial findings of the project strongly suggest that there is wide scope for further investigation into the use

Left:

Figure 4
Building using the online help pages and object lists

Above:

Figure 5
An avatar negotiating The Amazing Maze, built collaboratively online by eight children

of shared 3D virtual worlds in the primary classroom. These technologies clearly have exciting possibilities within Art and ICT, but also show great potential for extending a creative approach to teaching and learning across the wider curriculum – most particularly, for example within areas such as Literacy and Geography.

In relation to these curriculum areas, a number of key questions have now been identified which will underpin the project during its second phase, namely:

- How and to what extent does the construction and use of interactive virtual environments and characters develop children's creative and imaginative skills and provide opportunities for self-expression?
- How will the interactive nature of the technology impact upon children's language, communication and critical skills – thinking, speaking, listening, writing and visual expression?
- To what extent can virtual technologies and associated software tools develop children's skills and confidence in ICT?
- To what extent can virtual environments develop children's self-confidence and social skills, and encourage problem solving and collaborative learning between children?
- How and in what way can working in shared virtual environments develop children's understanding and awareness of their own and other children's lives, cultures and experiences?

In order to investigate these questions, (and no doubt to raise more), the second phase of the project will begin in September 2000 and develop over three academic years, extending its involvement with its established school partners.

During this time, the overall aim of the project will be to investigate the use of 3D virtual worlds' software as media tools with which children can express themselves imaginatively and creatively, and to use the real time communications capability to encourage children to explore and share their ideas, and work collaboratively with each other over the Internet.

As a framework within which to address these questions, we aim to work directly with children in a hands-on, constructionist way, enabling children to create a network of virtual worlds through collaboration with each other – each world representing a different school. Facilitated by multi- media artists and designers, children will participate in the creative process of designing and constructing their environment through the use of traditional as well as virtual tools, ranging from drawing, collage, and photography to image manipulation and paint programmes, 3D modelling and animation packages, and web design tools.

Each world will have its own name and location – virtual environments each with their own specific set of characteristics as defined by each group of children. Children will work together to design and create the physical and social structures of their new community: the landscape, the architecture, the different public and personal spaces – communal areas, play-spaces, living areas, individual homes. The children's constructions will draw upon their own lives and experiences, and they will populate these landscapes with interactive avatars, based on their own characters and personalities, communicating something about themselves and the real world environments they live in.

As each world develops, they will be linked together, enabling children from each remote location to visit each other's environments in order to meet, play, explore, exchange ideas, share skills and work collaboratively on specific projects or assignments.

It will be these activities and their outcomes that will be monitored throughout the three years in order to address the questions posed above, and to evaluate exactly how, and what, children learn through actively engaging with these technologies.

Towards the end of this next phase, as well as children having created a new network of virtual worlds, the objective will be to produce a teaching resource based on the processes and outcomes

of the project. This will aim to give a practical insight into utilising shared 3D Virtual Worlds in the classroom, point towards some possible ways forward for teachers, and aim to identify clear areas of connection for future development in relation to Art, ICT and the wider curriculum.

References

1. DfEE Press Release, 6th September 2000 http://www.dfee.gov.uk/ICT/results

2. DfEE Press Release, 6th September 2000 http://www.dfee.gov.uk/news/news.cfm?PR_ID=986

3. Jones, S. G. (Ed.) [1995] *Cybersociety. Computer Mediated Communication and Community.* Sage Publications; and Shields, R. (Ed.) [1996] C*ultures of the Internet. Virtual Spaces, Real Histories, Living Bodies*. Sage Publications

4. See for example, Waterworth, J. A. [1998, 1999] *Virtual Reality in Medicine: A Survey of the State of the Art*. Department of Informatics, Umea University, Sweden http://www.informatik.umu.se/~jwworth/medpage.html; Virtual Reality Games Network http://www. vrgames.net; Cybermind UK http://cyberminduk.com

5. The NICE Project (Narrative Constructionist /Collaborative Environments) Interactive Computing Environments Lab and the Electronic Visualisation Lab at the University of Illinois at Chicago. http://www.ice.eecs.uic.edu/~nice; Roussos, M., Johnson, A., Moher, T., Leigh, J., Vasilakis, C., & Barnes, C. 'Learning and Building Together in an Immersive Virtual World', in Winn, W., and Moshell, M. [Eds] *Presence* vol. 8, no 3, June 1999, special issue on Virtual Environments and Learning. MIT Press, pp. 247–263; or http://www.ice.eecs.uic.edu/~ nice/tile/NICE/NICE/PAPERS/PRESENCE/presence.html

6. Bers, M. [1999] 'Zora: a Graphical Multi-user Environment to Share Stories about the Self'. MIT, Media Laboratory. http://kn.cilt.org/csd99/A03/A03.htm

7. Blaxxun Interactive http://www.blaxxun.com; Onlive! Traveller http://www.onlive.com/; Superscape http://www.superscape.com

8. ActiveWorlds: http://www.activeworlds. com

9. ActiveWorlds Eduverse: http://www.active-worlds.com/edu/

10. Moar, M. [1998] 'The Construction of Dynamic Documents by Children'. PhD Thesis. Open University; Bailey, F. 'The Rosendale Odyssey'.[1995–1997], A Multimedia Storytelling project involving Rosendale Infants School and The Photographers Gallery. Exhibition, CD-Rom and website. http://www.iniva.org/rosendale. See also, Sinker, R. [1999] 'The Rosendale Odyssey. Multimedia Memoirs and Digital Journeys', in Sefton-Green, J. (Ed.) *Young People, Creativity and New Technologies. The Challenge of Digital Arts.* Routledge

11. 'A Tale of Four Cities' [1997–1999), devised and co-ordinated by Bailey, F. International email and image exchange between children in London, Nairobi, Cape Town and Dhaka. Exhibition and website. http://www.photonet.org.uk/programme/projects.html; Garner, R. and Gillingham, M. [1996] *Internet Communication in Six Classrooms. Conversations Across Time, Space and Culture*. Lawrence Erlbaum Associates, Publishers.

12. Stephanie and Anthony, Oakthorpe Primary School. From a taped discussion with Bailey, F. [1999]

13. Joe and Fataha, Soho Parish Primary School. From a taped discussion with Bailey, F. [2000]

14. Maria at Oakthorpe Primary School. From a taped discussion with Bailey, F. [1999]

15. As above

16. As above

17. Mahabir, S. Year 3 Teacher and ICT Co-ordinator at Soho Parish Primary. From taped discussion with Bailey, F. [2000]