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# Video Conferencing the experiences of a mathematics teacher

By

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#### <u>Abstract</u>

Video conferencing is a relatively new technology for primary schools in England and it is normally used as a tool for distance learning. This thesis is a phenomenological case study that describes a course of mathematical enrichment sessions delivered through the medium of video conferencing to a group of 36 able children across six primary schools. The sessions are delivered by me, which gives the study a reflective and reflexive aspect since I have a dual role as both the teacher and the researcher.

As well describing the experiences of the children, there is a focus on the teaching strategies that are used in this virtual environment and how they evolve over time. The thesis is structured around a framework of teaching strategies consisting of four categories; cognitive, compensation, metacognitive and affective strategies. The project makes use of video recordings, children's diaries, a personal log, lesson plans and interview transcripts and the methods used include visual discourse analysis and Bloom's method of stimulated recall.

Successful and effective are the terms used for describing the outcome of a video conference in relation to technology and pedagogy respectively. This study shows that the evolution of teaching strategies is centred around creating routines to address the uncertainty of the virtual environment rather than focusing directly on pedagogy.

The three major findings of this study are:

- 1. Site facilitators are not an essential requirement for ensuring the smooth running of a video conference. This study has shown that the participants themselves are able to take on any required responsibilities in this area if the number at each endpoint is relatively small (i.e. between four and eight participants).
- 2. Remote behaviour management and monitoring strategies are an important aspect of the video conferencing tool-kit for teachers. This study has demonstrated the importance of screen layouts in facilitating the use of such strategies.
- 3. The production features associated with children's educational television programmes may be able to inform effective pedagogy for teaching and learning through video conferencing. In particular, this study has highlighted the potential of using theme tunes as auditory anchors to emphasise key points during a video conference.

By the end of this study, it will be argued that the children enjoyed taking part and they became more independent as learners. Furthermore, it will be shown that if the teaching strategies are appropriate and if the mathematical content is enriching and open-ended, then video conferencing can create valuable learning opportunities for children that are not readily available in the traditional classroom environment.

#### **CHAPTER 1 – INTRODUCTION**

'There are many teachers who could ruin you. Before you know it you could be a pale copy of this teacher or that teacher. You have to evolve on your own'

Hunt, A. 2007

This thesis is a case study focusing on a course of mathematics enrichment sessions that I delivered using video conferencing technology. The recipients of these sessions were a group of approximately 36 children spread across six primary schools. This thesis explores the decisions that were made in the planning and delivery of the sessions and the experiences of the children. The research is also reflective since I consider the teaching strategies used with a focus on explaining how and why they evolve.

This thesis is exciting and timely since the use of video conferencing technology in the classroom is growing year on year, whilst the literature related to video conferencing in the context of primary schools is sparse. This new area of research is naturally exploratory and attempts to uncover and understand some of the key issues.

Chapter one will consider the background to this study. It will outline the provision for children who are considered to be more able in mathematics including the implementation of *enrichment* and *acceleration*. The end of chapter one will look back at the pilot project that preceded this study and will consider the early decisions made, the consequences of those decisions and their impact on the main study.

Chapter two will be a thematic review of the relevant literature based on the opportunities and constraints of video conferencing and on teaching strategies. The key issues will be discussed and

the gap in the literature to be filled by this thesis will be outlined. The literature related to teaching and learning strategies will be used to develop a framework that will in turn be used to structure chapters five to eight.

Chapter three will establish the research design and the methods of data collection to be used. The use of a phenomenological case study methodology will be justified as will the use of the method of stimulated recall. The ethical considerations will be outlined and this will include not only the general concerns of undertaking educational research, but also those specifically related to working with video data and children. By the end of this chapter, the reader should have a clear idea of how the research will be conducted.

Chapter four will begin by describing the individual circumstances of each of the schools involved in this study. Pseudonyms will be assigned to both the schools and the children so that they can be clearly referenced throughout the thesis. The remainder of chapter four will focus on the experiences of the children.

As described earlier, chapters five to eight will be divided in accordance with the teaching strategies framework developed in chapter two. I will not detail the contents of these chapters in depth at this stage, but I will outline the chapters now to give the reader an idea of the overall structure of the thesis. The structure will be such that cognitive teaching strategies are covered in chapter five, compensation teaching strategies in chapter six, metacognitive teaching strategies in chapter seven and affective teaching strategies in chapter eight.

Chapter nine will bring together the analysis from chapters four to eight and seek to answer the research questions. In this chapter, I will make clear what contribution to knowledge this thesis has made and will seek to position this study within the field of existing research.

At this stage, it is worth clarifying that in this study I had a dual role as both the teacher and the researcher. This may sometimes cause confusion and so in cases of uncertainty, I have sought to make this distinction clearer by including "Adam the teacher" or "Adam the researcher" where appropriate. This dual role is discussed further in chapter three in the context of reflexivity.

I will now outline my personal and professional circumstances to give the reader an idea of why this research is of interest to me. My name is Adam Boddison and I am 28 years old. When I started this research, I was teaching mathematics at the local comprehensive secondary school. I had recently completed a Masters in Educational Research Methods and was keen to understand more about how research could inform classroom practice. Fortunately, the opportunity to undertake this case study came about and I began work planning it. I was able to secure complete funding for the technology and basic infrastructure required for this project, but only partial funding towards my tuition fees and no financial support with my living costs. Therefore, in order to financially support myself I taught alongside my research.

As teachers, we are constantly having our performance in the classroom evaluated through lesson observations, examination results, parents' evenings and OfSTED amongst other things. It can be difficult to know what to do for the best, but we do have our own experiences to draw upon as well as support from our colleagues and official guidance. However, there are occasions when we encounter new contexts for which (i) such guidance and support may be less accessible, (ii) our own experience may be limited and (iii) there is an uncertain research base. Such a context might be brought about by new technology, which was the stimulus for this research project.

As a secondary school mathematics teacher, one of my responsibilities was to work with local primary schools on transition from key stage two to key stage three with a focus on mathematics provision for the more able. In addition, I was interested in using ICT in the classroom, which

resulted in me being in a new situation with little experience or literature to draw on. I was to be responsible for delivering a course of mathematics enrichment sessions to more able children in year six using video conferencing technology. Although I had taken part in a small number of video conferences I had never delivered any, and all but one of the primary schools had never used this type of technology before. Teaching able children at primary level was also new to me, although I did have some experience of mathematical enrichment activities. I started to think about the teaching strategies I would need to use to make the video conferences successful and effective and how and why these strategies might evolve. At that stage, it was not clear to me what the difference was between a successful and an effective conference nor what teaching strategies might be required.

#### 1.1 Provision for More Able Children

Until the publication of the Smith Inquiry, *Making Mathematics Count*, in February 2004, provision for those children considered to be more able in mathematics was generally decided upon and facilitated by schools. Whilst NAGTY (the National Academy for Gifted and Talented Youth) offered general support, there was little subject-specific guidance offered centrally through LAs (Local Authorities) or the QCA (Qualifications and Curriculum Authority). The focus on providing for able children in mathematics was of particular importance since the number of learners choosing to study mathematics at A-level and university was declining and there was a national shortage of mathematics teachers. In his report, Professor Smith made the following recommendation:

"The Inquiry recommends that the QCA and its regulatory partners should be funded to develop an extension curriculum and assessment framework for more able pupils at Key Stages 3 and 4. This extension curriculum should be firmly rooted in the material of the current Programmes of Study, but pupils should be presented with greater challenges. These should involve harder problem solving

in non-standard situations, a greater understanding of mathematical interconnectedness, a greater facility in mathematical reasoning (including proof) and an ability to engage in multi-step reasoning and more open-ended problem solving."

(Smith, 2004, Recommendation 4.5, p87)

This recommendation highlighted the need for more central provision for able children in mathematics and indicated that this provision should include mathematical enrichment as will be discussed later in this chapter. In the Government's initial response to the Smith Inquiry, Charles Clarke stated

"We are clear that if we are to find ways of interesting more young people in mathematics and increasing the numbers that progress beyond GCSE, we must ensure that we have a curriculum, assessment and qualifications framework that responds to the needs of every learner and allows them to fulfil their potential."

(Clarke, 2004, p39)

The report went on to suggest that one aspect of giving learners the opportunity to reach their full potential was to ensure that the most able were stretched (Clarke, 2004, p39). In addition to addressing the individual needs of the learners, the focus on more able children was intended to help address the shortfall in mathematics teachers described above.

Currently, schools in the UK provide for able children in a multitude of ways. Differentiation, enrichment, acceleration, setting and streaming are just a selection of the different mechanisms available. Essentially, the aim is to keep able children focused and motivated in the subjects in which they excel by providing them with an appropriate level of challenge.

The first stage of providing for able children is to identify who they are. Again, schools use a wide variety of approaches, but achievement in standardised tests, teacher nomination and portfolios of work are most common. Often teachers use a combination of these approaches to ensure that as many children as possible have the opportunity to reach their full potential.

In the spring of 2005, six primary schools in the West Midlands identified their most able mathematicians in year six using a combination of key stage two SATs scores and teacher nomination. All of the children selected had been predicted a level five in their maths SATs and their class teachers believed they would benefit from an additional challenge in the subject.

Some funding had been made available by the PLN (Primary Learning Network) to provide for the children identified in these six schools. In May 2005, the Head Teachers met to discuss how they would spend this money. One of the conditions of this funding was that an evaluation of the project was conducted. As a mathematics teacher in the partner secondary school with some grounding in educational research methods, I was invited to attend this meeting with a view to me taking on a leading role in the project.

During the meeting it was very quickly agreed that the development of a community of able mathematicians across the six schools would be of great benefit. A number of options were discussed to facilitate this, but the three most popular options were:

- (i) The children should visit the secondary school once per week for a mathematics enrichment session with me.
- (ii) Online collaboration between the children and me through websites, message boards and blogging with a focus on mathematics enrichment.

(iii) A weekly mathematics enrichment session delivered by me using the medium of video conferencing.

Option (i) was ruled out because of both costs and logistics. A minibus or a coach would be needed to transport the children to and from the secondary school and it was felt that the cost of this would not be sustainable over time. Indeed, one of the aims was to ensure that whatever option was implemented would continue to run once the funding had finished. Timetabling and rooming constraints at the secondary school were just two of the difficulties that would have been associated with scheduling the sessions during the school day. Twilight sessions were also difficult to arrange since the primary schools had varying finishing times of the school day.

Initially, option (ii) was considered to be the best way forward since it offered good value for money and was relatively easy to set up and manage. However, after some discussion it was felt that the level of interactivity between the children and me would not be adequate to keep the children motivated over the course of the year. Online collaboration also presented issues related to the sharing of diagrams and using mathematical symbols. There were several pieces of software available that would have allowed collaboration of this type, e.g. Elluminate, but these were not known to either me or the others in the group at that time. Those Head Teachers present at the meeting felt that face-to-face interactivity was important to both establish the community of able mathematicians and to have a sufficient level of communication between the children and myself. As a result, option (ii) was also ruled out.

The Head Teachers were initially very cautious about agreeing to option (iii) due to concerns about implementing and using the technology. Only one of the primary schools already had the necessary equipment and networking requirements to facilitate H.323 video conferencing. I did have some

limited experience of using video conferencing technology since it was available in the secondary school, although at that time I had never actually coordinated and delivered a video conference.

The positive side of option (iii) was that after the initial financial outlay, the running costs were minimal, ensuring a sustainable method of provision for this group. The children were able to stay in their own schools for the sessions, which we envisaged to have the least possible impact on their wider curriculum, since there was no lesson time lost to travelling. It was agreed at the meeting that if video conferencing could be set up quickly and with ease, then this would be the best option in terms of challenging this able group of mathematicians. I was tasked to coordinate and deliver this project.

This early decision in choosing to deliver these sessions by video conference was crucial in understanding the basis of this research, since it was not only for financial reasons, but also for pedagogical reasons that this choice was made.

The technical team at the Local Authority agreed to fast-track an upgrade to the networks in each primary school so that they were ready for H.323 video conferencing. The initial outlay of video conferencing equipment turned out to be more costly than expected and at that stage there was some uncertainty as to whether the project would be able to go ahead. £4,500 had been budgeted for the purchase of equipment, but the actual cost was closer to £10,000. Bulk buying the equipment centrally helped to reduce the costs a little, but it was the additional funding of £6,000 from the SSAT (Specialist Schools and Academies Trust) and £600 from the LA that allowed the project to go ahead.

The pilot project was due to begin in September 2005, but the equipment and networking was not fully installed until December 2005. The result was that the sessions in the Autumn term were delivered face-to-face and video conferencing did not begin until the beginning of the Spring term in

January 2006. As we will see from the evaluation of the pilot project towards the end of this chapter, this was an important decision that will shape the entire study. The face-to-face sessions were seen as being crucial in ensuring the effectiveness of the sessions delivered by video conference. The result was that having face-to-face sessions in the Autumn Term was carried forward into the main study in the second year.

The Head Teachers agreed that the aims of the project were:

- (i) To create a community of able mathematicians
- (ii) To facilitate independent and personalised learning
- (iii) To enhance the key stage two / key stage three transition process

I agreed to evaluate the project against these aims, although I had my own concerns. I was to be the person presenting these weekly video conferences to the year six children, yet the new context meant that I was uncertain about what teaching strategies would be most successful and effective when using video conferencing. I was unsure how to plan for such sessions, how to deliver them or how the children would respond. It was from these practical and pedagogic concerns that the research questions for this thesis were born.

How do teaching strategies evolve when delivering a course of mathematics enrichment sessions using the medium of video conferencing?

- What decisions are made in the planning and delivery?
- What strategies are used and how do they evolve?
- What is the experience of the children?

The first year that the project ran (September 2005 to June 2006) was used as a pilot year to iron out any major technological and logistical problems. The second year of the project (September 2006 to June 2007), with the next group of able year six children, was used to explore the research questions above. I should make it clear that it is crucial to understand the reasoning behind the early decisions made in the pilot project, since these shaped the original teaching strategies, as has already been demonstrated with the introduction of face-to-face sessions and the decision to use video conferencing for both pedagogical and financial reasons. I will be considering many of these early decisions retrospectively towards the end of this chapter and I will refer to them throughout the thesis. I should also acknowledge that the teaching strategies used (by Adam the teacher) have evolved during the first year and these too will be considered retrospectively (by Adam the researcher) when addressing the research questions above.

#### **Academic Rationale**

Although the research questions stated above initially grew from the need to solve an immediate practical problem, this study has wider academic significance. Firstly, this is a new field in which there is not an established research base. This research would give me the opportunity to help develop that knowledge base by contributing a case study in the under-reported area of video conferencing in primary schools with a focus on mathematics.

Secondly, the literature on video conferencing is often descriptive and, whilst this is valuable, it is often difficult to generalise from. In the literature, there appeared to be much pragmatic advice for those wishing to undertake video conferencing within their own school, yet there was little analysis of how instructional methods evolve. This is important for academic research since it is very difficult to know how to change or develop instructional methods unless it is understood why those methods occurred in the first place.

This study takes a more analytical approach and seeks to understand how pedagogical practice evolves.

Thirdly, in my initial review of the literature I found very little reporting of research methods and methodology. This study could offer insight into methods and methodology of research that are appropriate for the research of video conferencing. Particularly novel in this study is the use of the method of stimulated recall to interpret data from recorded video conferences.

Lastly, the literature reviewed in this area tended in many instances to be over-optimistic, as is often the case in early research into new applications of ICT. This study takes a more critical view of new technology and explores the opportunities and constraints of video conferencing. This could offer a more balanced perspective to the research.

The research questions identified above are now grounded in both educational practice and academic fields, and the gap in the literature that is to be filled by this study will be discussed in more detail at the end of the literature review in chapter two. This thesis is timely since it is interested in this new and emerging field of using IP video conferencing in schools. The pilot project, which will be discussed later in this chapter, helped to identify the gap in the literature and to convince me that there was an academic rationale for this study. The initial reading of the literature informed the project and informed my reflection on the project as discussed in chapters four to nine.

#### 1.2 Mathematics Enrichment Tasks

Before talking about mathematics enrichment, it is worth defining exactly what is meant by enrichment more broadly. Enrichment is an alternative to the more traditional approach in providing for able children, namely acceleration. Acceleration involves moving through the

curriculum more quickly and the main benefit is that children are able to move at their own pace. This might be done as a cohort or as an individual learner, but the outcome can sometimes be that school is completed in fewer than the usual number of years (Shore, 1979, p77). In practice, this might be achieved by learners skipping year groups in their curriculum or by sitting examinations early (Kennard, 2001, p44). The result is that learners are not held back by others who may be moving relatively slowly. A logistical problem with acceleration is that a learner may be gifted in mathematics but not any other subjects and accelerating in only one curriculum area may prove problematic for timetabling. Montgomery (1996, p66) describes some alternative approaches that allow schools to facilitate acceleration more easily such as out-of-school classes with teachers or vertical groupings that allow younger children to work with older children. However, this does not address the social and emotional difficulties associated with acceleration. Sometimes children may be academically ready to move ahead, but not emotionally ready to cope with public exams (Eyre, 2003, p105). A study in a secondary school in Hamburg reported problems with the social integration of children that had been accelerated (Prado and Schiebel, 1995, p68). This is not uncommon and a well documented case is that of Ruth Lawrence who took her O-level mathematics exam at the age of eight and graduated from her mathematics degree at Oxford University at the age of 13. At the age of 27, it was reported that Professor Lawrence still found it difficult to make friends or small talk as a result of the social consequences of her accelerated learning (THES, 1998). A more recent case is that of Ainan Celeste Cawley who passed his O-level chemistry in Singapore at the age of six and at the time of writing he is looking for a university place (The Times, 2007). Despite these concerns some believe that acceleration can be successful if care is taken to address the potential problems (Freeman, J., 1998, p40).

In contrast to acceleration, enrichment does not centre on teaching new material or moving at a quicker pace, but instead focuses on exploring existing material more deeply and more broadly. This is generally accepted as a broad definition of enrichment, but beyond this there are varying ideas of

what enrichment actually involves (Kennard, 2001, p45). To help define enrichment in the context of this study, it is first worth considering how enrichment works with more able children.

Freeman (Freeman, J., 1998, p44) states that the point of enrichment for the more able is to relate learning to other areas and 'play' with ideas so as to come up with new ones. One of the advantages of enrichment is the ease with which it can be implemented in schools. It can be used in the 'ordinary' classroom since enrichment tasks are accessible to children of a wide ability range, yet they simultaneously allow the more able children to explore new ideas and demonstrate their skills (Piggott, 2004, p4). Such enrichment tasks are sometimes referred to as "low threshold – high ceiling" tasks. Whilst there are some clear benefits to an enrichment approach, there are difficulties associated with the demands on teachers' time to devise such activities (Kennard, 2001, p45).

In the context of this study, enrichment will refer to tasks which include:

- (i) the low threshold high ceiling quality. It should be easy for children to understand what is required to complete a given task, but not necessarily straightforward for children to know how they will go about completing it.
- (ii) multiple methods for children to approach a given task and perhaps multiple methods of presenting their solutions. Implicit in this is the idea that the tasks are open-ended and facilitate exploratory learning.

In working on such mathematics enrichment tasks, the children may use some problem solving techniques. Mason (1985, pp1-48, 109, 154) describes these techniques using terminology such as:

- specialising and generalising
- stuck, aha!
- check, reflect, extend
- convince yourself, convince a friend, convince an enemy

Where problem solving skills were used by the children during this study, then the above terms are to be used as appropriate in chapters four to nine.

#### **The Content Decision**

The meeting between the six Head teachers and me was described earlier in this chapter. However, during this meeting, there was also some discussion about what the content of the sessions should be. The Head teachers had decided in advance that they would like the content to be mathematics enrichment tasks and their reasoning was that they wanted the children to use their existing knowledge in new ways rather than to learn lots of new mathematics too early, which might leave them bored in secondary school. I was initially reluctant to agree to this, since I had little experience of delivering mathematics enrichment tasks. However, I do value enrichment as part of the mathematics curriculum and so I did agree on the condition that I could select the tasks myself.

There were also some further potential benefits in using enrichment tasks. The low threshold aspect of enrichment meant that relatively little explanation of the task was required for the children to get started. Furthermore, the children were likely to get stuck at different times during the tasks and so they would want to ask questions at different times. The thinking was that this would reduce the chance that lots of children would want to ask questions simultaneously, which could prove difficult to manage. Another potential benefit to the enrichment approach was that it would encourage and develop independent learning. In other words, the children should be able to move forwards with a task at their own pace and in their own direction with minimal input from me (Adam the teacher).

Any input that did come from me was to be in the form of guidance or questions designed to make the children think about the key aspects of what they are doing.

#### Planning the Tasks

Having decided to use an enrichment approach, the next stage was to identify a range of tasks that could be used for the video conferencing sessions. A well-publicised resource for mathematics enrichment material is Nrich, a website developed as part of the MMP (Millennium Mathematics Project). The aims of Nrich, as listed on the website, include enriching the experience of the mathematics curriculum for all learners, developing mathematical thinking and problem solving skills and showing rich mathematics in meaningful contexts. Nrich has tagged the activities on their website making it relatively simple to search for tasks on a specific theme or for task suitable for children of a specific age and ability. As such, I was quickly able to identify some tasks and group them into themes for the individual video conferencing sessions.

The actual process of selecting the tasks was somewhat arbitrary. However, it is worth outlining the process, since this forms an important part of the early decision making process. I searched Nrich for tasks suitable for children working at key stage 2 or 3 and then I looked for open-ended tasks that matched the enrichment criteria above. Once I had found a task that I thought was appropriate and interesting, I looked for other tasks based around a similar theme and grouped them together. The learning objectives emerged from the tasks and a title was decided upon for the theme. I tried to select groups of tasks that would cover a range of curriculum areas.

The table below shows the theme and content for the sessions in the pilot study and these remained the same for the main study.

Session	Session Title	Planned Activities a	Planned Activities and Learning Objectives	
		Odds and Evens • Writing probabilities as fractions		
1	Probability	Flipping Coins	<ul><li>Using sample space diagrams</li><li>Pattern spotting</li></ul>	
		Cosy Corner	- Fattern spotting	
	Area and Perimeter	Fence It	Maximising area with a fixed perimeter	
2		It Doesn't Add Up	<ul><li>Exploring triangles and trapeziums</li><li>Using basic algebra</li></ul>	
-		Area and Perimeter	Linking area and perimeter	
		Hallway Borders		
	3D Visualisation	Cubes within Cubes	Using sequences and series	
3		Multiplication Square	Pattern spotting     Payaloning logical thinking skills	
		Nine Colours	Developing logical thinking skills	
	Problem Solving 1	Make 21	Exploring properties of odd and even	
4		Trick or Treat	numbers	
4		Consecutive 7	Lateral thinking     Calculation	
		ISBN Numbers		
		Special Sums and Products Conjecture,	Exploring number properties	
5	Factors and Multiples	Block 4	Using factors of numbers more broadly	
		Helen's Conjecture		
	Strategy Games 1	Traffic Lights	Developing communication of	
6		Attack or Defend	mathematical strategies  • Making logical decisions	
		O's and X's		
	Milk and Chess	Milk Crate Puzzles	Reframing problems	
7		Chessboard Puzzles	Interpreting tricky problems	
		Mathematics or Logic?		
	Squares and Rectangles	Is a Square a Rectangle? Chessboard	Exploring properties of shapes	
8		Hidden Squares	Communicating mathematical ideas in a	
		Squares on a Chessboard	logical order	
	Number Fun	Function Machines	Exploring properties of number	
9		Down to Nothing	Calculation	
		Clock Face	_	
		Treasure Island	Using coordinates	
10	Coordinates	A Cartesian Puzzle	Properties of shapes	
		10 Hidden Squares	_	
		Guesswork	Exploring properties of binary numbers,	
11	Number Magic	Never Prime	square numbers and prime numbers	
		Number Rules OK!		
		Five Quick Problems	Developing logical thinking skills	
4.2	Problem Solving 2	Sweet Shop	Exploring nets of shapes	
12		Cut Nets	Using trial and improvement	
		Chocaholics		
		Fifteen	Developing logical decision making for	
13	Strategy Games 2	Got It!	mathematical games	
			Number Mazes	-

Table 1 – Themes, activities and learning objectives

The culmination of these activities into an overall plan as shown above is significant in that it provides information about the early decisions. My reasoning for grouping activities together through themes was to provide some structure and routine to the sessions, which I felt was important (as Adam the teacher). On reflection, it is possible that these early decisions about structure and content were related to a feeling of insecurity from not being physically present in the room with the children during the sessions. It is certainly the case that having a regular structure and a detailed plan can help to manage behaviour in the more traditional face-to-face classroom environment. So it stands to reason that I might utilise similar methods when teaching in different contexts. The analysis in chapter five will consider the appropriateness of this structure in the context of this learning environment.

#### **The Structural Decision**

Each session was to be one hour long and the activities were to take around 15 minutes each. The internal structure of the individual tasks varied, but generally each task consisted of instructions on what the task was, time for the children to try the task and some guidance and feedback from me. Depending on the progress made by the children, there was to be additional time for them to act on the guidance and feedback. In addition to the tasks outlined above, there was to be a regular weekly activity of a competitive nature designed to last around five minutes. Again, this demonstrated my need to take control of the session by providing structure. In term one, this activity was to be the numbers game from the Channel Four television programme *Countdown* and in term two it was to be a variation of the ITV television programme *Who Wants To Be A Millionaire?* The reason for choosing these particular games was to do with my experience as a classroom teacher. I have used internet applications of both of these games in the standard classroom environment and both were a popular choice with the children and kept them engaged. Ironically, I chose to create my own version of these games for the video conferences and not to use the preprepared internet applications.

A key point here is that these activities were chosen to 'keep the children engaged'. This is perhaps the same reason why it was my intention to give the children a relatively short amount of time to complete the tasks. If I was in a face-to-face environment, I would expect to spend more than 15 minutes working on the tasks described in the table above. Moving the children on quickly through different tasks and choosing activities to keep them engaged suggests that these choices were more about preventing the children from going off-task, and perhaps misbehaving, than about learning.

Having decided that each session would involve three 15 minute tasks and the regular weekly activity, some decisions had to be made on the order. The following framework was used for a typical video conferencing session but, as with all teaching and learning sessions, this was flexible and small changes were made in some cases. Interestingly, this impromptu structure remained relatively unchanged through the entire study.

Connection made 10/15 minutes prior to conference start time

Introduction to session and explanation of the theme (5 minutes)

Task One (15 minutes)

Task Two (15 minutes)

Weekly activity (5 minutes)

Task 3 (15 minutes)

The remaining details in relation to the content and structure of these sessions are described in the next sub-chapter, which outlines the findings of the pilot project.

#### 1.3 The Pilot Project

The six primary schools involved in this project were split into two groups of three to make the sessions more manageable in terms of numbers. Each session was taught by video conference on Friday mornings during term time. Session one ran from 9:30am until 10:30am. Session two ran from 11am until 12noon. Schools were advised to timetable mathematics for year six during these sessions, although this was not always possible. There were around six children based at each of the three schools and I was based at the secondary school. The decision to use six children at each school was based on recommendations from the literature which suggest that there should be a maximum of 8 people at each endpoint in order to improve the level of interactivity between individual participants (Husu, 2000, p264; Jacobs and Rodgers, 1997, p301). Some participants felt that video conferencing technology gave them the confidence to participate in a way they would not in equivalent face-to-face sessions since they felt they could be seen and heard by the other participants in the conference. However, this sense of presence can be lost as the numbers at each endpoint increase. As will be seen in chapter two, giving each school a sense of presence in the video conferencing sessions was a focus for the analysis in this project.

The reader will remember from earlier in this chapter that, during the pilot project, the technology was not ready in time to start video conferencing from the beginning of the Autumn term. As such, it was decided that the children should meet face-to-face at the secondary school for the sessions that took place during the first term. This proved to be useful in getting to know the children and was helpful in encouraging the children to get to know each other. For these reasons, the plan was to also include face-to-face sessions during the main study. At the end of the Autumn Term, each school was equipped with a standard box of mathematical resources to assist them with the activities that would delivered by video conference in term two and term three. The details of these resources are outlined in appendix one.

Towards the end of the Autumn Term, I ran a training session with the member of staff responsible for the video conferencing equipment in each school (Adam the teacher). In only one school was this person the ICT coordinator, in the other five schools the Head Teacher or Deputy Head Teacher took on this responsibility. Informal conversations with these Head Teachers and Deputy Head Teachers indicated that other teachers in the school were unwilling to take on this responsibility due to them worrying about problems with the technology. The training session lasted around 20 minutes and was delivered one-to-one with each teacher. The session covered setting up the video conferencing equipment, how to resolve video and audio issues, what to do if the connection was lost during a conference, how to use the remote control and some general trouble shooting guidance. Each teacher supported their group of six children through their first video conference. Once the children were confident in using this equipment, they were given the full responsibility of managing it independently of the teachers during the video conferencing sessions. This involved controlling the camera and microphone, as well as resolving any audio or video issues. As such, the teachers no longer needed to be present during the video conferences, although an adult was always in the nearby vicinity in case of any emergencies.

All of the tasks for the Spring Term and the Summer Term were made available to teachers and children online in advance. The idea here was that children could have a think about the tasks before they came along to the session, although it is worth adding that the resource was not particularly well utilised. This might be because a hard-copy of the tasks was made into a booklet and given to each child. This was so that in the case of any technical difficulties, the children could still attempt the activities. However, it was clear from the questions asked about the activities during the conferences that the majority of children had not used the booklets to prepare in advance as was originally intended and only used them during the sessions. This might be because some schools kept the booklets with the box of resources, which was not accessible to the children other than during the sessions. The website also contained a message board with the aim of

allowing the children to share their ideas and solutions or to ask me for help between video conferencing sessions. This resource was initially well used by the children and was used more for social conversation than for mathematical conversation. After about five weeks of video conferencing, the message board was rarely used.

In order for the children to communicate their ideas and solutions during the sessions, I suggested that they use a flipchart or whiteboard along with a dark coloured pen. The children were discouraged from using a standard pen and paper as this may be difficult to read. This decision was based on my own limited experience of video conferencing. Each school was also given a recommendation from me in terms of how to arrange the room in which the children would be video conferencing. The recommendation was that the children sit around one end of a table with the microphone placed at the centre and the camera at the opposite end of the table. This immediately allowed all six children to be seen and heard throughout the video conferences giving them a sense of virtual presence, which will be discussed further in chapter two. The recommendation was that the flipchart was to be positioned to the side of the table in such a way that the camera could be easily turned to view whatever was written.

The camera could be moved and made to zoom in and out by using the buttons on the remote control. During the training session with the teachers, I suggested that they should have two preset positions stored on their camera. The first was for the table view of the children and the second was for the flipchart view. This is indicated by the arrows in figure one. The image being received was shown on a screen or television positioned behind the camera. Again this was based on my limited experience of video conferencing. The implementation of this recommended room layout was not consistent in each school and the evolution of the room layout during the main study will be discussed further in chapter seven.

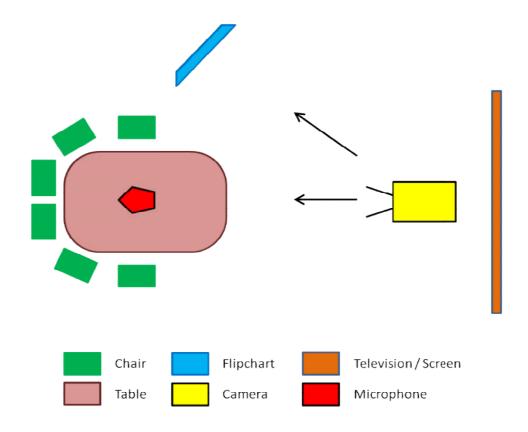


Fig. 1 – Recommended room layout for schools

Before discussing the outcomes of the pilot project, it is necessary to inform the reader of how the video conferencing technology works on a practical level, and to give the reader an indication of what the children and I can actually see on the screen or television receiving the video. Figure two shows two typical screenshots from the video conferences in this study.



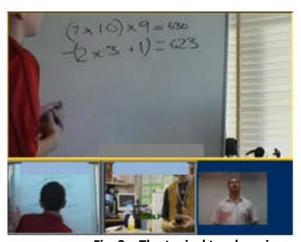


Fig. 2 – The typical teacher view

This is my view and so the small picture at the bottom right shows me, but in the other schools where the children were based, they would have seen themselves instead. This is so that presenters are able to identify the image of themselves that others are receiving, and can hence reposition their camera accordingly. The other three images on the screen (two small and one large) show each of the other schools in the conference. The small screens allow you to monitor what is happening in other schools, whilst the larger screen is reserved for the school that is presenting at that particular time. These screens changed frequently throughout the conferences as the children in different schools presented their solutions or engaged in dialogue with me. However, the equipment was set up in such a way that the changes were automatic. The microphones detected which schools the sound was being transmitted from at any particular time and then moved their image to the large screen. It should be noted here that this specific technology can only detect which endpoint the sound is coming from and cannot identify the individual children that may be speaking. If sound was being transmitted from more than one endpoint at the same time, this might cause the large image to continually change in a problematic way. Other sounds such as coughing or school bells ringing might also cause the image to change. As such, I adopted a technique used other video conferencing providers whereby schools that are not presenting leave their microphone on mute. During any quiet times in the conference, children could switch their microphone off mute and ask questions. However, more generally I acted as a chairperson for the conference and gave children at each endpoint an opportunity to talk in turn.

The video conferencing equipment at the secondary school was superior to the equipment in the primary schools in that it allowed a computer to be directly connected. This enabled me to transmit PowerPoint presentations to help explain the tasks to the students. I did this because I found that PowerPoint was particularly helpful, since it has built in motion paths that can be used for creating simple animations to emphasise key points. Having the computer connected also allowed me to transmit music at various points in the conference; the start of the conference, the end of the

conference and during *Countdown* and *Who Wants To Be A Millionaire?* Using music to signal the key points of the sessions is not something I would generally do in my face-to-face teaching. In fact, using music in this way is a strategy that I devised specifically for use in the video conferencing sessions. The idea came from thinking about the use of music and theme tunes on children's television programmes. Music was used in the same way during the main study and the key decisions, in relation to the type of music and when the music should be used, will be discussed in more detail in chapter seven.

As explained above, the idea behind the pilot was to iron out any major technological and logistical problems. The pilot project was not rigorously researched, but was instead evaluated through my own observations when planning and delivering the sessions and through group interviews with the children. The interviews lasted around 30 minutes and were conducted face-to-face in school groups. The children were asked questions around different aspects of the pilot project; self-confidence, enjoyment, independent learning, mathematical language, difficulty, session structure, the website and technical issues. What follows below are some of the key outcomes of this evaluation.

The children found the mathematics covered in the video conferencing sessions "hard" and "challenging". A number of children enjoyed the level of difficulty as it "made them think more". Some children became frustrated when they faced problems with no solution. A significant number of them commented positively on the variation of topics between consecutive sessions. One group of children made a distinction between re-explaining material in numeracy lessons and in video conferencing sessions (see quote below). Strategy games was by far the most popular topic, with more than half of the children saying they found this easiest to explain through the video conferencing sessions. Generally speaking, most children found the level of difficulty about right and

all children felt that they had been stretched at some point. A small number of children found the activities too difficult.

'Child: I think we learn more in like maths challenge [video

conferencing] cos in normal class you've got to go through the

same things again so other people understand.

Interviewer: Oh, so sometimes you're going over things that you already

know?

Child: Yeah.

Interviewer: Okay. Did you not find that in the video conferencing a bit?

Sometimes, if the other groups didn't know what was going on

and you did, that I was sometimes explaining it and you

already knew what was happening?

Child: Yeah, but we still learnt more.'

(Child from School 3)

When asked about the length of the video conferencing sessions, a significant number of children raised concerns about the scheduling of sessions, rather than the duration. Some children missed part of break time or lunch time to attend sessions. Some children had to make a choice between video conferencing and sporting activities. Some children had difficulties rejoining their face-to-face lesson part-way through once the video conferencing session had finished. The children valued being told how much time they had to complete tasks so they could prepare their presentations. All of the children interviewed benefited from having face-to-face contact with each other and me before the video conferencing sessions began. Some children felt that one whole term of face-to-face sessions was too long and they would have liked to have begun video conferencing sooner.

The weekly activity (i.e. *Countdown* or *Who Wants To Be A Millionaire?*) was one of the most popular elements of the video conferencing sessions with some children asking for two weekly activities during each session. A number of children expressed a preference for being in the room without the physical presence of a teacher as they felt they were able to communicate more "freely". A small number of children wanted somebody to be available during video conferencing sessions to tackle technical problems when they occurred. The children were happy with the use of PowerPoint to support the video conferencing sessions, but some said they would have liked to have seen both the PowerPoint and the presenter simultaneously.

All of the children felt that they were able to ask any questions that they wanted to, although sometimes they had to wait for another conversation to finish.

'Interviewer:

And what about, you know, at the beginning of the year when we all got together first, and you got to know each other in the classroom and then you did the video conferencing? Do you think was better than if we'd done the video conferencing straight away?

Child:

Yeah, it's better because if we were doing the video conferencing straight away we would still remain distant. We wouldn't have known them as well as we do now. So we're confident with them and relaxed. If we meet them one day we might be able to say "hi", but if we'd done the video conferencing straight away we'd be like, "Who's that?".

Interviewer:

How well do you think you got to know them then?

Child:

Quite well. Well we recognise them when we see them. Yeah, if we see them, like when [school name] and us went on Friday

to [school name], we noticed quite a lot of the [school name] people there. And when me and [pupil name] went on this swimming competition we saw a guy from [school name] there.'

(Child from School 4)

'I think the video conference lessons are more interactive because you actually get to try out stuff. I think it's, I like it because it's very hands on, not like most other lessons where it's put a heading in your work book and do the work.'

(Child from School 5)

Most children reported no issues with sound quality. However, there was one incident in which sound from a PC was communicated directly across the video conferencing link by mistake from one of the primary schools. The problem could not be rectified during the session as there was nobody immediately available at the school with any knowledge of the video conferencing equipment. This was a particularly distressing experience for me (Adam the teacher) since the other schools involved would have been disturbed by this incident. I was responsible for ensuring the success of the session, yet I was powerless to stop the noise from continuing.

The children gave mixed responses with regards to picture quality. The problems they highlighted included a delay in picture compared with sound. The picture was reported to freeze with some blockiness, whilst the sound seemed to be less problematic. I have made a number of enquiries to technicians about these issues and I have concluded that the poor picture quality is due to internet traffic and bandwidth limitations. Sound is prioritised because that a video conference with video and without audio temporarily is unworkable, whilst a video conference with audio and without video temporarily is workable, but a nuisance. I have little control over the picture quality, but all

children agreed that the quality was good enough to understand what they had to do to complete the tasks.

The music that was streamed during the sessions was discussed positively by most children. They claimed that it helped them to prepare for the sessions since once the music started they began to get into the 'correct frame of mind'.

Based on the success of pilot project, it was decided not to change the content or delivery of the sessions for the main study. The scheduling of the video conferences was adjusted slightly to help address the logistical problems in the primary schools. To help tackle the technical difficulties, the children were supplied with a quick reference trouble shooting card that outlined the most frequently occurring problems and possible resolutions.

#### 1.4 Background to Video Conferencing

The term *video conferencing* has a number of meanings depending upon the context in which it is used. For example, video conferencing could be used to mean the transfer of video and audio between individuals using relatively well known software such as AOL Instant Messenger or Microsoft MSN Messenger on a personal computer. Alternatively, video conferencing could refer to stand-alone systems such as the video-phone features now available on many mobile telephone handsets. In the context of this thesis, video conferencing refers to middle cost stand-alone systems that transmit and receive audio and video data via the internet and the specific systems used in this project will be detailed later in this chapter.

#### A Brief History of Video Conferencing

The first recorded usage of video conferencing occurred in 1956 when US telecommunications giant AT&T built the first Picturephone test system (Park, 2003). By 1970, AT&T was able to offer Picturephone services for a cost of \$160 per month (Roberts, 2004), but as a result of high costs, confusing controls and the tiny black and white display, the product never sold as widely as AT&T would have liked (Zondy, 2006). By 1976, IBM was using video conferencing to link its Japan offices to its US offices (Roberts, 2004); however, video conferencing never became fully commercialised until 1986, when PictureTel released a video conferencing system costing \$80,000 plus \$100 per month line rental (Roberts, 2004). Whilst this might seem very expensive, it was considerably cheaper than the only colour video conferencing solution available in 1982, released by Compression Labs, which cost \$250,000 plus \$1000 per month line rental (Roberts, 2004).

The creation of ARPANET in 1969 culminated in the creation of the Internet in the decades that followed. However, the first video conferencing solution to use the internet, CU-SeeMe, did not emerge until July 1992 (Roberts, 2004). The introduction of CU-SeeMe revolutionised video conferencing, although a major drawback was the fact that it had been developed for the Macintosh computer at a time when the majority of computer users were using a Windows operating system. By 1995 a fully functioning Windows-based system had been developed with video, audio and the ability to communicate with multiple users simultaneously. The CU-SeeMe Project was developed at US-based Cornell University and was the beginning of a wave of internet-based video conferencing solutions that has continued to date. Although CU-SeeMe was the first video conferencing software to make use of the internet, it was not the first to be based on a personal computer. In 1991, IBM released PicTel, a relatively low cost black and white system that used multiple telephone lines for connectivity.

The costs associated with video conferencing have decreased since 1980 and as a result the technology has become more accessible for a wider variety of potential users. Currently, low cost systems (for example, a webcam used with the freely available MSN Messenger) can be purchased for around £20 with negligible running costs; these are often used by individuals and small businesses. Middle cost systems (for example Tandberg 550MXP or Polycom VSX7000 stand-alone units) currently retail for between £2,000 and £4,000 with relatively small running costs and tend to be used by larger businesses, schools, universities and medical organisations. Before going on to discuss the higher specification video conferencing equipment, these two middle cost systems will be described in detail since the Tandberg was used by the primary schools and the Polycom was used by me throughout this study.

## Tandberg 550MXP



Fig. 3 - Tandberg 550MXP

Figure three above shows the front and rear view of the Tandberg 550MXP as well as the remote control used to work the equipment. Looking at the rear view, the four identical sockets located to the right are for telephone cables to transmit and receive the audio and video. However, in the pilot project the internet was used to transmit and receive data rather than telephone cables. As such a standard patch cable was used to connect the port labelled 'ethernet' (adjacent to the four identical sockets) to an internet port. The large round socket located below the camera towards the middle

of the unit is a standard microphone port. A flat microphone designed to be placed on a table was plugged in here. The red socket was to connect speakers to the unit so that participants could hear the received audio. In order to view the received video, the yellow socket labelled 'video out' was connected to either a television screen or a data projector.

As can be seen, the remote control looks very similar to what might be used with a DVD player and it is arguably as simple to use. The yellow button at the top of the control allows the user to switch their microphone on or off and the blue button allows the user to switch between transmitting video or data from a computer to the other users. The zoom button to the right of the control allows the user to zoom the camera in or out and the arrow buttons allow the camera to be moved up, down, left or right. Once the camera has been moved and zoomed to a useful position, this position can be saved to one of the numbered buttons. Having several saved preset camera positions allows the user to quickly move from one camera position to another by simply pressing the corresponding numbered button. As with a telephone, the green button connects calls and the red button disconnects calls. Lastly, the self view button, located above the red button, is used to overlay a small image of what video is being transmitted on top of the received video, which allows the user to monitor what others can see. This small picture-in-picture can be moved around the screen to a suitable position by pressing the layout button located above the green button.

## Polycom VSX7000



Fig. 4 – Polycom VSX7000

In terms of functionality, there is little difference between the Polycom unit and the Tandberg unit. The microphone socket on the Polycom unit is not a standard port meaning that you can only use Polycom microphones. However, through this port it is possible to use an adapter that allows you to connect document cameras and personal computers directly to the unit. The video conferences in the main study were recorded using the video out and audio out sockets located at the back of the Polycom units. Figure five shows how the equipment was set up to record the conferences.

## Projector Screen

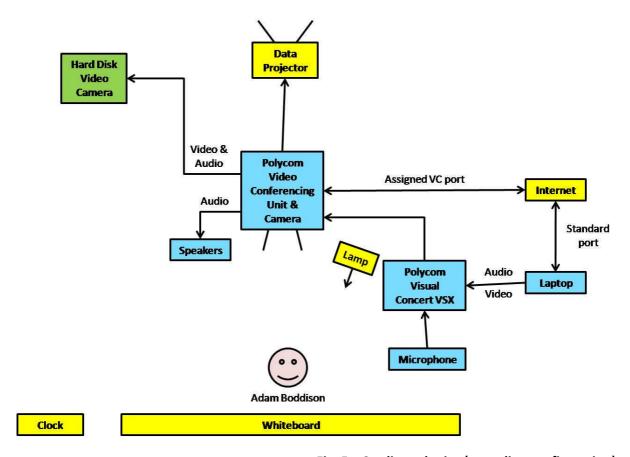


Fig. 5 – Studio endpoint (recording configuration)

On the projector screen I was able to view the other participants of the conference, whilst the hard disk video camera allowed me to monitor the recording. Two internet ports were required; one for the video and audio to be transmitted and received and another for accessing the internet on my laptop. A lamp was set up to provide extra light since I knew from the pilot project that the standard lighting in the room being used was insufficient. The whiteboard and clock were positioned behind me as I delivered the conferences and the use of these will be explained in more detail later.

Returning to the different specifications of video conferencing equipment more generally, the most expensive, and arguably the best, video conferencing equipment currently available is the Halo Collaboration Studio in association with Dreamworks Animation Studio SKG. A studio costs

\$550,000, plus a cost of \$18,000 per month for servicing and maintenance (Del Nibletto, 2006, p4). Halo enables users to share documents and data directly from their laptops. Some also have collaboration screens above the plasma screen displays. A high magnification camera is used for zooming in on objects revealing the finest of details and colour shading (Del Nibletto, 2006, p4). Halo achieves a quality that makes it feel like the other participants in the video conference are in the same room as well as allowing for non-verbal communication such as body language.

Since the introduction of CU-SeeMe in 1992, the volume of literature addressing video conferencing has increased. It seems that the focus is usually on either the technology or the pedagogy, although in some cases both are considered. Literature that focuses on the technology used for video conferencing is important for educational research for a number of reasons. Firstly, better video quality may mean that ultimately more people will use it (Del Nibletto, 2006, p4), and secondly video conferencing users have a high expectation of quality, probably because they are accustomed to the standards of television (Kies, 1997, p86). However, it is important to note here that there is no pedagogy or instructional method that is suitable for all (Beyth-Marom et al., 2005, p246). This indicates that video conferencing technology will inherently present users with different opportunities and constraints and these are discussed further in chapter two.

### Video Conferencing Terminology

It is generally agreed that video conferences fall into two categories known as *point-to-point* and *multipoint*. Point-to-point refers to one endpoint directly connected to only one other endpoint whilst multipoint refers to one endpoint directly connected to at least two other endpoints (as shown in figure six).

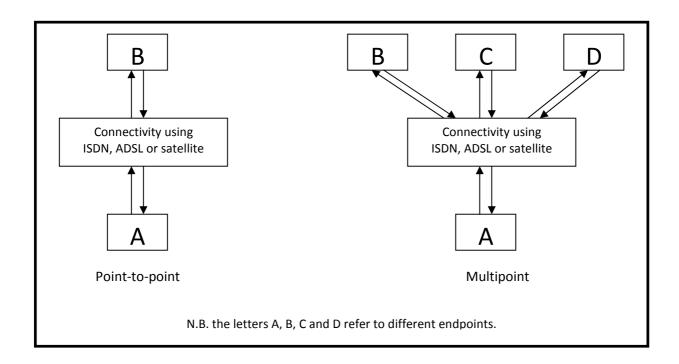


Fig. 6 – Point-to-point and multipoint

The methods of connecting endpoints together over a significant distance have varied over time and they often depend on cost and quality. The three methods most commonly used for connectivity to transmit both video and audio data have been:

- 1) ISDN a series of telephone lines used in parallel
- 2) ADSL A high-speed broadband internet connection
- 3) Satellite microwave signals sent to a receiver via an orbiting satellite

The multiple line rental for ISDN can prove to be costly and similarly, a multipoint connection using satellites is expensive as a video conferencing bridge is required (Laouenan, 1999, p178). This is almost certainly part of the reason that broadband connectivity via the internet (sometimes known as IP conferencing) has become increasingly popular during the last decade, since schools can connect directly to each other at for minimal additional cost.

Within the two classifications of point-to-point and multipoint, there can be further divisions and for this thesis I have chosen to use Smyth's classifications of one-to-one, one-to-many, one-to-some and some-to-some (Smyth, 2005, p810).

The one-to-one configuration refers to having only one person at each endpoint and is typically used with PC-based applications. This could be point-to-point or multipoint and an example is shown in figure seven. When a webcam is used with a PC in this way, users are often seated at a desktop (or laptop) computer and as a result this type of conferencing is often referred to as MDVC (Multipoint Desktop Video Conferencing) or DVC (Desktop Video Conferencing).



Fig. 7 – One-to-one screenshots

The one-to-many configuration involves one person at one endpoint (often responsible for delivering the content of the session) and a relatively large number of people (say between 12 and 500) receiving the content at each of the other endpoints. Although the technology can facilitate two-way communication, this rarely occurs since many people are sharing one endpoint, which can make it difficult to be individually seen or heard. The degree to which individuals can choose to be seen or heard is sometimes referred to in the literature as *virtual presence* and it is believed by some

that there must be a sense of virtual presence for all participants if a conference is to be effective (Hu, 2000, p381). The one-to-many arrangement has been a typical configuration for universities with more than one campus as they are able to broadcast a lecture to several sites simultaneously (Laouenan and Stacey, 1999, p179; Knipe and Lee, 2002, p302; Laurillard, 1993, p166). Video conferencing technology is capable of giving individuals a presence, although the one-to-many configuration is an exception to this since by design it prohibits the majority of participants from being seen and heard.



One-to-many using point-to-point http://times.hankooki.com/lpage/nation/20051 1/kt2005110219470010600.htm



One-to-many using multipoint video.haifa.ac.il/ Images/SiteImages/mcu1.jpg

Fig. 8 – One-to-many screenshots

In an educational context, the one-to-some configuration usually consists of a teacher at one endpoint, who acts as a chairperson, and up to eight students at each of the other endpoints. Various arrangements are used to ensure that all participants have a virtual presence, but a common arrangement is to be sitting around a table with the camera positioned at one end and the microphone positioned on the centre of the table. The reader will probably recognise this as being the configuration that was used in the pilot project.

Some believe that the one-to-many endpoint configuration is most suitable for video conferencing (Laurillard, 1993, p167) whilst others believe the one-to-some configuration is more appropriate

(Mason, 1998, p81). In fact, the one-to-some configuration is becoming increasingly popular and recommendations from the literature suggest that there should be a maximum of eight participants at each endpoint. The thinking here is that more than eight participants would make it difficult for individuals to establish a presence and would decrease the level of interactivity (Husu, 2000, p264; Jacobs and Rodgers, 1997, p293).



One-to-some using point-to-point http://www.videoconferencingjobs.com/videoconferencing/multipointvideo-conferencing.html



One-to-some using multipoint http://www.vcon.com/solutions/management.systems/multipoint.video/index.shtml

Fig. 9 – One-to-some screenshots

The some-to-some configuration is similar to the one-to-some configuration with the exception that there are between two and eight people at *every* endpoint and there is not normally a chairperson. This kind of configuration is ideal for business users as it can remove the need for international travelling, which helps to cut costs in terms of both time and money. Large international companies, for example Sony, IBM, Dreamworks Animation, Microsoft and HP have all used the some-to-some configuration in this way. It is believed by some that video conferencing should be used as a tool for supporting dialogue rather than for content delivery (Hearnshaw, 1997, p55). However, it was argued by Hearnshaw that the some-to-some configuration does not lend itself to effective dialogue.



Fig. 10 – Some-to-some screenshots

### **Global Leap and Motivate**

In order to make some of the early decisions about how to deliver the video conferencing sessions during the pilot project, I looked at the existing practice of other organisations. I was particularly interested in those organisations that managed educational video conferences on a regular basis and the two projects that had most relevance were Global Leap and Motivate. Both projects were well utilised by schools and some of the findings of the related research are discussed below.

Global Leap is a not-for-profit organisation that helps schools in the UK to obtain educational content that can be delivered by video conference. A wide range of curriculum areas are covered and schools can use the Global Leap website to book interactive video conferences in which the content is delivered directly from external providers, such as galleries and museums. Global Leap was a key feature of the DfES commissioned 'video conferencing in the classroom' project that began in October 2001 and which considered the experiences of 28 schools (Comber et. al., 2004). A separate project focused on six case studies based on the video conferencing activities already taking place in six schools (Lawson and Comber, 2005). Both studies were published through Becta and one of the important points in relation to construct validity was the distinction between what

constituted a *successful* video conference and what constituted an *effective* video conference. The summary report from the six case studies suggests that a successful video conference is one in which the conference "works" (Lawson and Comber, 2005). This can be interpreted as a video conference that runs smoothly with few technical difficulties and an agreed protocol to ensure that participants have a sense of virtual presence. Furthermore, the summary report suggests that the success criteria should also include behaviour management and careful pre-conference planning. This is in contrast to the report's definition of an effective video conference, which constitutes the learning objectives being met.

This distinction between a successful and an effective conference is uncomfortable since it does not match neatly with the pre-existing divide between technology and pedagogy. In the context of this thesis, I will use the terms successful and effective to refer to the overall quality of a video conference, but with a slightly amended definition to the report discussed above. A successful conference is one in which the technology works and an effective conference is one in which the learning objectives are met. These definitions are simpler and fit more naturally with the divide between technology and pedagogy.

Before moving on to look at the work of Motivate, it is worth considering these six case studies in more detail. Of the six schools involved, two were primary schools. One of the primary schools used video conferencing regularly and the model used was one in which an entire class had access to a remote expert provided through organisations such as Global Leap or NASA. The feedback from one of the children in this study was that he would have preferred to "communicate on a more personal level". It is clear here that this participant did not have a strong sense of virtual presence in the video conference, perhaps on account of the one-to-many configuration used by the school. The other primary school was based in a more rural area and they used a variety of endpoint

configurations to help children in key stage two improve their literacy skills. Some of the sessions were organised by Global Leap and some were organised by the school themselves.

The remaining four case studies involved schools using the technology for a variety of purposes in addition to enhancing the specific curriculum subjects. These included using the technology for lesson observations, job interviews, working with gifted and talented students and liaison with primary feeder schools and universities. When these schools did focus on specific subject areas, languages was a focus for two schools since the technology gave the children and staff direct access to native speakers across the world. History was the focus for another school with the final school using video conferencing to personalise the learning in a broad range of subjects. Interestingly, none of these case studies indicated that the schools had used or had any intention of using the video conferencing technology for mathematics. Since this thesis is interested specifically in using the technology to deliver a course of mathematics enrichment sessions, it is now worth exploring the research related to the Motivate project, which is of particular relevance since it incorporates both mathematics and video conferencing.

In 1999, the Faculties of Mathematics and Education at the University of Cambridge formed a partnership known as the MMP (Millennium Mathematics Project). From this project, a number of programmes were brought together, one of which was Motivate and another of which was Nrich, previously discussed in chapter one. Prior to this partnership, Motivate already existed as it had been established in May 1997 by two mathematicians based at the University of Cambridge. The MMP website has the following description of Motivate:

"Motivate is a real-time video-conferencing project which links professional mathematicians and scientists, often university researchers, to primary and

secondary schools throughout the UK and overseas to explore mathematics beyond the basic school curriculum."

Sometimes, Motivate provides an expert in a particular field to present the conference and a separate person is involved to chair the session, although on other occasions, the conference is both presented and facilitated by the same person. The number of students that participate is left for the individual schools to decide and this typically means that whole classes are involved, as has been discussed previously. However, there have been occasions on which Motivate has catered for large numbers of children at one end point, in lecture theatres for example.

The idea is that these conferences can be used for gifted and talented groups or mixed ability groups (Gage, 2001, pp22-25). Gage believed that if students had the opportunity to use video conferencing regularly over a long period, then this could enable them to develop their mathematical communication (Gage et. al, 2002).

At the time of writing there are three different models of video conference offered by Motivate. The first is a one-off daylong conference running from approximately 10am to 3pm. The exact timetabling of the day depends on the topic being delivered and the person leading the session. However, having personally delivered a small number of one-day conferences for Motivate, I am able to describe roughly how the day is broken down. Firstly, the person chairing the video conference explains any protocols that need to be followed, such as keeping the microphone muted when not speaking, and outlines the timetable for the day. Each of the schools involved is then given the opportunity to introduce their school and the part of the country (or the world) that they come from. The chairperson then hands over to the person leading the conference who introduces the theme and explains the tasks. Schools are given some time away from the camera (as much as

fifteen minutes) to try out ideas and the chairperson then invites each school to present their findings before handing over to the person leading the conference to feedback.

The second model is similar, but involves two shorter conferences of approximately one and a half hours that are about a month apart. The first conference is used to present new ideas to the children and for them to try activities and present in the same way as the first model described above. The role of the chair, the introductions and the protocols are all as they were for the first model. However, some extended tasks are set for the children to work on between the conferences with the aim of each school delivering a short presentation during the second conference.

The third model of video conferencing used by Motivate is known as the *long conference*. In this model there are two video conferences per term across an academic year with opportunities for independent work between conferences and presenting ideas to the camera as in the second model. Motivate ideally aims to have four schools involved in each conference. However, as was discussed above, some schools come together at the same endpoint, which could result in more than four schools being involved in any one conference, although the number of endpoints would remain fixed at four.

## **Summary**

Chapter one has set the scene for this project, which essentially seeks to understand what is happening throughout the planning and delivery of a course of mathematics enrichment lessons delivered using video conferencing technology. An academic and educational rationale was presented and the research questions were defined as:

How do teaching strategies evolve when delivering a course of mathematics enrichment sessions using the medium of video conferencing?

- What decisions are made in the planning and delivery?
- What strategies are used and how do they evolve?
- What is the experience of the children?

When considering these questions, it was important to include a brief analysis of the early decisions that were made in relation to the structure and the content of the video conferencing sessions. These will no doubt relate to the personal values, the situational demands and the professionalism of me as a teacher, and chapter one discussed my reflections on these decisions, which will be revisited in chapter nine. Chapter one went on to define mathematics enrichment tasks as those which have the low threshold – high ceiling quality and also allow the children to use multiple methods to approach and present their solutions.

The evaluation of the pilot project was such that very few changes were made in preparation for the main study. This could mean that those early decisions were well-placed, but equally it could mean that the evaluation failed to identify the key issues with the structure and content of the sessions delivered during the pilot project. The remainder of this thesis will seek to identify and understand the strategies utilised in these video conferences and one should read on to learn about the evolution of these strategies and to discover more about the children's experiences.

#### **CHAPTER 2 – REVIEW OF THE LITERATURE**

"The real test of literature is that it will bear repetition"

Samual McChord Crothers

This chapter is broken down into three sections so that the literature is structured in an appropriate manner. The first two sections consider the opportunities and constraints of video conferencing technology in the context of higher education, commerce and schools. However, it should be made clear here that opportunities and constraints are not necessarily neat and mutually exclusive categories and what is considered to be an opportunity in one situation might be a constraint in a different situation. A thematic approach will be used to identify the key opportunistic and constraining factors and these will include technical support, interactivity, training, virtual presence, site facilitators, video conferencing etiquette and blended learning.

The third section of this chapter will define the term 'strategy' and will describe how a framework of teaching strategies has been developed from work undertaken in the field of learning strategies. This framework is important for the study, since it provides in part the structure of the following chapters. The chapter will end with a summary of the key points and will identify the contribution to knowledge that this study can make. It will identify the gaps in the literature that the study is intended to address.

# 2.1 Video Conferencing in Higher Education and Commerce

Much of the literature about video conferencing reports on its use in higher education and commerce. There is less literature on the use of video conferencing technology in schools, although this has recently begun to increase, perhaps as a result of the decreasing running costs with the

wider availability of IP video conferencing (Merrick, 2005, p4). Whilst much of this chapter will focus on schools, it is legitimate to consider both higher education and commerce contexts as well, since more work has been carried out in these areas and there are considerations in the use of technology which operate across contexts.

There are a variety of justifications for using video conferencing in the higher education sector, but the most common rationale is to provide access to a remote expert (Laouenan, 1999, p177; Freeman, M., 1998, p197; Carville and Mitchell, 2000, p42; Barbour, 2005, p1055). This is in keeping with much of the literature, which argues that the rationale for using video conferencing technology should be to take advantage of pedagogical opportunities rather than a desire to save time or money in replicating what already takes place (Hearnshaw, 1997, p52; Smyth, 2005, p817; Smith, 2004, p9). Whilst this is an admirable ambition, the reality is that financial considerations are a high priority, particularly in the context of the current challenging financial climate. Video conferencing does require investment and the technical quality of a conference is closely related to its cost, yet little is known about the relationship between cost and pedagogy (Hearnshaw, 1997, p58), although it is argued in some studies that the benefits of video conferencing may not outweigh the costs (Freeman, M., 1998, p197). Cochrane (1996, p320) makes the case for prioritising pedagogy over technology clearly by stating that, "merely linking individuals/groups at different locations does not in itself create a learning environment". Generally, there is much disagreement about how much pedagogical opportunity is added when technology is introduced. Some believe that technology can add value if the content of the learning material is well selected (Guimares et. al., 2000, section 1) whilst others believe that it is the style of delivery that is important (McCormick and Scrimshaw, 2001, p42).

One of the key issues in the literature related to higher education and commerce was the impact of both technical support and the reliability of the equipment. A research project that examined the delivery of business finance lectures was carried out in Australia (Freeman, M., 1998, p197). Students were split across two sites such that 80 students were at one site and 250 students were at another site. Video conferencing was used to deliver material to both sites simultaneously with the course consisting of a one-hour lecture once per week for 13 weeks. To ensure that neither group was disadvantaged, the lecture was broadcast from alternate locations each week. To record his results, Freeman surveyed all the students that took part, chaired focus groups and interviewed individuals in addition to considering data from video recordings, exam results and reflective diaries. Freeman expected the quality of learning for students to be improved since the teaching load for the lecturer was reduced as a result of not having to duplicate sessions. However, Freeman's results were not as he expected. He reported problems with being unable to send two images (one of the lecturer and one of the lecturer's notes) simultaneously using the satellite technology. The students noted a reduction in learning time as a result of these technical problems as well as the time required for setting up and shutting down the conferences (Freeman, M., 1998, p203). Indeed, this study argued that to achieve satisfactory quality from the technology, technical support, for example camera operators, was required (Freeman, M., 1998, p207).

A number of other studies have reported a similar reduction in learning time as a result of technical difficulties. For example, one study reported on the use of video conferencing for tutors of an early childhood studies course to deliver material to their students (Carville and Mitchell, 2000, p44). The teachers delivering this material also reported a reduction in learning time as well as interruptions to the flow of their lessons. A second study involved Masters students receiving their lectures by video conference and they too reported a reduction in learning time (Knipe and Lee, 2002, p310).

Freeman's (1998, p207) argument above that technical support is necessary to ensure a successful video conference is generally supported by the literature (Gill, 2005, p574; Laouenan, 1999, p179). Language learning has been a focus for a number of higher education institutions using video

conferencing, perhaps because of the potential of the technology to access other cultures with relative ease. Technical support in this context appears to be of particular importance as high quality audio is required to support language learning (Laouenan, 1999, p179).

Another consideration in getting started with video conferencing is what Mason (1994, p107) describes as *techno-stress*. She defines this as something that video conferencing users will experience after more than one hour of continuous use. A number of studies reported that those teaching or presenting through the medium of video conferencing experienced techno-stress at some point. Indeed, in Freeman's study (Freeman, M., 1998, p208) discussed above, the lecturers reported a 'massive increase in stress'. A separate study reported that some teachers demonstrated uncharacteristic tension when video conferencing and this in turn made the students feel uncomfortable (Jacobs and Rodgers, 1997, p294). The study goes on to suggest that this tension may be due to the difficulties in handling both the technology and the students simultaneously as well as the unpredictability of the video conferencing environment (Jacobs and Rodgers, 1997, pp292-294).

Carville and Mitchell (2000, p44) describe the initial experience of presenting through the medium of video conferencing as both apprehensive and exciting, yet the dominance of techno-stress in some of the more longitudinal studies suggests that whist excitement may dwindle over time, the apprehension in relation to the reliability of the technology appears to remain. Laouenan (1999, p179) describes video conferencing experiences as 'nerve-racking', yet makes the point that such 'live' performances give a spontaneity to the presenter that would not otherwise be available. This is in contrast to other parts of the literature, which suggest that video conferencing technology limits teaching style rather than providing opportunities for spontaneity (Freeman, M., 1998, p208; Carville and Mitchell, 2000, p44). This brings into focus one of the clear points of tension in the literature, which is does video conferencing technology actually helps or hinder the quality of teaching.

Indeed, some see video conferencing technology as both an inhibiting and a facilitating factor (Husu, 2000, p258; Thorpe, 1998, p402).

One area in which the literature is in general agreement is that site facilitators should be used at remote endpoints to assist with behaviour management and to ensure the smooth running of the conference (Gill, 2005, p576; Carville and Mitchell, 2000, p42). Sometimes, the use of site facilitators was deemed necessary as a control mechanism for the presenters (Jacobs and Rodgers, 1997, p293; Freeman, 1998, p208) and it could be argued that this would help to reduce technostress, although this has not been stated explicitly. Whilst the majority of the literature views the use of facilitators as contributing to the success of a video conference (for example in dealing with technical issues), there are some that that have also recognised the value that can be added in terms of enhancing the effectiveness of the video conference (Carville and Mitchell, 2000, p48). One study stated that if the students' experience is to be a good one, then there needs to be a lot of preparation and input at the remote sites (Gage et. al., 2002, section 4). Interestingly, Smith (2004, p8) discusses the general idea that activity should be managed at the remote sites, yet she does not make it clear whether this should be done by site facilitators or remotely by the presenter. Indeed, little has been done to research the role of remote presenter in managing behaviour and learning without the use of site facilitators. In those studies where site facilitators have not been used, this has tended to be as a result of logistical convenience rather than being a pre-planned decision.

Many of the studies about video conferencing reflect on the opportunities and constraints of this technology in comparison with traditional face-to-face teaching. As discussed above, there are some studies that have reported clear drawbacks to using video conferencing such as limitations in relation to teaching style and spontaneity (Freeman, M., 1998, p208; Carville and Mitchell, 2000, p44) and some believe that students learning at remote endpoints experience a poorer quality of teaching and have different experiences than those learning face-to-face (Knipe and Lee, 2002,

p301). Several studies reported that presenters found it more difficult to make effective use of eye contact and body language in the virtual environment (Ertl et. al., 2005, p149; Knipe and lee, 2002, p310, Freeman, M., 1998, p207) and these problems were sometimes worsened as a result of movement restrictions (Carville and Mitchell, 2000, p45). In contrast, an additional strength of video conferencing that was identified in the literature was the extent to which it can empower learners who might not be as empowered in a face-to-face environment. For example, one study stated that for learners who are "easily overawed or lacking in confidence, personal video conferencing may be of help in easing social interactions through being one step removed from reality and so alleviating the anxieties involved in face-to-face interactions" (Thorpe, 1998, p402).

It is thought by some that video conferencing sessions can be comparable, in terms of outcomes, with face-to-face sessions (Ertl et. al., 2005, p149), and indeed there have been a number of studies that have reported no overall differences in the test scores between students taught in person or using video conferencing technology (e.g. Husu, 2000, p262; Peterson and Bond, 2004, p350; Ertl, et. al., 2005, p149). This prompts questions about what contributed to using video conferencing technology as effectively as possible.

It is suggested that detailed planning and training are both key factors in ensuring a successful and effective video conference (Gill, 2005, p573). Furthermore, it is argued by some that the amount of planning and preparation required for a video conference is significantly greater than that required for a face-to-face session (Couzins, 2004, p3; Freeman, M., 1998, p207). Little research has been conducted into whether the amount of planning needed would reduce over time as presenters became more accustomed to using the technology, although it is generally the case that presenters become more efficient over time (Jacobs and Rodgers, 1997, p294). One study reported that good face-to-face presenters were not always good video conference presenters (Jacobs and Rodgers, 1997, p294), which emphasises the need for additional planning time and training.

In relation to training, the literature seems to suggest that there are certain techniques or strategies that help to improve teaching and learning in the virtual environment (Carville and Mitchell, 2000, p42; Jacobs and Rodgers, 1997, p294). Many of the recommendations concern practical considerations that are 'packaged' in the form of an etiquette or code of conduct for video conferencing (Couzins, 2004, p2). Such etiquette includes advice about chairing video conferences, staff/student ratios, level of interactivity and room layout amongst other things (Smith, 2004, p8; Gill, 2005, p574; Cochrane, 1996, p320). The advice given by Gill (2005, p574) in the form of twelve tips for video conferencing captures much of the essence of the etiquette suggested in the wider literature.

Although many studies indicate that training is essential, some of the research reports that video conferencing sessions have been successful with the presenters having had little or no training and this was often attributed to presenters embracing the technology with a positive attitude and being prepared to be flexible to make it work (Carville and Mitchell, 2000, p48; Miller and Glover, 2002, p18). This demonstrates another area of tension in the literature. Some researchers believe that there is a loss in teaching quality when using video conferencing and that this is in part due to inexperience, unsuitable teaching strategies and inefficient training on the part of the presenter (Knipe and Lee, 2002, p311). Others believe that the new skills that teachers have to learn in order to present lessons using video conferencing are not just desirable, they are essential (Jacobs and Rodgers, 1997, p300). Couzins (2004, p29) states, "managing a video conference and turning in an impressive performance is a skill that still needs to be learned along with a whole new set of ground rules and etiquette, so training beforehand is critical".

However, the literature also suggests that the virtual environment itself is conducive to certain types of teaching and learning, and perhaps a significant aspect of any training in this area ought to be related to developing an awareness of the relevant opportunities and constraints. In particular,

there are numerous arguments that video conferencing is a natural tool for dialogue, collaborative learning and group work (Hearnshaw, 1997, p52; Knipe and Lee, 2002, p307; Ertl et. al, 2005, p149). Although much of the literature compares video conferencing and face-to-face teaching, there is little that has considered how collaborative learning in video conferences can be supported through specific instructional measures (Ertl et. al., 2005, p148).

The notion of interactivity, as introduced above, is clearly an important consideration in the literature. Interacting with ideas and other people is seen as being important for learning since it allows understanding to occur (Carville and Mitchell, 2000, pp45-46). However, the literature suggests that on some occasions the full interactive potential of video conferencing is not being exploited as a result of the limitations of the technology (Carville and Mitchell, 2000, p46). Gill (2005, p573) includes interactive teaching as one of the key principles for success in video conferencing and Salmon (2002, p380) argues that interactive and reflective activities are seen as a key part of the learning process.

Another key consideration that was discussed widely is the number of participants that should be at the endpoints. This is generally referred to as *tele-presence* or *virtual presence* and it considers the extent to which individuals can participate in the video conference. Jacobs and Rodgers (1997, p296) discuss how the appropriate set-up of the teaching room can help to bridge the psychological distance between participants and this is perhaps a reference to virtual presence as well as Moore's notion of transactional distance (Moore, 1992). It is argued by some that there must be a sense of virtual presence for all participants if a conference is to be effective (Hu, 2000, p381). One way of establishing virtual presence is to limit the number of participants at each endpoint. One suggestion is that the number of participants at each endpoint should be about six to allow everybody to be individually identifiable on a television monitor (Jacobs and Rodgers, 1997, p293). Others would suggest that four participants at each endpoint is more appropriate (Hearnshaw, 1997, pp55-56).

The smaller number of participants may be beneficial for teaching as well as for learning, since it facilitates monitoring, an area of development identified in Laouenan's research (Laouenan, 1999, p180).

## 2.2 Video Conferencing in Schools

The adoption of video conferencing technology in schools has been relatively slow in comparison to higher education and commerce. Historically, ISDN connections were used for video conferencing and it could be argued that the high costs associated with maintaining dedicated telephone lines prevented the technology from penetrating school environments at the same rate as was seen in the higher education sector. More schools are now starting to use video conferencing and some would argue that this is due to the emergence of increasingly reliable IP network reliability (Merrick, 2005, p4). Furthermore, as a result of the improved networks and the availability of greater bandwidth for schools, many educators began to believe that video conferencing could be an ideal educational tool (Anderson, 2008, p110). This chapter section considers the video conferencing literature associated with educational use in schools. The themes that emerged from the literature on higher education and commerce will be considered in the context of teaching and learning in schools, and any new themes emerging from the schools literature will also be discussed.

A good starting point is the DfES 'video conferencing in the classroom' project (Comber et. al., 2004), which considers the video conferencing activities of 28 schools with a range of experiences and across a range of curriculum areas. The most common curriculum areas found to be using the technology were English, Geography, History and Modern Foreign Languages (Comber et. al., 2004, p7), although other curriculum areas also made use the technology, including mathematics. The findings of this study were numerous and the most relevant are discussed here.

Firstly, the DfES study concluded that video conferences could be divided into four broad categories; familiarisation, substitution, enhancement and adaptation (Comber et. al, 2004, pp23-25). Familiarisation was described as an early phase during which the participants are getting used to the equipment. Substitution involved replacing lessons traditionally delivered face-to-face with delivery through video conferencing. Enhancement, which is described as the most common usage, involves including some video conferencing sessions to support wider curriculum activities. Adaptation is described as using video conferencing to support innovative pedagogies that might not otherwise have been possible without the technology.

Secondly, the DfES report stated that video conferencing was found to be motivating for students and to increase their self confidence (Comber, et. al., 2004, pp45-47). Numerous other studies have reported similar side effects (Thorpe, 1998, p401; Gerstein, 2000, p183; Gage, 2003; Butler and Fawkes, 1999, pp46-47) including a large study about video conferencing of 52 schools across a range of curriculum areas (Austin et. al., 2003, p61).

Real-time collaboration seems to be a key factor in improving student confidence. One study described how students from two different countries collaborated through the medium of video conferencing (Harris, 2002, p452). The students asked questions in the foreign language and answered questions in their native language and it is argued that this has led to increased communication skills. Similarly, Gerstein (2000, p184) reports an enhancement in students' communication and presentation skills as a result of video conferencing. A different study described how pupils' self-esteem and self-identity were improved just through having the opportunity to ask questions during a video conference (Abbott et. al., 2005, p234).

In the DfES video conferencing in the classroom project, advice was given to teachers about how to arrange rooms in order to maximise the visual experience for participants (Comber et. al., 2004,

p57). Implicit here is the idea that the participants' general experience is linked to the level of interactivity they experience during a conference. Returning to Lawson and Comber (2005, p6) the point is made that over time schools begin to exploit the potential for interactivity that is inherent within video conferencing technology. This again emphasises the importance of interactivity in the context of using video conferencing technology within an educational setting. Heath and Holznagel (2002, pp10-11) make the point that whilst video conferencing technology can provide students with opportunities to develop high levels of interactivity, this does not automatically occur and must be encouraged and fostered by the presenter. Although there is general agreement on the importance of interactivity during video conferences, there is disagreement about the whether the technology itself acts as a barrier or as a facilitator of interactivity (Doggett, 2008, p35; Anderson, 2008, p112). In one study about working with special needs students from three different schools, it was argued that the formal setting of video conferences can lead to constraints on teaching style resulting in a more didactic than interactive approach (Thorpe, 1998, p396). However, Yamada (2009, pp830-831) argues the opposite, claiming that video conferencing can facilitate interactivity since participants can use non-verbal cues to promote comprehensive communication between learners.

A further finding is that additional training is required for teachers if they are to demonstrate good practice when video conferencing (Comber et. al., 2004, p38) and this is supported in several other studies (Harris, 2002, p453; Anderson, 2008, p120; Gage, 2003). This need for additional training suggests that teachers need a new or modified set of skills and techniques (Heath and Holznagel, 2002, p7; Doggett, 2008, p30). As with all technology, video conferencing has its own limitations and obstacles, but these can often be overcome with careful forethought and planning (Gerstein, 2000, p179). For example, in Gerstein's study, the students at each endpoint had to prepare a video and a box of equipment for a particular video conference and these items needed to be exchanged in advance of the conference taking place (Gerstein, 2000, p178). This is not an activity that can be left until the last minute, particularly if the endpoints are very distant from each other, and

demonstrates clearly the need for planning. Arguably, more planning and preparation is required for multipoint conferences in comparison with point-to-point conferences because of the increased communication that may be required in advance (Lawson and Comber, 2005, p7).

Comber et. al. (2004, p26) discuss the different *patterns of interaction* used by schools for video conferencing in a variety of learning environments. This refers to the *endpoint configuration*, which is the terminology used in my study. The report suggests that schools most commonly use a one-to-many endpoint configuration, which in practice involves using whole classes (Comber et. al, 2004, p26). This may be because teachers do not want to exclude any pupils from participating in a video conference. The average class size for secondary schools in England has remained steady between 20 and 22 pupils since 1992 according to Government statistics (Parliamentary Publications, 2006). If the one-to-some endpoint configuration is to be used more frequently within schools, then this would mean withdrawing pupils from their classes since this only allows for a maximum of eight pupils at each endpoint. It may be that because of the novelty of the technology, some teachers are inclined to focus on giving students an experience of video conferencing rather than focusing on the potential learning opportunities. However, once the novelty has passed, teachers may begin to think again about the appropriateness of the endpoint configuration that they have chosen. Indeed, Gage (2003) reports that some teachers were worried about the class size being too big since they would not be able to involve all of the participants.

It was earlier argued that a one-to-some endpoint configuration was most appropriate in ensuring the participants had a virtual presence in a video conference. In the context of schools, there are similar views. Indeed, a number of studies suggested that having smaller numbers of participants at endpoints was more effective for interactivity (Austin et. al., 2003, p66; Butler and Fawkes, 1999, p47; Thorpe, 1998, p397). In considering virtual presence, it may be appropriate at this stage to consider Moore's theory of transactional distance, which is considered relevant to video

conferencing (Thorpe, 1998, p397; Heath and Holznagel, 2002, p7; Moore, 1993, p28). The theory evolved from basic insights regarding independent learning and learner autonomy (Gorsky and Caspi, 2005, p1) and became a concept describing the "universe of teacher-learner relationships that exists when learners and instructors are separated by space and/or time" (Moore, 1993, p22). In video conferencing, there is a physical distance between teachers and learners, but it should be made clear here that Moore's theory assumes it is pedagogy that has the most profound impact (Gorsky and Caspi, 2005, p3). That is, there is a cognitive, psychological and physical distance, all of which are elements of Moore's notion of transactional distance. This means that even in face-toface teaching and learning environments, there is some transactional distance (Moore, 1993, p22). In relation to measuring transactional distances, it is suggested that three pedagogical variables are considered; dialogue, structure and learner autonomy (Moore, 1993, p22). However, some believe that transactional distance should be measured more statistically by considering student misunderstanding expressed as a percentage (Gorsky and Caspi, 2005, p8). The pedagogical variables above are arguably relevant to video conferencing and will be discussed later in the thesis. In comparison with other interactive media, it is argued that video conferencing can reduce transactional distance and also increase the autonomy of learners (Moore, 1993, p31).

Some research has indicated that there are sometimes issues in relation to the roles played by site facilitators at the remote endpoints (Comber et. al., 2004, p62). Such roles might include mediating, managing behaviour or additional teaching to support the presenter. As was seen earlier, site facilitators were seen as necessary to ensure that a video conference was effective (Lawson and Comber, 2005, p8). One study described a situation in which there was no site facilitator due to unforeseen circumstances (Lawson and Comber, 2005, p9). The result was confusion, which diminished the effectiveness of the session.

It may be that this leads to an underlying assumption that children will behave poorly without physical supervision, though some have still argued that participating in video conferences can improve the behaviour of the students (Comber et. al., 2004, p47). Furthermore, Thorpe (1998, p401) suggests that this positive modification of behaviour is not a result of the novelty of the technology, but rather a result of positive peer pressure and a structure which has fewer distractions. In terms of the strategies that can be used to manage students' behaviour during video conferencing sessions, little has been written. One study reported that some teachers reminded students in advance about appropriate behaviour and manners (Gerstein, 2000, p180; Lawson and Comber, 2005, p8) and another discussed teachers' preferences for utilising a split screen to supervise students at remote endpoints (Anderson, 2008, p114). Again, this is perhaps a reflection of the fact that site facilitators are often used for video conferencing and so remote behaviour management is not a major consideration.

One practice that could be considered a behaviour management tool is enforcing the use of video conferencing etiquette, sometimes referred to in the literature as tele-presence skills. This might include explaining video conferencing protocols in advance and muting the microphone at appropriate times during a conference (Lawson and Comber, 2005, p8). It might also include general guidance about how sessions should be conducted and perhaps such advice is most crucial for inexperienced users of video conferencing (Butler and Fawkes, 1997, p47). Furthermore, it is argued by some that the greater the number of participants, the more need there is for clear rules in the form of video conferencing etiquette (Comber et. al., 2004, p58).

Moving away from site facilitators, the other key personnel for running smooth video conferences are technical support staff. The DfES project reported that very few technical issues occurred in the 28 schools involved in the study (Comber et. al., 2004, p13). However, this is perhaps a result of most schools using costly ISDN connections rather than the newer, and less reliable, IP connections.

Nevertheless, the DfES project goes on to state that technical support is an important factor in improving the quality of the video conferencing experience (Comber et. al., 2004, p38) and this view is supported by the wider literature (Austin et. al., 2003, p61; Butler and Fawkes, 1999, p47). Doggett (2008, p40) goes further and argues that the technical support should also be rapid, perhaps in recognition of the live and synchronous nature of video conferencing. However, the importance of technical support is brought into focus by Lawson and Comber (2005, p8), who state that whilst teachers acknowledged that video conferencing technology was generally easy to use, some teachers were put off from using the equipment at all in case of a technical breakdown. This lack of willingness by some teachers to use unfamiliar technology is not new (Harris, 2002, p454), but could perhaps be attributed to techno-stress as discussed earlier in this chapter. Indeed, some suggest that such willingness is not a conscious decision on the part of the teacher, but perhaps inherent in their personality (Doggett, 2008, p40). A good analogy when considering the use of video conferencing technology in schools is the use of the interactive whiteboard, which has been more readily accepted into the school environment. It is believed that for the interactive whiteboard to impact on pedagogy, there must be a willingness on the part of the teacher to use and develop the technology (Miller and Glover, 2002, p18) and so perhaps the same argument holds if video conferencing is to impact on pedagogy.

One area that is discussed widely in the schools literature is how current knowledge about learning theories can be applied to video conferencing. Before looking at the schools literature, it is worth briefly outlining the relevant learning theories in a broader context. Understanding how processes of learning work is important for those who intend to develop their teaching and learning (Pritchard, 2009, p1) and hence they are of importance to my study. It is generally agreed that there are two main branches in the psychology of learning, behaviourism and constructivism, although these can be broken down further. Behaviourism is concerned with the behaviour that takes place as a response to particular stimuli and the idea is that learning takes place by repeating and reacting to

what others do. In the classroom environment, this is expressed by teachers conditioning students to respond in particular ways to particular circumstances, perhaps using routines, drill, rewards and punishments (Pritchard, 2009, p8). Constructivism, on the other hand, is more about understanding and is based on the idea that knowledge is internally constructed by the individual based on the experiences they have. Of particular relevance to this study is the idea of social constructivism, championed by Vygotsky (1978), in which the emphasis is placed on the interaction, often discussion, between the learners and others in the learning environment (Pritchard, 2009, p24). Indeed, it has already been demonstrated in this chapter that interactivity was a key theme that emerged in the literature associated with video conferencing.

Within the schools literature, some argue that the teaching strategies required in a traditional classroom are different to those required when using technology and so appropriate pedagogies and teaching strategies need to be selected (Gibbs and Gosper, 2006, p47; Eales and Bryd, 1997, p157). In the context of video conferencing, there is much support for the idea that this technology can facilitate collaborative learning if used effectively (Heath and Holznagel, 2002, p9; Gerstein, 2000, p180; Gibbs and Gosper, 2006, p48). In particular, Austin et. al. (2003, p60) argue that the constructivist theory of education requires a rich and dynamic teaching and learning environment. Here, video conferencing can facilitate students sharing ideas between endpoints, which is arguably more beneficial to them than individual study (Abbott et. al., 2005, p228). However, it should be noted that not all literature is in favour of using a socio-constructivist learning model for video conferencing as illustrated by the quote below.

"Constructivist, collaborative and inquiry-based learning models demand that students be active and engaged and that this engagement leads to significant improvements in learning and attitudes towards learning. As a stand-alone system, video conferencing does not provide the level of standard engagement with

teachers, other students or content needed to sustain their attention, enthusiasm and ultimately high levels of learning"

Anderson (2008, p112)

Blended learning involves using combinations of learning strategies and such an approach has the potential to significantly enhance the learning experience (Garrison and Vaughan, 2008, p3). In the context of video conferencing, this argument could be extended to demonstrate that there is ample scope for blending learning theories in practice. For example, the etiquette and routines required for the smooth running of video conferences and for developing appropriate communication skills requires a behaviourist approach, whilst the acquirement of knowledge and understanding requires a socio-constructivist approach.

#### 2.3 Teaching Strategies

The process of teaching is complex in any curriculum area (Cowan, 2006, p1) and there is still much to be understood about the complexity of teaching and learning in mathematics (Sutherland, 2007, p24). This study adds a further dimension for consideration by bringing in the additional aspect of using video conferencing technology. The selection of appropriate teaching strategies is an important part of any project that utilises video conferencing technology, since new technologies provide teachers with new challenges. More specifically, the success of ICT is dependent upon the way in which a variety of discrete classroom strategies are integrated into the teacher's overall pedagogy (Leach and Moon, 2000, p268).

Before continuing the discussion of teaching strategies, it is necessary to define the term *strategy* since it has been interpreted and used in numerous ways. The multiple definitions below demonstrate the obscure nature of the term.

"...in the literature, strategies have been defined as 'techniques', 'tactics', 'potentially conscious plans', 'consciously employed operations', 'learning skills', 'basic skills', 'functional skills', 'cognitive abilities', 'problem solving procedures'."

Walker (2001, p84)

The difficulty in defining what a strategy is goes back decades and some have stated that the lack of clarification of the concept of strategy was a fundamental problem that needed to be addressed by educational research (Scarth, 1987, p246). A dictionary definition of strategy is 'a particular long term plan for success' (Collins Concise Dictionary, 2001). However, this raises further issues over what constitutes 'long term' with some believing that strategies might even be sub-conscious and impulsive (Scarth, 1987, p253). The quote above describes a strategy as being a technique, but again there is disagreement. Some have defined a technique as 'a method for doing something that needs skill' and a strategy as 'a particular plan for gaining success in a particular activity', which suggests that technique is a broader term than strategy (Marriott and Torres, 2009, p4).

Scarth summed the issue up well when he stated that:

"the concept of strategy suffers from a lack of clear and consistent definition. Thus the term strategy is used to refer to a wide variety of phenomenon [...] It almost seems as if strategy can refer to anything that a teacher does at any time in any context"

Scarth (1987, p251)

For the purposes of this research, I have chosen to define a strategy as a series of conscious and subconscious decisions made in the planning and delivery of a task leading to a predefined outcome. Using this definition, it can be seen that a strategy can be made up of several smaller strategies, which could themselves be broken down into even smaller strategies if required. At this stage, I will define small discrete strategies as micro-strategies and those strategies that encompass several micro-strategies as macro-strategies. Grouping in this way is not unusual and has been used by others (e.g. Mitchell, 2008, page ix; Cowan, 2006, pp73-74; Killen, 2007, p80). However, there are many different ways of structuring and grouping teaching strategies, yet there does not appear to be one consistent approach. Later in this sub-chapter, the teaching strategies used in this study will be grouped to form a framework for the analysis and discussion that occurs later in the thesis. However, given the inconsistencies described above, it will be important to justify the approach taken.

In this study, many different teaching strategies were used, which is not surprising since a variety of teaching strategies are needed if learning is to be as effective as possible (Killen, 2006, p74). Indeed, it would be wrong to assume that any one teaching strategy alone would be an effective learning tool for all students (Killen, 2007, p59; Richardson-Koehler, 1987, p27; Marzano, 2003, p79). Making a conscious choice about which teaching strategies should be used for a particular lesson can be very difficult, since the number of factors involved can be large (Killen, 2006, p75). However, it was discussed above that some teaching strategies are implemented impulsively and sub-consciously (Scarth, 1987, p253), which suggests that effective teachers may have a natural ability and flexibility to select appropriate teaching strategies in particular learning contexts (Killen, 2007, p79). Such spontaneity allows effective teachers to make teaching look easy (Cowan, 2006, p69) since little or no advance thinking appears to have taken place in relation to which teaching strategies should be used. Indeed, given that it is not always possible to anticipate the ways in which students will respond to mathematical problems (Sutherland, 2007, p88), such spontaneity is perhaps helpful for teachers.

One suggestion for dividing teaching strategies is to group them according to (i) the arrangement of the learning context, (ii) cognitive strategies and (iii) behavioural strategies (Mitchell, 2008, page ix). In this context, cognitive teaching strategies refer to those that help learners to acquire cognitive skills (e.g. analysing) and contained within this category is metacognition (i.e. helping students to think about their own thinking). This broad categorisation is somewhat different to Cowan (2006, pp73-74) who uses a narrower categorisation (e.g. whole class teaching or small group work). Amongst the broadest of categorisations is perhaps that of teacher-centred strategies and student-centred strategies (Killen, 2000, p14). Teacher-centred strategies are those which are expository or deductive by design so that the teacher has control (e.g. lectures, demonstrations), whilst student-centred strategies are those which are inductive by design so that the teacher has little or no control (e.g. investigative work). In the context of this study, it is clear that I had much control over some aspects, and little control over other aspects, of teaching and learning, which supports the earlier idea that a variety of teaching strategies are required for learning to be as effective as possible.

Whilst the discussion so far has advocated the use of a variety of teaching strategies, there are still potential pitfalls in using this approach. It is possible that moving too quickly between strategies could result in none of the strategies being implemented effectively (Orlich et. al., 2010, p207). This may be because some students are not used to particular styles of learning that are brought about by particular teaching strategies (Killen, 2006, p128). Therefore, some would argue that it is not just the choice of teaching strategies that is important, but the also the time and energy that teachers invest in implementing them (Orlich et. al., 2010, p207).

Returning to the concept that a variety of teaching strategies should be implemented, it is helpful to consider why this might be beneficial from the perspective of the learners. It could be argued that varying the teaching strategies used provides greater opportunity and choice for learners, which in turn can motivate and enhance creativity (Kondor, 2007, p8; Van Tassel-Baska, 2003, p3; Tomlinson,

2003, p73). Furthermore, the choice of appropriate teaching strategies can facilitate learners' thinking, reasoning and understanding, and this is when learning is most effective (Killen, 2006, p73)

In considering the categories for grouping the teaching strategies in this study, I am mindful of the various approaches and inconsistencies discussed above. As such, it is my intention to consider grouping the teaching strategies based on two models originally designed for categorising learning strategies. This approach recognises and builds upon the unique relationship between teaching and learning.

O'Malley and Chamot (1990, p46) grouped learning strategies into four categories; metacognitive, cognitive, social and affective. They described metacognitive strategies as those used to make decisions on the learning and to organise and manage the learning, whilst cognitive strategies were those used to directly process any information being handled. Social and affective strategies were to do with the learner and their attitude towards themselves and others. Oxford (1990, p84) had a more comprehensive breakdown of the various categories of learning strategy. She began by dividing learning strategies into direct and indirect strategies before breaking them down further into memory, cognitive, compensation, metacognitive, affective and social strategies, as shown in figure 11.

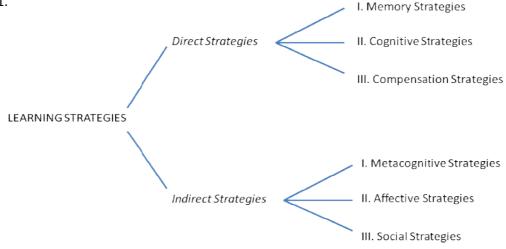


Fig. 11 – Oxford's learning strategies framework for languages

The two additional categories in Oxford's model were memory strategies and compensation strategies. Memory strategies were used when learners memorised key information or facts which could later be recalled to help achieve a specific desired outcome. Compensation strategies were the things that learners did when faced with unexpected situations. Oxford's framework was flexible since it could be applied to many different learning situations. In this thesis, I intend to reframe Oxford's model and combine it with O'Malley and Chamot's model so that it becomes suitable for categorising teaching strategies as described above.

The first stage of this reframing is to remove memory strategies. Teachers do not generally have to recall information in examinations or tests and they often work from a plan, which renders the memory strategies categorisation obsolete. In the O'Malley and Chamot categorisation, social and affective strategies were combined. It could be argued that social strategies are a sub-section of affective strategies and so I have chosen affective strategies to appear as one of the macrostrategies in my refined framework. The final revision to the framework consists of removing the divide between direct and indirect strategies, which now feels artificial when considering teaching rather than learning. My revised framework appears in figure 12 and below that each macrostrategy is defined in turn.

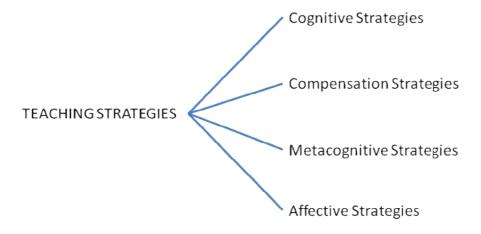


Fig. 12 – Revised framework of macro-strategies

Cognitive strategies consist of decisions made by teachers at the time of the learning that directly impact on the progress of the learner. This might include questioning, explaining, and any input from teachers that encourages the learners to think. Compensation strategies consist of impulse decisions made by teachers in response to unexpected situations. When using technology, this might include resolving technical issues, although more generally it might involve setting further extension work for learners that exceed what was originally planned for. Metacognitive strategies are those that facilitate the learners thinking about their own thinking. This is perhaps the most controversial category in the framework since some might argue that it should be grouped together with cognitive strategies. Metacognition in the context of teaching rather than learning is about being aware of the learners' mental processes and ways of learning and about teachers adapting their delivery accordingly. Metacognitive teaching strategies will be discussed more fully in chapter seven and at that stage the difficulties in describing this concept in the context of teaching will be considered in more detail. Lastly, affective strategies consist of decisions made by teachers that impact on the learners' attitude or behaviour. This might include managing poor behaviour from learners or encouraging them to be a more active participant in the learning environment.

The breakdown of micro-strategies within these macro-strategies is discussed in detail at the beginning of chapter three, since this constitutes a shift from reframing a model based on the existing literature to finalising the framework around which the methodology and methods will built.

Now that the categorisation of the teaching strategies in this study has been completed, it is worth considering some of the wider factors impacting on effective teaching and learning. Effective teachers are aware of the importance of establishing a positive teaching and learning environment (Cowan, 2006, p64). However, in the context of video conferencing, whilst the teacher has control over the teaching environment they have little control over the learning environments. Control over the learning environments could be improved through increased virtual presence (Perry, 2006, p235;

Shea et. al., 2003), which emphasises the importance of this concept as discussed earlier. Some argue that effective teaching and learning is 'active and interactive' rather than 'passive and isolating' (Perry, 2006, p229). Achieving such interactivity is perhaps even more challenging in the context of video conferencing, but teaching strategies that promote interactive learning should be strived for nevertheless (Cowan, 2006, p58; Austin and Mescia, 2004, p2).

During any analysis of teaching strategies that occurs, it would be wrong to assume that any strategies occurring frequently are effective (Killen, 2007, p109). Similarly, it would be wrong to assume that such strategies are ineffective. Arguably the best way of evaluating the effectiveness of teaching strategies is to compare them with the learning outcomes and then to consider the extent to which those outcomes have been meet (Killen, 2006, p123).

### **Summary**

This chapter allowed themes to emerge from the existing literature associated with higher education, commerce and schools in the context of the opportunities and constraints of video conferencing. A number of key themes were deemed to be of relevance to this study and were discussed in detail including technical support, interactivity, training, virtual presence and the use of site facilitators. A blended learning approach, which combines the etiquette of video conferencing with the potential for collaboration was suggested and will be reflected upon in chapter nine.

Having conducted this thematic review of the literature, it is clear that my research can add value to range of areas, although one area in particular has been identified as being of unique importance as it is currently under-theorised. This is the extent to which using no site facilitators and managing both behaviour and learning remotely can contribute to the delivery of a successful and effective

video conference. This significant gap in the literature will be addressed in the context of the research questions and will be discussed further in chapter nine.

This research will also add value in a number of different areas. The themes identified above are considered in much of the literature related to video conferencing and the way in which the remainder of this thesis is structured facilitates the emergence of these themes (and perhaps additional themes) which will seek to either strengthen or contradict the wider research field. Indeed, it could be argued that the relatively low volume of literature in this area increases the value of any additional research, including this study. The literature on higher education, commerce and schools raises several points of tension in relation to the themes that have emerged. The table below represents a summary of some of the key themes from the literature review and this will be revisited in chapter nine in the context of this study.

Point of Tension	Majority View	Minority View	Brief Reflection
Site facilitators	Site facilitators are an essential requirement to ensure the smooth running of a video conference. They should manage behaviour and learning at the remote endpoints.	When site facilitators have not been available, video conferences have still taken place successfully.	Very little research has been conducted into the remote behaviour management and monitoring strategies that may be required when there are no site facilitators.
Training	Training and careful planning are paramount in preparing for participation in a video conference.	Some presenters naturally adapt to using video conferencing technology because they are willing to be flexible.	The majority view that training is essential is consistent across the contexts of higher education, commerce and schools.
Rationale	The justification for using video conferencing should be for pedagogical, and not financial or logistical, reasons. Video conferencing is a potential method of distance teaching and learning across multiple locations.	Video conferencing can be as good as face-to-face teaching (i.e. students have produced similar scores in tests)	Although there is wide agreement that video conferencing should be used for pedagogical reasons, it appears that few studies have considered using video conferencing in situations when it would be simpler to teach face-to-face.
Reliability of the technology / technical support	The reliability of the technology is a key factor in ensuring that video conferences are successful.  Technical support is particularly helpful in resolving technical issues as they occur, although they are few. When there are technical issues, they can result in a reduction in learning time.	Remote technical support is sufficient to resolve most problems that occur. For example JVCS have a telephone helpline.	Although the studies report few technical problems, these views may be skewed for school-usage, since they generally use IP rather than ISDN. IP video conferencing is generally less reliable than using ISDN, but is the cheaper alternative, so most likely to be used by schools.
	Interactive teaching and learning is a key factor in ensuring an effective video conference. This is harder to	In situations when there would have been limited face-to-face activity, for example lectures, it	If increased interactivity requires smaller groups of participants at the endpoints, then there are wider

Interactivity / virtual presence	achieve when there are large groups at the endpoints. A smaller number of participants can increase their virtual presence and improve interactivity.	is acceptable to use large numbers of participants at the endpoints.	implications in the school context, since class sizes are not generally fewer than eight students.
Pedagogical approaches	Video conferencing supports dialogue and collaboration.	Video conferencing may support instructional or didactic teaching.	In the traditional classroom environment, different strategies are required to support different types of teaching. The same may be true when video conferencing is used.

Table 2 – Summary of the points of tension

The difficulties with the definition of the term *strategy* were discussed with some suggesting that in an educational context a teaching strategy could refer to anything a teacher does at any time (Scarth, 1987). With so many different interpretations of the term *strategy*, it was necessary to define what is meant by *strategy* for the purposes of this thesis. I chose to define a strategy as a series of conscious and sub-conscious decisions made in the planning and delivery of a task leading to a predefined outcome. Using this definition, it was argued that a strategy could be made up of several smaller strategies. These smaller discrete strategies were defined as micro-strategies and those larger strategies that encompass several micro-strategies were defined as macro-strategies.

The final part of this chapter considered the relationship between learning strategies and teaching strategies. Oxford's (1990, p84) flexible framework of learning strategies for languages was revised and adapted to become the framework of teaching strategies. The four macro-strategies were defined as cognitive, compensation, metacognitive and affective strategies and chapter three will detail how the revised framework will be applied to structure the description and analysis.

#### **CHAPTER 3 – RESEARCH DESIGN**

"Try not to become a man of success, but rather, try to become a man of value"

Albert Einstein

The quote above captures the idea that good research is not necessarily about obtaining successful and positive results, but about obtaining results that are rigorous and valuable. Chapter three will ensure that this research is conducted in a professional manner. This chapter of the thesis sets the scene for the analysis that follows in chapters four to nine and explains exactly how this study has sought to address the research questions.

How do teaching strategies evolve when delivering a course of mathematics enrichment sessions using the medium of video conferencing?

- What decisions are made in the planning and delivery?
- What strategies are used and how do they evolve?
- What is the experience of the children?

Having defined a framework of macro-strategies for teaching in chapter two, it is now appropriate to define the micro-strategies. By looking through recordings of the video conferences and other data from the pilot project, I was able to list the different micro-strategies being used. Some micro-strategies might have been able to be categorised in more than one way and so decisions needed to be made to ensure that each micro-strategy occurred in only in one of the macro-strategies. The final version of the revised framework is shown below.

## 1. Cognitive Strategies

- a. Explaining solutions
- b. Guiding pupils to improve their solutions
- c. Using non-verbal communication

### 2. Compensation Strategies

- a. Mathematics
  - i. Extending task time
  - ii. Setting extension tasks
- b. Technology
  - i. Resolving audio issues
  - ii. Resolving visual issues
  - iii. Giving technical instructions to pupils
  - iv. Resolving connectivity issues

### 3. Metacognitive Strategies

- a. Lesson planning
  - i. Choice of resources
  - ii. Choice of presentation style (e.g. using PowerPoint or a standard whiteboard)
  - iii. Using competition
- b. Technical Preparation
  - i. Choice of screen layout
  - ii. Choice of theme tune
- c. Evaluating pupils' learning

# 4. Affective Strategies

- a. Building pupils' confidence and giving praise
- b. Managing behaviour
- c. Using pupils' names and school names

This framework will be used to breakdown the description and analysis in chapters four to nine, and the methodology and methods to be used for the analysis will be described in this chapter.

Chapter three is divided into three sections. The first section will consider the different methodologies that could be used to underpin this research. By the end of this section, the justification for using a case study design will be clear and some thought will have been given to the reflexive nature of this research. Section two will look in detail at the specific methods that were used to collect and analyse the data. The volume and richness of the data collected will be discussed

and a justification will be made for focusing the qualitative aspect of the research on key participants from each school. The final section of this chapter will discuss the ethical issues that needed to be considered. Some of these issues are generic to many educational research projects, whilst others are specific to this project, including the risks and potential drawbacks of using video conferencing technology over a sustained period in addition to the legal situation regarding the remote supervision of children.

### 3.1 Research Planning and Methodology

When planning a research project, the first thing to consider is the purpose of the research (Cohen et al., 2003, p89). This research project is about understanding how and why teaching strategies evolve over time in the specific context of using video conferencing technology to deliver mathematics enrichment sessions. The purpose for undertaking this research is to provide a point of reference for other practitioners wishing to undertake similar projects. In a more general sense, this research is about sharing experiences with other practitioners so that they can learn from my successes and failures, and perhaps build on this to understand their own unique situation.

This research has culminated in two separate documents being produced; one for practitioners and another for educational researchers. The practitioners' document is relatively short and consists primarily of the key findings and recommendations that emerge in the later chapters of this thesis along with some of the background to the project. The language has been adapted to make the document more relevant to practitioners. This thesis constitutes the document for the educational research community.

The fixed timescale of around three years is a constraint that needs to be considered when planning an educational research project for a PhD. We already know from chapter one that the video conferencing sessions (and the face-to-face pre-sessions) ran across one academic year. The result

was that the planning for the main research project ran in parallel with the pilot project during the first year of the PhD. The main data collection took place during the second year, and the majority of the analysis and discussion of the data took place during the third year.

The choice of research methodology for a project is often decided by considering a combination of different factors. The research question and the values and beliefs of the researcher are both important considerations. The researcher's attitude towards how educational theory should be used is also a factor. Some believe that theory should be the starting point for educational research whilst others would prefer the theories to emerge from the data. There are numerous methodologies available for researchers to use and it is not feasible to describe them all given constraints associated with writing a thesis. However, the methodologies that I considered for this research can be broadly grouped into four categories:

- (i) Experimental research
- (ii) Analytical surveys
- (iii) Action research
- (iv) Phenomenological case study research

Each of these categories will be briefly explained in the context of its relevance to this thesis and through this a justification will be made for using a phenomenological case study research design for this project.

Experimental research is a rigorous scientifically grounded methodology designed to test the impact of a predetermined intervention. The usual approach is to assign participants to a control group and an experimental group. The experimental group receives the intervention and the control group does not. Prior to the project, hypotheses are established to explain what the researcher believes

the impact of the intervention will be. A rigorous comparison of the two groups then allows the researcher to claim whether or not the hypotheses were correct, often with the support of statistical data.

One of the difficulties with this methodology is finding similar participants for the control and experimental groups. In ideal laboratory conditions, the participants would be identical so that a fair comparison can be made between the two groups. However, in practice, no two participants are ever the same since everybody has their own unique life experiences. Sometimes, this issue is addressed by using groups of participants that have naturally had similar experiences. Other studies use *matched pairs*. This is when a participant from the control group and a participant from the experimental group are deemed to be similar, based on a pre-test or some other initial conditions, and then paired together for direct comparisons to be made between the two individuals.

In the context of this research, an experimental methodology was not appropriate for a number of reasons. Firstly, dividing the children into two groups such that the control group would not receive any access to the mathematics enrichment activities through the medium of video conferencing would have posed an ethical dilemma. It was believed that the intervention would benefit the children and so actively excluding half of the children in the interests of educational research was something I considered to be unethical. On a more practical level, it was unlikely that the Head teachers of the schools involved would support a methodology that may have only benefited 50% of the target group. The experimental methodology would have also been unhelpful in addressing the research questions. This study is not about testing specific hypotheses, but is instead more descriptive and exploratory in design. I wanted to understand what teaching strategies would be used, how they would evolve and why. For these reasons, I decided not to use an experimental methodology for this research.

An alternative research methodology that would have retained some of the rigour of the experimental design is the methodology of analytical surveys. Much like the experimental methodology, analytical surveys are deductive by design. Often a sample is drawn from a population and they are surveyed across a range of variables. The level of correlation between the different variables is established with a view to generalising the results to the larger population that the sample was taken from.

This research was in part about my own individual development and so the methodology used needed to be naturally reflective. As such, an inductive methodology was more appropriate and so I decided not to use the analytical surveys methodology for this research.

The experimental and analytical methodologies described above are both grounded with an objective epistemology. The nature of the research questions in this thesis are such that subjective views from the participants are important as are my own reflective and reflexive views. Without these subjective viewpoints, it would become difficult to establish whether or not external factors have impacted upon the data collected. Conversely, a more subjective methodology such as ethnography or heuristic inquiry would be equally unsuitable because of the difficulties in utilising more deductive methods to analyse some of the more objective data. To summarise, a mixed-methods approach was needed and I decided that this might be best facilitated by adopting a constructivist methodology such as action research or phenomenological case study research.

"Action research provides a means whereby research can become a systematic intervention, going beyond describing, analysing and theorising social practices to working in partnership with participants to reconstruct and transform these practices"

(Somekh, 2006, p27)

The above quotation illustrates that action research involves both action and research. Research takes place with the aim of trying to understand a situation and this is followed by an action or intervention with the aim of improving the situation. It is worth highlighting here that the researcher is trying to understand the impediments to change rather than to ameliorate an unfair system. The process, however, does not end with the intervention. The action researcher then monitors any changes that take place following the intervention and begins the whole process again to further improve the situation. The number of cycles that take place will vary depending on the specific research project being undertaken. This iterative process of action and reflection is widely referred to as the action research cycle and there have been numerous variations of it in recent years (Taylor et. al., 2006, p6; Zuber-Skerritt, 1996, p99; Robson, 2004, p218; Bassey, 1998, pp94-95; Somekh, 2006, p6).

Zuber-Skerritt identifies the four stages of action research as plan, act, observe and reflect. However, these stages of action research are not neat and mutually exclusive (Taylor et. al., 2006, p5). For example, reflection is an ongoing process that may occur throughout all four stages of action research.

Action research is a popular methodology for practitioners conducting educational research since it is practical and can impact directly on teaching and learning. Action research is particularly well suited to driving change at the local level (Taylor et. al., 2006, p5; Cohen et. al., 2003, p226; Somekh, 2006, p24) because it often focuses on understanding a specific situation by observing the impact of pre-planned interventions. As such, recommendations can be made about how to improve that specific situation. The drawback of such a focus is the difficulty to generalise beyond the situation being studied. However, I would argue that if recommendations for intervention are made as a result of a case study action research project, then further research could be used to test these interventions more rigorously in broader sets of circumstances. This is not to say that the action

research paradigm lacks rigour, but rather that, as with all studies, further research will either strengthen or weaken the initial arguments. Indeed, it is particularly true of educational research more generally that recreating an identical situation is virtually impossible.

The flexibility of case studies in design and approach, as well as in the use of method, encourages their use as a model for action research (Robson, 2004, p217; Cohen et. al., 2003, p228). One of the difficulties with case studies is the difficulty in guaranteeing reliability at a number of levels. For example, coding data such as audio transcripts or video clips, is subjective and may be interpreted differently by different researchers. Such issues need to be addressed when deciding upon the specific methods to be used in collecting and analysing the data. In this study, precautions were taken by using additional people to interpret the data more objectively.

The research questions for this thesis have a focus on self-evaluation and self-analysis. This type of reflective research, which in turn informs practice, is important since it may have practical implications on the teaching and learning taking place. In the words of McNiff (2003, p20), "the quality of your influence may be assessed in terms of how others respond to your practice". This emphasis on self-improvement with a view to improving the local situation is a typical feature of action research (Robson, 2004, p215; McNiff et. al., 2003, p14).

Action research is flexible since it can take the form of a qualitative or a quantitative design, or both. Quantitative methodologies can allow researchers to discover a correlation between two variables and with further qualitative evidence, it is sometimes possible to argue for causality (Taylor et. al., 2006, p3). In action research, however, critics would argue that it is impossible to know whether or not the changes observed would have occurred anyway without any intervention, since there is no control group. There is no simple way of avoiding this issue and I would agree with the response of McNiff who affirms that whilst we do not know what could have happened without the intervention,

we do know what has happened *with* the intervention (McNiff et. al., 2006, p70). This further strengthens the argument for selecting a methodology that allows a mixed methods approach to be used so that triangulation can be achieved.

Robson (2004, p216) suggests that action research fits well with the approach of a flexible, qualitative design and is alien to that of a fixed quantitative design. However, it could be argued that the distinction between quantitative research and qualitative research is often false. Whilst I would agree that action research is broadly suited to a qualitative methodology, I believe that some quantitative methods (e.g. visual discourse analysis, procedural analysis and basic statistics) were necessary to convert the data collected in this study into evidence. This distinction between data and evidence is an important one and is highlighted by McNiff who argues that whilst descriptions can be used to share data, any explanation of data becomes evidence (McNiff et. al., 2006, p23). As explained above, this interpretation of the data raises issues of reliability that need to be addressed. It was also vital to be open to surprises and responsive to the opportunities that occurred during the collection and analysis of the data. In other words, I appreciated from the outset that any contribution to knowledge might have emerged from the data.

Despite the numerous academic advantages of using an action research methodology as described above, it is the practical considerations that made it unsuitable for use in this project. At the heart of action research is the premise that the interventions are structured by design. This does not fit with this study, since I am describing a natural, spontaneous process, whereas action research consists of analysing the impact of deliberately planned changes. With the option of an action research methodology ruled out, it was necessary to consider an alternative case study methodology that would, as far as possible, incorporate the strengths and address the weaknesses of action research in this particular context. Arguably, the most suitable methodology was that of phenomenological case study research.

Robson (2004, p195) states that "phenomenological research focuses on the subjective experience of the individuals studied...at its heart is the attempt to understand a particular phenomenon". In the context of this research, it was about seeking to understand my own experience and the experience of the children. For this study, the phenomenon was the delivery of a successful and effective video conference. As such, all of the factors contributing to this were identified, described and analysed using a framework of teaching strategies that will be described in detail in chapter four.

Gray (2006, p28) describes phenomenological research as a "perspective that uses relatively unstructured methods of data collection". Whilst this research design is broadly qualitative, the above quote indicates that both quantitative and qualitative methods can be used within this methodology to help inform the claims made by the researcher. Phenomenology allows the researcher to monitor and analyse situations that are constantly evolving in a natural way through both planned and spontaneous interventions. This flexibility encourages the use of phenomenological research in education, since planned interventions are not always feasible in a classroom setting as described above.

A second benefit of phenomenology is that it attempts to understand specific situations by interpreting the opinions and subjective accounts of those involved. Moreover, the methodology lends itself to monitoring how the impact of particular phenomena change over time by determining the views of the participants.

The unstructured nature of phenomenological research makes it particularly difficult to replicate. This raises concerns about the generalisability of any claims or conclusions by the researcher and as such, this methodology is used primarily to understand a situation rather than to apply the learning to wider context. Nevertheless, the researcher can still argue that if a similar set of circumstances is seen elsewhere then similar results would be expected.

The fundamental difference between action research and phenomenology is that in action research the research informs the practice; whilst in phenomenology the practice is relatively independent of the research. In the context of this project, I was both researcher and practitioner, which may at first sight appear to be at odds with the independent nature of phenomenology. Knowing that the project is being researched did, of course, impact on the decisions that I made, but I would argue that this impact would still have been a factor if an independent researcher had been involved. The real issue that needed to be considered here was that of self-analysis. Appropriate measures needed to be taken to ensure that the data was collected and analysed reliably and that the reflexive nature of the analysis was acknowledged.

At this point, it is worth outlining why a phenomenological case study was more suitable for this project than a straight forward case study. Phenomenology can be seen as a specific type of case study that is more inductive than deductive in approach and relies primarily on qualitative rather than quantitative methods. This is in contrast to case studies more generally, which tend to be deductive in approach (Gray, 2004, p124). This label of phenomenology helps to position the research in the context of other case studies, which can be very broad in terms of their approach and theoretical perspective. For example, Yin (1993, in Gray, p124) argues that a case study could be either quantitative or qualitative in approach. However, despite my positioning of case study within a specific methodology, some would argue that case studies are distinguished less by the methodologies that employ them and more by the subjects of their inquiry (Hitchcock and Hughes, 1995, p316). Before reporting upon the specific methods of data collection and analysis that were used, it was useful to undertake a critique of the qualities of case study more generally.

The idea of using a case study was that it would allow me to capture the thoughts and feelings of the participants and then describe them to the reader (Cohen et. al., 2003, p182). A fundamental problem with capturing such thoughts and feelings is that they can only be gained by asking the

participants. The ideal time to ask participants would be when they are experiencing these thoughts and feelings, but this would have been problematic since it would have disturbed the situation that was being studied and potentially invalidate the findings. There would have also been problems with asking the participants about their experiences afterwards. They may not have been able to remember exactly what they were thinking or feeling or be certain of the reasons why they felt like this. However, using Bloom's method of stimulated recall allowed me to overcome some of these issues, and this method will be described in detail towards the end of this chapter (Bloom, 1953, p160).

Cohen et. al. (2003, p182) described some of the characteristics of case studies as:

- A rich and vivid description of events relevant to the case
- A chronological narrative of events relative to the case
- Blending a description of events with the analysis of them
- Focusing on participants and seeking to understand their perceptions of events

These were in keeping with the research questions and clearly demonstrated why case study lent itself as a model for this research.

It should be noted that in a case study, the 'case' can be anything (Robson, 2004, p180). It was essential to define the case and its context before the research was undertaken so that it was clear what is being researched and how this case differed from other cases (Cohen, 2003, p182). For example, in this research it was necessary to describe the school types, the participants, the technological parameters, the logistical constraints and the dual role of the researcher as a practitioner. It was also important at this stage to clarify the difference between the case and the

phenomenon, which was that the case constituted the wider set of circumstances in which the phenomenon was being observed.

The main argument for using case studies was that they are invaluable in "adding to understanding, extending experience and increasing conviction about a subject" (Gray, 2006, p123). Gray continues by arguing that the case studies are ideal when a 'how' or 'why' question is being asked. Some would argue that case study should only be used if the researcher has little or no control over the events being analysed (Hitchcock and Hughes, 1995, p322; Gray 2006, p124). This might appear at odds with this particular research project since it involves self-analysis. However, whilst I had control over the mathematical content and style of delivery, I had little control over the external factors that impacted upon these decisions. For example, there were technological and mathematical difficulties that affected the decisions taken during the video conferencing sessions. There are also some that would argue the researcher should be integrally involved in the case being studied (Cohen et. al., 2003, p182).

"Case studies provide unique examples of real people in real situations, enabling readers to understand ideas more clearly than simply presenting them with abstract theories or principles. Case studies can penetrate situations in ways that are not always susceptible to numerical analysis. Case studies can establish cause and effect."

Cohen et. al. (2003, p181)

The quote above illustrates the power of case study if used in an appropriate way. The ability to demonstrate ideas in a practical way was ideal for presenting this work to a practitioner audience and the ability to penetrate situations and establish cause and effect made it appropriate for an academic audience.

Some researchers take the view that all inquiries are effectively a type of case study (Robson, 2004, p185). This is an interesting perspective and is argued on the grounds that every study focuses on a specific case. It could be further argued that studies are only distinguished by the extent to which the researcher can justify generalising the findings to a broader set of 'cases'.

The nature of case study is such that multiple sources of data generally need to be collected, but these need to be focused in some way so that the researcher is not overwhelmed by the volume and breadth of the data (Gray, 2006, p124). It is for this reason that triangulation can be an important feature of case study research. Triangulation can be used to strengthen an argument for cause and effect by demonstrating that multiple sources are providing evidence for the same thing. In particular, some would argue that video data is best used in conjunction with other data to build up a comprehensive research focus (Flick, 2007, p243).

As with all research, there are some practices that need to be consciously avoided if the research is to be as reliable as possible. In the context of case studies, the researcher should ensure that they describe in full what is happening rather than picking out the most striking features. The smaller details are important since they can often give invaluable insights into what is happening in the bigger picture. Researcher bias also needs to be taken into consideration. All researchers will have their own opinions and beliefs, but this should not skew the selection of evidence that is reported. Earlier in this chapter, I explained that I needed to be open to unanticipated evidence emerging from the data. In order to ensure that I picked up on such emergence, I was careful not to immediately discard data that did not fit into the teaching strategies framework. Such data was described when it occurred and will be analysed further in chapters four to nine as appropriate.

If any piece of research is to be of worth then validity is a fundamental requirement (Cohen et. al., 2003, p105). In general terms, validity refers to demonstrating that the tools being used to measure

certain outcomes do measure what the researcher claims they are measuring. In the context of this research, validity was ensured by addressing a number of key factors. Firstly, a definition of the construct of the case study was required since this was largely based on the interpretation of the researcher. In chapters one and two, for example, steps were already taken to ensure construct validity by defining 'teaching strategies', 'video conferencing' and 'mathematical enrichment'. The triangulation of multiple data sources has already been discussed above and this helped to strengthen the internal validity of this research so that more powerful arguments can be made to demonstrate cause and effect. The external validity of a piece of research reflects the extent to which it can be generalised beyond the specific case being studied. As described above, the aim of this research is not to generalise the findings to all similar situations, but is instead to act as a point of reference for future teaching or research.

Building on the theme of validity, it is now appropriate to consider the importance of reflexivity in the context of my dual role as both teacher and researcher. In a sense, reflexivity could be considered to be about reflecting on one's own practice to ensure that personal values and beliefs have not skewed the research processes. It is argued that reflexivity in research is a way of ensuring rigour (Guillemin and Gillam, 2004, p275) and hence protecting the research from criticisms of researcher bias.

It is often the case that the researcher is in a privileged position in that they can choose which aspects of a study to report. For example, a researcher might collect and interpret data, then decide what themes are important and of value. Undoubtedly, justification will be given for the data collected and the chosen themes, but this begs the philosophical question as to whether any choices made by researchers can ever be truly free of subjectivity. Indeed, Robson (2004, p172) suggests that the social identity and background of a researcher could impact on the research process and such life experiences will undoubtedly affect the decisions made by a researcher. One aspect of

addressing the inherent subjectivity of researchers is for them to acknowledge their preconceptions and biases, but this may still not solve the problem completely. Even if researchers believe they are working objectively, it is not always easy to abandon these intrinsic preconceptions and biases (Robson, 2004, p173).

It is arguably important to minimise the impact of subjectivity and bias in any research and, in the context of this study, my dual role as both teacher and researcher was acknowledged in chapter one. In considering the implications of this dual role, there are two key areas that require further discussion. Firstly, it should be recognised that this study has a significant element of self reflection and so issues surrounding reflexivity need to be addressed. Secondly, and perhaps more broadly, there is an issue of multiple integrities (Drake and Heath, 2008, p140) in that I have divided loyalties to both the teaching community and the research community. The extent to which a researcher is an insider in relation to the context of a study is an important consideration and one that is well documented (Sikes and Potts, 2008; Mercer, 2007; Labaree, 2002). The various debates surrounding these two core issues are discussed below.

# Reflexivity

Finlay (2002, p224) explains that reflexivity is about exploring the dynamics of the researcher-researched relationship and perhaps it is clear from this explanation that this relationship is of particular importance when the researcher and the researched are one and the same. Indeed the relationship may be complex and difficult to understand, but still fundamentally necessary to address, as it may be central to a piece of research in much the same way that the distinction between Adam the teacher and Adam the researcher is fundamental to this study. Indeed, these properties are reflective of reflexivity more widely, which could be described as a central yet confusing topic (Lynch, 2000, p26).

In considering my dual role, it could be argued by critics that the circumstances are unfair since I have significant authority over both the provision of data (as Adam the teacher) and the reporting of evidence (as Adam the researcher). Effectively there is an in-balance in power between the other participants and me and this needs to be addressed in some way. Adopting a reflexive approach, which acknowledges bias goes some way towards solving this problem since the research process becomes transparent and the researcher is publically accountable for their decisions (Finlay, 2002, p210). However, simply acknowledging the issues may not be enough and could create further problems. For example, Humphrey (2007, p22) discusses the problems with acknowledging the potential bias in her own research, since doing so would publically reveal her views on various sexualities and potentially affect her role within the community that she was researching.

In considering ways to reduce the bias of the individual researcher, who is also a member of the community being researched, it has been suggested that multiple observers are used (Hockey, 1993, p221) or that a reflective journal is kept (Smyth and Holian, 2008, p43). Other researchers have addressed this issue practically (and perhaps incidentally) by leaving the community in which the research is being conducted in advance of the findings being published (Labaree, 2002, p114; Gallais, 2003, p3). This is helpful, since it removes a specific element of bias in relation to personal gain. In the context of this study, I did disengage from the field in advance of the research findings becoming readily available, although it should be acknowledged that this was more incidental than instrumental. Whilst such disengagement might be beneficial from a research perspective, care should also be taken to ensure that the departure is not seen as a betrayal to the community being researched. This is an ethical consideration that ought to be taken seriously and perhaps discussed in advance if disengagement is to be implemented successfully.

In considering the ethical issues associated with role duality, problems could arise if the data collected has negative or risky consequences for the alternative role held by the researcher within

the community being studied (Smyth and Holian, 2008, p39). For example, it is possible that an analysis of data would show significant weaknesses in an area for which the researcher has responsibility as part of their alternative role. Reporting such damning personal facts within a publically available document may not be possible for some researchers without undermining their own credibility. That said, it could perhaps be argued that acknowledging one's own weaknesses in public, whilst potentially damaging the credibility of the individual, actually strengthens the credibility of the wider research findings.

Reflexivity is a familiar concept in qualitative research (Guillemin and Gillam, 2004, p262) and some would go so far as saying it is the defining feature of qualitative research (Finlay, 2002, p211). Although reflexivity is not generally perceived as being an ethical concept, it is argued by some that it could be (Guillemin and Gillam, 2004, p262). This is relevant to the discussion here since it brings into focus the idea that reflexivity is a sensitising notion, which can empower the researcher if used appropriately. In order to achieve this sensitising notion, and perhaps to go beyond it, it is suggested that the researcher takes a step back at key points to consider the choices made and to question why those choices have been made (Robson, 2004, p173). This is described by some as 'double distancing' or taking two steps back (Jenkins, 2002, p50). The first step back involves capturing an objective observation of the research subject and the second step back involves reflecting on the observation itself (Guillemin and Gillam, 2004, p274). Lynch (2000, p30) describes this as 'critical detachment' and suggests that the second step back allows the researcher to become 'hyperobjective' and to have the ability to see what might have otherwise been taken for granted as being objective.

The idea of moving from a subjective to an objective position is sometimes questioned, since it could be argued that no research can ever be free from bias as all researchers' observations and judgements are dependent on their own previous experiences (Smyth and Holian, 2008, pp36-37;

Loxley and Seery, 2008, p22). That said, it is argued by some that researchers should still strive to achieve objectivity wherever possible (Labaree, 2002, p107; Gallais, 2003, p2).

A key element of reflexivity is the extent to which one has to make judgements about one's own performance. Such self-assessment should not be seen as alien, since it is common place within many organisations. For example, businesses are expected to assess their own finances and complete a tax return for the Inland Revenue. Similarly, schools are expected to assess the quality of teaching and learning within their institution for OfSTED. In both of these examples, it is clear that whilst self-assessment is acceptable, there are clear sets of standards and guidelines that ought to be adhered to along with an organisation to ensure that rigour is maintained. There is arguably a clear analogy to reflexivity in the context of educational research in the sense that judging oneself is appropriate so long as the rigour of such judgements is maintained by ethics committees and by the wider educational research field.

In considering reflexivity from a pragmatic perspective, it could be argued that it is about examining critically the assumptions underlying the actions of researchers, the impact of those actions and, from a broader perspective, what passes as good practice (Cunliffe, 2004, p407). Cunliffe goes on to argue that critical reflexivity should be a philosophy-driven practice and not treated as just another research method (Cunliffe, 2004, p408). It is for this reason that the discussion about reflexivity has appeared in the methodology section of the research design chapter rather than the methods section.

In trying to piece together the various aspects of reflexivity, Cunliffe (2004, p413) has devised a helpful map consisting of reflexive analysis, critically reflexive questioning and reflex interaction. Reflexive analysis is described as being both retrospective and anticipatory. In the retrospective sense, reflexive analysis is about making sense of past decisions and actions whilst, in an anticipatory

sense, it is about planning future actions and decisions. In the context of this study, reflexive analysis has taken place throughout and the importance of this is emphasised by the inclusion of this discussion in the methodology chapter. Critically reflexive questioning is about exposing contradictions, doubts and dilemmas through social collaboration with others. The key difference between reflexive analysis and critically reflexive questioning is that the former is generally an individual process, whilst the latter involves working with others. In the context of this study, it will be seen later in this chapter that critically reflexive questioning occurred when a colleague assisted with coding the video data. Reflexive interaction captures the idea that some decisions made by researchers could be based on habit and intuition. As was discussed above, researchers can demonstrate an awareness of such instantaneous and unselfconscious actions by acknowledging them and taking appropriate action when necessary.

The final point to make about reflexivity is that a researcher's apparent openness and attention to preconceptions and biases can, in fact, disguise the inequalities that are actually present within the research (Finlay, 2002, p226). Ultimately, however, it could be argued that subjectivity is inescapable, but by taking account of this using a reflexive approach as detailed above, the impact of such subjectivity is then minimised as far as possible.

### <u>Insiderness vs Outsiderness</u>

If a researcher is part of the community that is being researched, they are known as an insider. Otherwise, they are known as an outsider. Whilst this appears to suggest a dichotomy between insiderness and outsiderness, it has been argued by some that it is actually a continuum (Mercer, 2007, p3; Gallais, 2003, p11; Humphrey, 2007, p19). The extent to which a researcher is a part of the community they are researching is known within the literature as insiderness, although it should be acknowledged that it is not always easy to establish the insiderness/outsiderness of particular

individuals since the research scenarios are often very complex. For example, a female conducting research into an all-female organisation could be said to be an insider since the women may have shared experiences (Labaree, 2002, p104). However, if it also considered that this female is over 50 years of age and the organisation is a primary school, then the researcher could be argued to be an outsider. In the context of educational research, one might argue that the majority of researchers are insiders since many have been, or continue to be, practicing teachers (Hockey, 1993, p200). Indeed, Shah (204, p556) sums up the discussion well in stating that, 'we are all insiders and outsiders in different ways and settings'.

Within the literature associated with reflexivity, there is much discussion about the benefits and drawbacks of being either an insider or an outsider (e.g. Sikes and Potts, 2008; Mercer, 2007; Labaree, 2002; Gallais, 2003). However, there appears to be no clear agreement on whether it is best to be inside or outside of the community being researched (Shah, 2004, p556; Labaree, 2002, p117). Below is a discussion of some of the key considerations as well as the implications for my own research.

It was discussed earlier that a potential issue with having multiple integrities is the extent to which one can be objective. Some insider research is criticised because the methods and methodologies bring implemented may be inconsistent with the researcher's primary role in the organisation (Sikes and Potts, 2008, p7). Furthermore, it is possible that the researcher may not be able to easily distinguish between their research and their primary role (Scott, 1985, p120; Mercer, 2007, p5). In this study, it was very difficult to know whether I was acting as a teacher or a researcher in making particular decisions and this is reflected in the analysis and discussion of the research findings. In the context of reliability, this makes the study difficult to replicate, since if I cannot always distinguish between Adam the teacher and Adam the researcher, then there is arguably little hope for others.

The difficulty in guaranteeing objectivity in insider research is often countered with the argument that the researcher has an in-depth knowledge of the culture and working practices and is therefore able to recognise and capture appropriate or unexpected data more readily (Smyth and Holian, 2008, p36; Shah, 2004, p556; Gallais, 2003, p1; Haniff, 1985, p112; Hockey, 1993, p119). However, such closeness to the participants of a study can sometimes blind the researcher to familiar phenomena (Haw, 1998) or compromise their ability to critically engage with information (Drake and Heath, 2008, p129). The issue of researchers being 'close' to their research is arguably somewhat of an expectation since educational researchers often choose their project as a result of several years of experience in a particular field (Drake and Heath, 2008, p129). Indeed, Labaree states that, 'the status of insiderness must hold some value, or there would be little incentive for researchers to study those subjects or situations with which they are most intimately connected' (Labaree, 2002, p112).

One of the potential pitfalls of being close to individuals that are being researched is the way in which the relationship between the researcher and the researched can change (Mercer, 2007, p13). However, the use of an outsider may be worse since the data collected could be contaminated or even unobtainable (Loxley and Seery, 2008, p23). That is not to say that insider research data could not be contaminated. On the contrary, it is possible that those involved know the researcher, want the project to be successful and hence work towards this (Drake and Heath, 2007, p136). Closeness between the researcher and the researched may also result in preconceptions or assumptions of knowledge in both directions (Gallais, 2003, p3; Robson, 2004, p535), which suggests that outsiders have more potential for validity in their research. However, it is clear that the specific relationship between the researcher and the researched will impact significantly on the information that is given. There is still some disagreement as to whether participants are most likely to talk to an insider or an outsider, particularly if they have controversial views about their own organisation (Powney and

Watts, 1987, p40; Sikes and Potts, 2008, p177). Indeed, there may be greater expectations of an insider than of a stranger (Hockey, 1993, p199).

One of the key benefits of insiderness is the relative ease of access to data and participants (Sikes and Potts, 208, p4). Being a member of the community being researched does give the researcher unique access that is perhaps unavailable to outsiders, yet it may also deny access (Smyth and Holian, 2008, p40). For example, a study related to performance related pay may require the researcher to have access to the salaries of all staff, including superiors, within a particular organisation. In such a situation, releasing such information to an insider is potentially less likely than releasing the same information to an outsider. It should also perhaps be noted that access is not just about 'getting in' to an organisation (physical access), it is also about 'getting on' with the participants (social access) (Shah, 2004, p557), which requires insider knowledge and skills. Such skills include rapport building (Mercer, 2007, p4) and maintaining eye contact (Shah, 2004, p559). In the context of this study, this is potentially problematic, since there is an overlap between skills that are necessary for methodological purposes and skills that are being analysed as part of the teaching process.

The role duality of being both the researcher and a member of the teaching community can be stressful in that there may be considerable tension between the roles (Smyth and Holian, 2008, p40; Hockey, 1993, p205). Furthermore, it could be easy to lose a sense of oneself if there are continual switches between the teacher role and the researcher role (Humphrey, 2007, p23). Similarly, if we return to the continuum of insiderness/outsiderness, if researchers are constantly moving up and down the continuum, this may also result in losing a sense of oneself (Drake and Heath, 2008, p127).

In considering role duality, it appears that one of the key issues is the blurring of the role of the researcher and the role of the researched (Hockey, 1993, p199). In the context of this study, it was

often not possible to be certain about whether I was acting in a teacher capacity or in a researcher capacity. However, it could be argued that the solution to this problem lies not in establishing the roles being undertaken at specific times, but rather in establishing that all of the research is a credible as possible. In this regard, the methodology and methods outlined in this chapter seek to address the potential problems to ensure the validity and reliability of this study. Whilst there may be both advantages and disadvantages to insider and outsider research, it should be remembered that neither are erroneous (Hockey, 1993, p220) and that insider research in particular can be both scholarly and rigorous (Sikes and Potts, 2008, p7).

To summarise, the methodology used for this project was a phenomenological case study research. A mixed approach of both quantitative and qualitative methods was used so that the methodology could be strengthened through triangulation. Steps were taken to ensure the reliability and validity of the research, including the need for reflexive sensitivity, and I remained open to the fact that any contribution to knowledge might emerge from the data and lie outside of the coding categories used for the analysis of the data. The next section of this chapter will discuss the detail of the data collection and coding as well as the specific methods and processes used to analyse the data.

### 3.2 Methods

As described earlier in chapter 1.3, the pilot project was used to establish the feasibility of collecting various data and testing the methods that might be used to analyse this data. Based on the pilot project, the following plan was produced for the collection of data for the main research project.

#### <u>Video Data</u>

This consisted of recordings of the weekly video conferences, which were saved directly onto a hard disk video camera. They were then transferred to a PC in editable format for editing using Pinnacle

Studio software. A copy of the recordings was also be kept on DVD as a back-up. This method was designed to generate around 26 hours of video data in total.

# Weekly Diaries (children)

After each video conference, the children were asked to complete an individual diary entry. For ease of comparability between participants, sessions and schools, a template was produced for the children to use as shown in figure 13.

NAME		SCHOOL		DATE	
Which activit	y did you find easie Why?	est? Whi	ch activity did you Why?	ı find hardest?	
Oraw a circle arou	working in the  Working out in  your head	Presenting Ideas	u have done duri  Asking  Mr Boddison  for help	using equipmen	
Individual work	Using diagrams	Asking other students for help	Using the internet	Listening to explanations by other pupils	
Please write any o	other comments yo	u have about the ses	sion here:		

Fig. 13 - Children's weekly diary template

Each time the children were asked to complete this diary, they were reminded that there were no right or wrong answers and that they should be as detailed as possible with their responses. The categories that appear on this diary template, such as 'group work' and 'using diagrams', were established by observing the actions of the children during the pilot project. Since there were six children at each end point, each producing 13 diary entries, this could generate 468 diary entries in total. Although this is a large number, which might be infeasible to analyse as part of a case study, it was considered that in practice there would be fewer than this due to illness, recording errors and lost sheets. Furthermore, only a sample of the entries was analysed as will be explained in the detailed description of the methods below. I collected the booklets of diary entries at the end of the spring conferences and then again at the end of the summer conferences.

### Weekly Diaries (researcher)

At the end of each video conference, I wrote down my own reflections about the session. These were less structured than the children's diaries in that I was not using a template. The idea here was that this would allow me to reflect on those things I felt were valuable insights at the time rather than focusing on a pre-determined set of parameters that may or may not encapsulate my thoughts and feelings about the session. When writing my diary entry, I was writing as Adam the teacher and my reflections helped me to improve future conferences as would be the case in teaching generally.

### **Lesson Plans**

Prior to each conference, a lesson plan was produced, which outlined the theme and the activities to be covered as well as estimating the amount of time to be spent on each activity. The plan also included contingency measures in case of problems with the technology. It will contained details of the theme music to be used at the beginning and the end of sessions and the choice of screen layout selected for the conference. Any resources needed by the children or me during the session were

listed and a contingency plan in the case of lack of equipment was included. This plan was written onto a template as shown in figure 14.

Date	VC Theme	Schools Involved
Activity 1	Activity 2	Theme Tune
		Screen Layout
		Resources
Activity 3	Activity 4	
		Contingency Plans

Fig. 14 - Lesson plan template

The video conferences in the main study were spread over 13 weeks, although not consecutively, and as such there were 13 templates in total.

## Notes from interviews with children

After all of the video conferences were completed, I interviewed some of the children involved. I decided not to interview all of the children individually because the quantity of data produced would be difficult to deal with. The option of using group interviews was trialled during the pilot project and was deemed to be unsuitable for the main research project. Firstly, there were difficulties in transcribing the data as the children often interrupted each other and talked over each other. Secondly, when the conversation was more structured and the children were asked to speak in turn they often repeated what was said by the first child. Therefore, I decided to interview just one child

from each school, and these children were selected by the Headteachers independently of me. The interviews were semi-structured and used the video data recorded during the video conferences as a stimulus, as will be described in more detail below. This yielded six different written accounts of the children's experiences, which will be described in chapter four.

Now that the different types of data to be collected have been established, it is necessary to describe in detail the methods that I used to undertake the analysis of this data. I will begin by describing the visual discourse analysis to be used on the video data. The visual discourse analysis to be conducted can be broken down into three iterative stages; identifying the themes, isolating the relevant video, searching for patterns. Stage one of this method was conducted during the pilot project and the themes have been categorised according to the revised teaching strategies framework described at the beginning of this chapter. In stage two of this method, I used video editing software to isolate video clips that related to each of the micro-strategies. In this way, all of the clips that relate a specific micro-strategy could be viewed in turn, which enabled me to search for patterns in the video data and make observations for stage three of the process. The pattern spotting in stage three took place in a number of different ways and was dependent on the quantity and quality of the isolated clips from stage two. Simple statistics were used to monitor the change in the frequency of the occurrence of certain events in individual video conferences. However, much of the isolated video data observed yielded descriptive data that was not easy to quantify. In these instances, I was looking to identify similar occurrences so that I could describe the circumstances surrounding these occurrences with the aim of identifying common and uncommon features.

During these three stages, it was possible that new themes, perhaps unrelated to the original teaching strategies framework, could emerge. The iterative process of this method allowed me to consider these new themes using the same approach as was used for the original themes.

Often, the analysis of video data requires a number of factors to be considered such as the positioning of the camera, whether the zoom should give panoramic data or narrow-focused data and when to start and stop the recording (Flick, 2007, p242). The children at the endpoints had control of the cameras as part of the practical design of the sessions and the obvious choice was to start recording at the beginning of the session and stop recording at the end of the session. The concern with the positioning of the camera relates to the obtrusive nature of the camera having an impact on the behaviour of the children. I had little control over the direction in which the camera was pointing, but it was likely that over time the children would become used to the presence of the camera and behave 'normally' allowing a more valid analysis to take place.

The second method that was used to analyse the video data was the method of 'stimulated recall', which yielded qualitative interview data. Since one of the research questions is interested in the experience of the children, it would be useful to know the thoughts and feelings of individual children at specific times throughout the duration of the research. One method for achieving this is called the 'think aloud protocol', in which children would try to say out loud what they were thinking and this data could be recorded onto a dictaphone or equivalent tool for analysis at a later stage. The nature of this method means that it does not readily lend itself to group work since the children may end up distracting each other. Therefore, as an alternative, the specialised method of interviewing known as stimulated recall was used (O'Brien, 1993, p215; Stough, 2001, p2).

"The basic idea underlying the method of stimulated recall is that a subject may be enabled to relive an original situation with vividness and accuracy if he is presented with a large number of the cues or stimuli which occurred during the original situation"

(Bloom, 1953, p161)

Many of the studies that have used the method of stimulated recall reference Bloom's work on the thought processes of students (Yinger, 1986, p267). This may be because of Bloom's claims that his students could accurately recall as much as 95% of the verifiable situation they were trying to remember. There is, however, a second underlying assumption of stimulated recall which claims that the method not only allows participants to relive the situation, but more importantly it will allow them to remember what they were thinking and feeling at the time (Stough, 2001, pp2-3; O'Brien, 1993, p215; Yinger, 1986, p268). It is for this reason that I believed the method of stimulated recall was suitable for this research.

Kagan was one of the first researchers to use video data as a stimulus and furthermore my own use of this method relied on some of the interview techniques that he developed (Kagan and Krathwohl, 1967, pp104-123). The basis of these techniques is to play the video data to the participant asking them to stop the video at any point to explain what they were thinking or feeling. If the participant does not stop the video after a short time, then the researcher should stop the video and ask openended questions to elicit some responses (Stough, 2001, p5). The researcher can also stop the video at crucial interactions or exchanges if necessary (Yinger, 1986, p271). In this research project, the six children chosen for interview were all shown video clips of themselves interacting with me during the video conferences. In order to give context to the video clips and to ensure they provide the necessary stimulus, I began the video at the beginning of each particular activity. The video clips were shown in chronological order so that I could make some inference as to whether there were any changes over time in the children's experience. As with all interviews, the participants may have lots to say or may say very little. As such, I needed to be prepared to omit some video clips in order that each interview did not go on for more than 45 minutes. In these instances, I tried to show some video clips from the beginning, the middle and the end of the video conferencing sessions.

One technique of stimulated recall involves using specific instances to talk about more general procedures or beliefs (Yinger, 1986, p271). For example, if the video shows a child getting exciting whilst solving a mathematics problem, then the researcher could ask how they normally feel when solving problems. This technique is particularly useful for obtaining more general data. I included this technique as appropriate in the interviews with the children so that I could establish whether their experience of mathematical enrichment when video conferencing was different to their normal experience of mathematical enrichment.

One of the criticisms of stimulated recall is the difficulty in distinguishing between events that participants have recalled and events that they have constructed (Yinger, 1986, p270). For example, a child may have found it quite challenging to solve a particular mathematical problem, but when reflecting on it, the child might not remember the challenge and only how easy the solution was when they solved the problem. Indeed, the participants themselves may be unaware that they have constructed any events making it even more difficult for the researcher to identify these occasions. This was a threat to the validity of the method and could not be completely resolved. However, one way to reduce this threat was triangulation in the form of using stimulated recall with more than one participant; in this case the six children. The fact that they were all from different schools strengthened the triangulation argument, since the impact of external factors, such as poor class teaching or the school ethos, was reduced.

It is important to note here that the method of stimulated recall relies on the participants being interviewed individually (O'Brien, 1993, p218). It was for this reason along with the time and resource issues described above that I was not able to interview all of the children involved in this project. Indeed O'Brien (1993, p216) suggests that between two and four children should be used for any one research project utilising stimulated recall and the six children selected has already exceeded this limit. O'Brien states that participants selected for the stimulated recall interviews

should "have an ability to articulate their thoughts; ...[be] able to express their ideas; ...[be] willing to be frank about their thinking; ...[be] prepared to spend time being interviewed; ...show a preparedness to be videotaped in the classroom" (O'Brien, 1993, p216). The video conferencing aspect of this research meant that many of the children taking part were likely to exhibit these qualities and as such I need not be too concerned about which children were selected.

Bloom emphasises the importance of building rapport with participants in an interview situation. He claims that this is the biggest factor that will impact on whether participants reveal their most private thoughts (Bloom, 1953, p162). O'Brien goes even further and states that rapport building should begin well before any filming takes place (O'Brien, 1993, p216). Some participants might distort or censor their recall of a particular situation in order to present themselves more favourably and it is through rapport building that this effect can be reduced (Calderhead, 1981, p215).

One of the key research questions in this study is related to the evolution of teaching strategies and the quote below is particularly pertinent in this respect since it highlights how stimulated recall can be used to provide relevant insights.

"(stimulated recall) can provide valuable insights for teachers when considering which strategies are more efficient at enhancing the thinking and learning of different individuals or groups of students"

(O'Brien, 1993, p219)

Calderhead does give a note of caution when interviewing using this method in that some areas of a participant's knowledge may never have been verbalised and so may not be communicable in verbal form (Calderhead, 1981, p213). If this appeared to be the case during an interview, then care would

have been taken not to cause undue stress or anxiety to the child as they would likely reveal less information throughout the remainder of the interview.

In conclusion, I remain satisfied that the method of stimulated recall was suitable for use in this research as described above. It was relatively easy to use and the information it provided had the potential to be both diverse and rich (O'Brien, 1993, p220). Once the stimulated recall interviews had taken place, the notes made were analysed so that patterns and emerging themes could be identified as described above. Previous studies show that the recall of events has been found to be considerably greater in research involving stimulated recall than any alternative method (Calderhead, 1981, p216).

# **Summary of the Analysis Processes**

The analysis began once the video conferencing sessions had finished and all of the data had been collected and collated. The first task was to edit the video data in accordance with the microstrategies in the teaching strategies framework as defined at the beginning of this chapter. This involved viewing the all of the video data and isolating clips that could be coded as examples of specific micro-strategies. For example, clips showing teacher praise were identified and coded as examples of affective teaching strategies. Similarly, clips showing the resolution of technical problems were identified and coded as examples of compensation teaching strategies. Many clips were coded in more than one category, but when the later analysis occurred, each clip was considered in the context of the coding.

To illustrate the next part of the process, I will continue with the example of teacher praise introduced above. The identified clips were isolated and joined together to make a series to illustrate praise. I then watched these clips with a teaching colleague, first to moderate my judgement that these were indeed examples of praise and second to consider similarities and

differences in the praise being offered and, where possible, some of the consequences for pupil learning. These are later discussed in chapters four to nine. During the viewing we were both open to the emergence of new themes and some did occur. These included, for example, the concept of uncertainty and the use of routines, both of which are discussed further in chapter nine. In a similar way my weekly logs were also coded, again using the micro-strategies from the teaching strategies framework. These were entered into NVivo software which made the later collation and analysis of codes easier to carry out.

Interviews with the children were also coded and the analysis carried out within NVivo. A time consuming aspect of the interviews was the preparation for stimulated recall. Video clips were selected on the basis that they showed the interviewee presenting or visibly engaged in activity in the background. These were then isolated and collated together, which resulted in different total durations of clips for each interviewee. This process was particularly lengthy as different clips were selected for different pupils. The interviews were structured according to the video clips that were generated and so the questions asked varied according to pupil. However, since the interviews were covering the same themes there was an overall similarity, which allowed for comparison within the interview data.

The children's weekly diaries were not analysed until after the stimulated recall interviews had already taken place. Only the diaries of the six children who were interviewed were considered in detail. These diaries were copied and organised by child and by date of video conference. This allowed my analysis to consider the views of all six children for an individual session or to consider how a child's comments had evolved over time.

Later in this study, a number of judgements are made about the video conferences and conclusions are reached, and I will now outline for the reader how the data was interpreted and analysed. In

chapter four, for example, it will be argued that the children enjoyed taking part in the video conferences. This judgement was made through triangulation within a number of data sources. For example, when asked during their stimulated recall interviews, the children said they enjoyed taking part. The video data shows the children laughing and celebrating when they correctly solved a problem. Their weekly diaries had many cases of positive comments to indicate that they enjoyed taking part. The children's class teachers made informal comments about the children's experiences. This evidence is supported by my own interpretation as a practitioner that the children enjoyed taking part. There is of course some evidence that contradicts this view, such as the observable frustration when the children did not understand the mathematics. However, the overall judgement that the children enjoyed taking part was made by considering multiple data sources and the conclusion reached is credible.

At other times, the judgements made are more speculative, and whilst the conclusions are based on the data, there may be variation within the data. An example occurs in chapter four, when I argue that the children value equity in the sense that they felt it was unfair that some pupils at some end points had a teacher in the room to support them. This is again based on multiple data sources as discussed in chapter four. However, there were other data to suggest that children valued being away from a teacher and at times felt advantaged that they did not have a teacher at their end points. Hence, while it was clear that children were aware of an issue (that of equal treatment) the consequences of this were not clear to the children. However, it could be speculated that the evidence lent itself to the view that the children valued equity in the teacher support available at the different endpoints.

This study does not strive to achieve statistical correlation between variables, but it does aim to establish ideas of cause and effect as normally understood in qualitative study. Again, some of these judgements are credible and well supported, but others are more speculative. An example of a well

supported judgement occurs in chapter six when it is argued that technological failure can result in a reduction in learning time. This is a trustworthy conclusion based on the triangulation of data sources (for example video data showing time spent resolving issues that would normally have been dedicated to teaching and learning and notes in my weekly log explaining that learning time has been lost) and is externally validated against the literature. An example of a more speculative claim occurs in chapter five, when it is argued that body language can have an effect on the receiver within video conferencing. There is limited evidence to support this judgement, for example the issue was not always explicitly discussed with pupils and some of the video data was difficult to interpret in this regard. However, there were sufficient examples to warrant drawing a speculative conclusion, such as video clips showing the children getting to work on tasks more easily when they received more body language than a 'talking head' as well as external validation from the literature.

The process by which the analysis was conducted should now be clear to the reader and will be considered in later chapters, although for reasons of space, the triangulation of data and external validation will not be presented in full to justify every judgement made.

# 3.3 Ethical Considerations

The final section of this chapter focuses primarily on the ethical issues that needed to be considered when undertaking this educational research project. Whilst I have adhered to the revised BERA ethical guidelines (BERA, 2004), this section explores in detail the reasoning behind some of the ethical decisions that were made in this research. It should be noted here, that this section does not intend to cover all of the ethical decisions made, but rather it concentrates on those that are of most relevance to this particular project. These issues include the cost/benefit analysis, informed consent, access, anonymity, confidentiality, risk and ethical concerns that specifically relate to using digital technology. Towards the end of this section, the 'case' being studied is clearly defined within the

parameters of confidentiality, ensuring that organisations' and individuals' rights to privacy have been protected as far as possible.

I would like to begin this discussion on ethics by reminding the reader that I do not have a privileged voice on what constitutes ethical behaviour (Robson, 2004, p71). However, I do have a responsibility to the profession of educational researchers and to the participants of this research and so the use of an ethical code is essential. I chose to use ethical guidelines that are specific to educational research rather than to social sciences more generally since these are more likely to cover the specific issues that I might face, such as working with young people and schools. Therefore, I adhered to the BERA ethical guidelines throughout this study.

Ethical issues, however, are not absolute. Some issues are obvious and a matter of courtesy and common sense, but others are less clear (Gray, 2006, p58). It is not always obvious what constitutes right and wrong. As would be the case with any ethical code, it is not possible to give guidance on every potential set of circumstances and so naturally there will be some omissions. What is considered ethical in one instance may not be ethical in another instance. Where such decisions were made in this study, I have sought to clarify my position and reasoning below.

Robson (2004, p66) describes 'ethics' as relating to the general principles of what one ought to do and 'morals' as relating to a specific act consistent with the accepted notions of right or wrong. Similarly, the Chambers dictionary defines 'ethics' as 'a system of moral principles' and defines 'morals' as 'principles or habits with respect to right or wrong conduct'. However, for the purposes of this research, the terms 'ethics' and 'morals' will be used interchangeably to cover both general and specific principles.

When undertaking any form of educational research, it is important to undertake a cost/benefit analysis (Cohen et. al., 2003, p50). This involves weighing up the social benefits of the research against the personal costs to the participants. In this research, the children taking part missed the same lesson every week in order to be involved. The recommendation to the participating schools was that numeracy should be the lesson that is missed, which would have meant that numeracy was being replaced with a different type of mathematics. However, this was not feasible in every school every week given the timetabling and other constraints that schools generally have. Since this research took place over the course of several months, there was concern that the children may experience a significant loss in classroom learning time. However, I argued that there could also be significant gains for the children taking part. The aim was for the video conferencing sessions to improve the children's communication skills and make them more independent as learners. The sessions also gave the children the opportunity to meet other children from other schools. The majority of these children were likely to be grouped for mathematics when they moved to the secondary school and hence these sessions might have assisted with the transition process from key stage two to key stage three. There might have also been costs to the year six teachers who may have needed to facilitate the children leaving and returning from the main teaching group, possibly in the middle of a class activity. The social benefits of this research are such that other primary schools could improve the way in which they provide for their most able mathematicians by considering the findings of this study. As such, I was able to draw the conclusion that the benefits of this research outweighed the costs to the individuals taking part.

When undertaking research involving children, the issue of informed consent is paramount. Some would describe informed consent as informed refusal to reflect the fact that participants have as much right not to take part in the research once they have been made aware of what they are agreeing to (Cohen et al., 2003, p51). Cohen goes on to state that the idea of informed consent places some responsibility on the participants should anything go wrong with the research. This

raised an immediate question as to whether it was reasonable or indeed moral to put such a responsibility onto the children involved in this research project. I would argue that this is both reasonable and moral so long as the children were fully aware of the responsibility they were taking on and are not at risk of suffering any physical, mental or emotional damage.

This argument is in keeping with the generally accepted requirements for informed consent as described in numerous authorities on educational research (Cohen et. al., 2003, pp50-53; Gray, 2006, pp251-252; Robson, 2004, pp68-71). They describe that informed consent requires the participants to have the mental and physical ability to participate. The participants must also have a genuinely free choice of whether or not to participate. In other words, pressure should not be intentionally placed on participants to take part. Whilst participants may feel obliged to take part, it should be made clear to them that they have the genuine option of withdrawing from the research at any time. The participants should have a complete explanation of what will happen and what they are agreeing to, including any risks and the participants should also have the ability to completely understand exactly what it is that they are agreeing to.

In this project, I briefed the Head Teachers of each school as to what would be involved in taking part in this research. However, I should remind the reader that the nature of the methods being used meant that not all children had the same treatment in terms of the research. For example, only one child from each school undertook the more in depth analysis of stimulated recall. The Head Teachers were required to select the six children that would be involved in the video conferencing and to explain to them what the requirement would be in terms of the research. The children were told that they would need to compete weekly diaries and that they might be chosen to participate in an interview at the end of the year. Then one child was chosen from each school for the detailed analysis of diary entries and the stimulated recall interviews, but this was not decided on until the

end of the year. This choice was made by the Head Teachers or teachers themselves and so whilst the choice was not random it was independent of me.

Given the above details, I hope it is clear to the reader that the Head Teachers had to give informed consent before the children were approached. Once the Head Teachers had agreed to take part, which they all did, they had the responsibility to gain the informed consent of the children and their parents or guardians. I provided them with consent forms in order to facilitate this, which required the signature of the child, the signature of their parent/guardian and a signature from the school. The consent form made it clear that the teaching sessions would be recorded for research purposes and that any of the signatories could withdraw their consent at any time.

Aside from the ethical arguments for obtaining informed consent, there were clear practical advantages. The Head Teachers and year six teachers, for example, were providing access to the children and they were unlikely to facilitate access unless they both understood and agreed with the fundamental principles of the research to begin with. There was less of an issue regarding access and informed consent from these schools than might generally be the case, since I was initially *invited* by the schools to pilot and run the video conferencing project with the research growing out of this relatively naturally. Generally speaking, however, it is worth remembering that access is not a right, and even over the course of this project I remained both polite and courteous and asked about access at the relevant points. Building up a good relationship with the Head Teachers and year six teachers in this way was important since the research involved significant intrusion and disruption to the normal routine, and access to the children was required over a sustained period of time (Cohen et. al., 2003, p54).

As the researcher, I needed to be open to the fact that some of the teachers or Head Teachers involved could have had negative perceptions of educational researchers and so they might not

instantly share the same viewpoint as me in relation to the weighting of the costs and benefits as described above. This might be a result of unethical or poorly organised research that has taken place in the past involving these particular teachers. If such circumstances had arisen, care would have needed to have been taken to establish a good working relationship with the teachers and to portray a more positive image of researchers in general. In this research, steps were taken to establish a good, strong, professional relationship with the teachers and Head Teachers during both the pilot project and the main study. As such, I was both trusted and respected within the community that the research took place and I made efforts to maintain this relationship over the course of the research and beyond.

One of the ways in which I intended to preserve this relationship was through maintaining the privacy of the individuals and organisations involved. In educational research, there are generally two methods for maintaining privacy (i.e. anonymity and confidentiality) both of which are discussed below. The broader issues relate to balancing the individual's right to privacy against the public's right to know. The participants in this research were vulnerable to invasions of privacy both during the research and when the research was completed. Therefore, steps were taken to ensure that individual's details were kept anonymous or confidential as appropriate. This involved ensuring that no unnecessary information was released during the dissemination and publication of the research findings. This might not always relate to personal details, but also to the setting. If the setting is described in too much detail, it may allow others to discover the identity of the individuals or organisations involved. On the other hand, if there is not enough detail, it is difficult to make inferences about the specific circumstances being researched, particularly when using qualitative methods as described above. As a general rule, the greater the sensitivity of information, the more safeguards are needed to protect individual's right to privacy. For example, if an individual's favourite television programme is publically discovered to be 'The Bill', this is likely to be far less problematic than if an individual's religious preferences are publicly discovered to be Christian when

that of their family and wider community is Buddhist. Whilst privacy is always sought, it should be remembered that there are never any guarantees (Cohen et. al., 2003, p61). Any of the participants could have revealed some of the details of this research to others at any time during or after the research.

The ideal way to ensure privacy in educational research is through anonymity, but this is not particularly practical for many of the methodologies and methods that might be utilised. Anonymity means that the individuals' and organisations' identities should not be known by anybody, including the researcher and the other participants. This can easily be achieved in online surveys, telephone polls, etc, but it is generally unachievable with many qualitative methods, since at the very least the researcher needs to know who the participants are if they are to be observed or interviewed. As such, anonymity is often an unreasonable expectation in educational research and so confidentiality is the preferred approach towards privacy.

Confidentiality is often used when the researcher is involved in the data collection, as was the case in this project. The researcher knows who the participants are, but takes steps to ensure that this information is not known publicly. Confidentiality is a general expectation from most participants in educational research, but as the researcher I was careful not to make promises of confidentiality that could not be kept. For example, the Head Teachers and teachers knew which other schools were involved and the children knew which other children were involved from these other schools. Whilst I asked that the participants did not discuss these details more widely, I was unable to guarantee this.

Cohen et. al. (2003, p63) describe some different methods for achieving confidentiality when writing the final research findings for dissemination. The first method involves the deletion of any details that could help to identify those involved in the research, such as the names and addresses of individuals or organisations. In this study, not using names could cause difficulties when analysing

the data and reporting the findings to the reader, since I need to distinguish between the various schools and participants. To tackle this issue, I used pseudonyms in place of real names. The six primary schools were named Angelford, Benefactors, Churchill, Daleway, Eastport and Fieldhaven. The six children chosen for the in depth analysis were called Amy, Brian, Charlotte, David, Emma and Frank respectively. Note that the first letter of each child's name corresponds to the first letter of the school names making it easy to identify which child is from which school during the discussion and analysis. This process of intentionally changing any details that might be used to identify the participants or organisations, yet leaving the research data unchanged, is known as error inoculation (Cohen et. al., 2003, p63).

A second method for achieving confidentiality during the reporting stage involves using crude reporting categories. Rather than deleting details, this involves making the details more general. For example, this might involve giving the year of birth of a participant rather than date of birth. I might also state that a school is a catholic school, but not state where it is located in the UK, or describe the workings of the Local Authority, without naming it. This principle will be used at the beginning of chapter four, when the specific 'case' of each school and individual is described to put the research in context for the reader.

One final method of achieving confidentiality described by Cohen et. al. (2003, p63) is that of microaggregation. This involves reporting on an 'average person' rather than reporting on specific persons. This is generally used in research where perhaps the organisation is already known and is used to prevent individual's comments from being identified. Given that I have kept the details of the organisations confidential in this research, there is little point in me utilising this technique for the purposes of this project.

At this stage, it is worth pointing out a moral dilemma that the Head Teachers themselves may have to face in relation to this research. Whilst they have agreed to keep the details of the organisations and individuals involved confidential, there may be occasions on which they want to discuss the project with a wider audience. If the project is successful, then the Head Teachers will likely want to share their innovative and excellent practice with other schools or even OfSTED. This was something that was ultimately out of my control, but preparations were made for this in advance. My approach to this was to make each of the Head Teachers aware of their responsibilities to each other and to the children participating in the research and I asked that if the project was discussed more widely, it was done so with these responsibilities in mind. As such, the consequences of this type of breach in confidentiality should be minimised as far as possible.

Some decisions were made in advance about what would do should if I discovered illegal activities or anything that might potentially put the children or others at risk. Such information may come to light through interviews, given the good relationship that will be established with the participants over the course of the research, or may be included in any recorded video footage. All participants were told in advance that any such behaviour would need to be reported to the authorities. Depending upon the circumstances, this might be the police, the school's child protection officer, the Head Teacher, the Local Authority or Social Services. It was made clear that such a discovery would override any previously made agreements in relation to confidentiality.

Whilst it was unlikely that such serious situations would arise, it was important to establish how these would be tackled in order to maintain my integrity as a professional researcher. It was more likely that less serious, yet equally concerning, issues would arise during the research process, such as bullying or other personal problems. These would still need to be reported, but the decision on how to proceed might depend on the individual wishes and the level of risk to child. It is important

to emphasise that I would not be alone in making such decisions, since I could talk over the possible alternatives with my research supervisors if required.

Whilst it might be useful to include clips from the digital recordings of the sessions in the analysis of this research to make key points, this is likely to compromise the confidentiality agreements made with the participants. Therefore, no video clips will be included in the analysis for the reader and instead only my interpretation of any video clips will be included. Any recordings made for this project will be destroyed once the research has been completed. In the meantime, the recordings have been kept in a secure location and have not been made available to any other parties for any other purposes, as this would be an abuse of the participants' rights for privacy. The Head Teachers were also asked to place a notice up informing other staff and students in the school that filming was taking place in case they were inadvertently recorded (Gray, 2006, p280).

## **Summary**

To summarise the research design for this project, the methodology chosen was a phenomenological case study. The intention was to use both quantitative and qualitative methods in the interests of establishing reliability during the discussion and analysis that will take place in the remaining chapters. Whilst the construct validity of this research has already been strengthened through the definitions of 'video conferencing', 'teaching strategies' and 'mathematical enrichment' in chapters one and two, it should be remembered that the aim of this research is not to generalise beyond the situation being studied, but to understand and explain the association between the teaching strategies being used and the phenomenon of the delivery of a successful and effective video conference. That said, it should be emphasised that if a similar case is observed elsewhere, then one could feasibly expect to observe similar phenomenon.

I remained open to the fact that any contribution to knowledge might emerge from the data and not from any predetermined ideas or coding. The methods that I planned to use included visual discourse analysis, stimulated recall, an analysis of children's weekly diary entries, an analysis of my own diary entries and an analysis of my lesson plans. The majority of these methods were based around the teaching strategies framework and each of the four macro-strategies will be considered separately in chapters five to eight. I adhered to the revised BERA ethical guidelines throughout this research project and I have outlined how some of the specific moral issues relevant to this research were dealt with. These issues included informed consent, access to the children and the privacy of participants through confidentiality agreements. The risks to all participants were considered through an assessment, which identified the necessary actions to reduce the risks. Lastly, pseudonyms were assigned to the schools and individuals involved to help protect their identities.

#### **CHAPTER 4 – THE CHILDREN'S EXPERIENCES**

"The person who has lived the most is not the one who has lived the longest, but the one with the richest experiences"

Jean-Jacques Rousseau

This chapter considers the experiences of the children both during and after the video conferences and as such is primarily based upon video data, the children's weekly diaries and their stimulated recall interviews. There are also some brief references to other data collected for this study such as my own diary notes. Due to technical issues in relation to the recording of the video conferences, some of the video data relating to the earliest sessions is not available. These issues will not be discussed any further here, but the issues are discussed fully in chapter six. It should also be noted that the children's diaries from Fieldhaven School were never received by me and I was informed that they went missing somewhere within the school.

This chapter is broken down into five sections; school information, general experiences, mathematical experiences, technical and practical experiences and discussion. By the end of this chapter, the reader should have a good understanding of how the children felt at key times throughout this study as well as a clear idea of the benefits and drawbacks from the children's perspective.

#### 4.1 School Information

In this chapter section, I will outline the 'case' of each of the organisations involved in this research as well as the child from each school selected for the in depth analysis. Much of this data has been taken from recent OfSTED reports, but these have not been referenced so that confidentiality can be maintained. The format for describing each school is consistent so that the reader can draw comparisons with relative ease.

Angelford Primary School is deemed by OfSTED to be a good school and has approximately 400 children aged four to eleven. It is a mixed gender school with most children from white British backgrounds and a significant proportion of children from minority ethnic groups. Angelford school has two-form entry with approximately 28 children in each class. Mathematics was highlighted as an area for development during the school's last OfSTED inspection, with the teaching in mathematics described as 'ineffective'. Prior to this research project, Angelford School had never taken part in any video conferencing activities. The numeracy coordinator has taken on the leading role in learning how to use the video conferencing equipment for the purposes of this project. The school has an ICT technician to support them one day per week provided through the Local Authority, but this is not usually on Friday when the video conferencing sessions take place. Angelford School has chosen to set their video conferencing equipment up in the ICT suite using an interactive whiteboard to receive video from the other schools.

The child selected by Angelford School to participate in the stimulated recall interviews is called Amy.

Amy's class teacher describes her as 'modest, but extremely sharp when it comes to mathematics'.

Amy is predicted a level five in her forthcoming mathematics SATs and is considered by her teacher to be the most 'lateral thinker' from those in the video conferencing group.

Benefactors Primary School is deemed by OfSTED to be a good school and has approximately 450 children aged three to eleven. It is a mixed gender school with about 50% of children speaking English as an additional language. Benefactors School has two-form entry with approximately 29 children in each class. Mathematics standards at the school are considered by OfSTED to be better than average, although not as good as English or Science. Prior to this research project, Benefactors School had never taken part in any video conferencing activities. One of the year six class teachers, who is also the school's ICT co-ordinator, has taken on the leading role in learning how to use the video conferencing equipment for the purpose of this project. Benefactors School has privately employed an ICT technician to support them one day per week. However, this technician claims to have no experience of video conferencing technology and has provided limited technical assistance to date. The technician will be available during some of the Friday morning video conferences. Benefactors School has chosen to set up their video conferencing equipment in the ICT suite using a data projector to receive video from the other schools.

The child selected by Benefactors School to participate in the stimulated recall interviews is called Brian. Brian's class teacher describes him as 'good in maths tests, but impatient in maths lessons'. She warns that Brian is sometimes a 'practical joker', but this tends to be when he has finished his work and is not interested in the extension task. Brian is predicted a level five in his forthcoming mathematics SATs.

Churchill Primary School is deemed by OfSTED to be a good school and has approximately 200 children aged four to eleven. It is a mixed gender school with most children coming from white British backgrounds and a significant proportion of the children coming from minority ethnic backgrounds, particularly from India. Churchill School has one-form entry with approximately 31 children in each class. Mathematics standards at the school have been better than the national average for a number of years, although OfSTED have identified provision for the most able as a

target for improvement. Prior to this research project, Churchill School had never taken part in any video conferencing activities. The Head Teacher has taken on the leading role in learning how to use the video conferencing equipment for the purposes of this project, although the school's Site Services Officer has also received some basic training. Churchill School has an ICT technician to support them one day per week provided through the Local Authority, and this is usually on Friday when the video conferencing sessions take place. This technician will normally be available to help resolve any technical issues as they arise. It should be noted that this is the same technician supporting Angelford School. Churchill School have set up their video conferencing equipment on a trolley so that it can be easily transported to different locations in the school as and when required. In general, however, the equipment is set up in the ICT suite for the video conferencing sessions and an interactive whiteboard is used to receive video from the other schools.

The child selected by Churchill School to participate in the stimulated recall interviews is called Charlotte. Charlotte's class teacher describes her as being 'outstanding at maths and always keen to impress others with what she knows'. Charlotte will often be found in the library at break time looking up 'weird and wonderful things' on the internet. Charlotte is predicted a level five in her forthcoming mathematics SATs.

Daleway Primary School is deemed by OfSTED to be a good school and has approximately 550 children aged three to eleven. It is a mixed gender school with about one third of the children coming from minority ethnic backgrounds. Daleway School has three-form entry with approximately 24 children in each class and the mathematics standards are considered to be better than the national average. Prior to this research project, Daleway School had already been involved with video conferencing for about two years, having taken part in activities coordinated through the Global Leap project described in chapter two. The Deputy Head Teacher at Daleway School is particularly experienced with using video conferencing technology and has taken on the leading role

for the purposes of this project. Whilst Daleway School do have an ICT technician provided through the Local Authority to support them for one day per week, this has had little impact on the video conferencing technology. This is because the technician is not usually available in the school on Friday mornings and the Deputy Head Teacher tends to resolve any technical difficulties personally. Daleway School has chosen to set up their video conferencing equipment in the ICT suite using a 42" plasma screen television to receive video from the other schools.

The child selected by Daleway School to participate in the stimulated recall interviews is called David. David is described by his class teacher as being 'very strong minded in maths' and 'not prepared to change his solution if he believes he is right'. He continues to explain that David often takes on a leading role with a small group, but can sometimes be 'a little bossy'. David is predicted a level five in his forthcoming mathematics SATs.

Eastport Primary School is deemed by OfSTED to be a good school and has approximately 500 children aged five to eleven. It is a mixed gender school with most children coming from white British backgrounds with a significant proportion of the children speaking English as an additional language. Eastport School has two-form entry with approximately 38 children in each class. Mathematics standards at the school are better than the national average, although OfSTED have identified provision for the most able as a target for improvement. Prior to this research project, Eastport School had never taken part in any video conferencing activities. The Deputy Head Teacher, who is also the year six teacher, has taken on the leading role in learning how to use the video conferencing equipment for the purposes of this project. Eastport School has an ICT technician to support them one day per week provided through the Local Authority, but this is not usually on Friday when the video conferencing sessions take place. It should be noted that this is the same technician supporting Angelford School, Churchill School and Daleway School. Eastport School have chosen to set up their video conferencing equipment in a classroom since space in the school is

limited. The consequences of this are that another class might simultaneously be in progress in the same room as the video conferencing sessions. It has been agreed that this unusual arrangement can go ahead, but it will be reviewed at a later stage if it is considered to be causing problems for the other schools in the conference. An interactive whiteboard is used to receive video from the other schools.

The child selected by Eastport School to participate in the stimulated recall interviews is called Emma. Emma's class teacher describes her as being 'very quiet when she is thinking about a maths problem, but then very vocal when she has a solution'. Emma is predicted a level five in her forthcoming mathematics SATs.

Fieldhaven Primary School is deemed by OfSTED to be a good school and has approximately 250 children aged three to eleven. It is a mixed gender school with about one quarter of the children coming from minority ethnic backgrounds and an above average proportion of children having learning difficulties or disabilities. Fieldhaven School has one-form entry with approximately 32 children in each class and the mathematics standards are considered to on a par with the national average. Prior to this research project, Fieldhaven School had never taken part in any video conferencing activities. The Deputy Head Teacher has taken on the leading role in learning how to use the video conferencing equipment for the purposes of this project. Fieldhaven School has an ICT technician to support them one day per week provided through the Local Authority, but this is not usually on Friday when the video conferencing sessions take place. It should be noted that this is the same technician that is supporting all of the other primary schools in this project other than Benefactors School. Fieldhaven School has chosen to set up their video conferencing equipment in a small meeting room normally used for one-to-one tuition for children with learning difficulties. A large television screen is used to receive video from the other schools.

The child selected by Fieldhaven School to participate in the stimulated recall interviews is called Frank. Frank is described by his class teacher as being 'good at maths, but often immature with his behaviour'. He continues to explain that Frank gets 'easily distracted' and 'has trouble concentrating for extended periods of time'. Frank is predicted a level five in his forthcoming mathematics SATs.

The secondary school in this project from which I was delivering the conferences has been given the pseudonym Osborne Road Secondary School. Osborne Road School is deemed by OfSTED to be a good school and has approximately 1750 children aged 11 to 18. It is a mixed gender school with about one quarter of the children coming from minority ethnic backgrounds. Osborne Road School has eight-form entry with approximately 28 children in each class. Osborne Road has a chieftechnician and two assistants who are available during normal school hours to assist with technical issues across the school. However, neither of the assistants have the experience or expertise to be able to help resolve issues relating to video conferencing. As such, I needed to rely on the chieftechnician who was often unavailable at short notice as he was dealing with other issues across the school. The chief technician was not prepared to be on standby to assist with problems during video conferences, but instead agreed to help out if he happened to be available at the time. Whilst not an ideal situation, it should be remembered that some of the primary schools also had limited technical support. Osborne Road Secondary School is a Maths and Computing College as part of the government-funded SSAT programme. The technology in the school is of a high standard since video conferencing equipment has been in place for around two years prior to this project beginning and the school also has a dedicated classroom with built in cameras and microphones for recording lessons. The school has several ICT suites and two banks of laptops available for staff to use across a range of subject areas. Maths provision in Osborne Road is considered by OfSTED to be well above average. The video conferencing equipment is generally kept in storage on a trolley when not in use. For the purposes of the video conferencing sessions, the equipment was set up in a small classroom normally used for teaching mathematics to small groups of 6<sup>th</sup> form students. The benefit of using this particular room was that it had two internet ports; one for the video conferencing equipment and another for connecting a computer to the internet.

### 4.2 General Experiences

Based on my conversations with the children and the comments written in their diaries, it is clear that the children enjoyed their experience of video conferencing. The children can be seen smiling, laughing and joking on the video recordings of the conferences and they talked fondly about the video conferencing sessions during their stimulated recall interviews. However, I should make it clear here that this does not mean the children enjoyed every aspect of every video conferencing session. On the contrary, there were numerous occasions on which the children appeared to be frustrated with the mathematics, the technology or with each other. Such instances were characterised by lively, constructive discussion and this will be discussed in more detail later in this chapter.

After the second session of video conferencing, Frank from Fieldhaven School wrote in his diary, "It was great fun". The enjoyment being experienced by the children at Fieldhaven appears to have been sustained throughout the course of video conferencing sessions. During the tenth video conference, the children were set a coordinates task with the aim of locating the buried treasure on a map and the children at Fieldhaven were in competition with the children from Daleway. The children at Fieldhaven won this competition and when I told them they had won, there was a big celebration not dissimilar to when a goal is scored in a football match. I showed a video clip of this to Frank during his stimulated recall interview:

Adam: You all look very pleased here. Why is your group so excited?

Frank: Because we were first to find out where the treasure was buried and it took us ages

to figure it out.

Adam: How did you all feel when you got the right answer by working as a team?

Frank: Really happy.

During their stimulated recall interviews, Brian, Charlotte, David and Emma all gave indications that

they had enjoyed video conferencing with comments such as, "I liked it", "It was good" and "I

thought it was good fun". Amy was not asked directly about whether she enjoyed the conferences

and so did not make a comment about this.

**Teacher Support (Endpoint Equity)** 

Some of the data collected suggests that the children might have valued not having a teacher in the

room. The two extracts below from the interview transcript with Amy show that the children at

Angelford School had perhaps gotten used to having no teacher in the room and maybe found it

difficult when their teacher was there for one of the sessions.

Adam: How did you feel about not having a teacher in the room with you?

Amy: A bit weird, but we kind of got used to it.

Adam: What do you mean by 'weird'?

Amy:

Well...erm...I'm not sure. It's like the pressure to do well because you want your

school to look good. But then I get used to it and it's okay.

Adam: Why was your teacher there for this session?

Amy: I don't know. She just turned up.

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Adam: Is she normally there?

Amy:

No.

Adam: What did you think about her being there?

Amy:

It was alright, but sometimes she didn't let us do our own ideas. She said they were

wrong and made us write a different idea that she had on the whiteboard.

The example above of a teacher acting as a site facilitator and supporting the children during the

video conferences was an isolated occurrence in this study. Therefore, it is difficult to establish from

the limited data whether Amy's frustration was related to receiving support from this particular

teacher or related to receiving support more generally. However, Charlotte did comment on the

support received by the children at Angelford. During the third video conferencing session, when the

teacher was sitting in and helping the children at Angelford, Charlotte wrote in her diary, "I think that

it is unfair that Angelford have a teacher and we don't". I asked Charlotte about this afterwards.

Adam:

What did you think about not having a teacher with you?

Charlotte:

This was great. We could do the problems using our own methods and we

didn't have to set it out like our teacher normally tells us to.

Summarising the data above, it could be that Charlotte values not having a teacher in the room with

her during the video conferences, but she thinks it is unfair if others do have a teacher in the room

with them. Again, the limited data makes it difficult to draw any firm conclusions here. However,

Emma's experience may help to provide a context for Charlotte's comments.

The children at Eastport School had a unique set of circumstances in that they did have a teacher in

the room with them during the sessions. Timetabling and logistics were such that a small class was

being taught at one side of the classroom and the Eastport children were video conferencing at the

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other side of the same classroom. Emma said that having this class in the background didn't really disturb them too much since it was rare that both the Eastport teacher and I would be talking simultaneously. On those occasions that we did talk at the same time, Emma said to me that the children "were concentrating quite hard anyway, so we couldn't really hear anything apart from [Mr Boddison]". In Emma's interview, she points out that having a teacher in the room was useful for resolving minor technical issues. However, she went on to say, "we feel a bit left out because all the other schools haven't got a teacher watching them all the time, which is better".

Both Charlotte and Emma have commented on the differences between the treatment and support that they have received in comparison with the children at the other endpoints and one plausible explanation of this data would be that Charlotte and Emma valued equity in relation to teacher support. However, it is acknowledged that there may be other equally plausible explanations that could be inferred from the data.

# **Peer Support**

Before looking at the various mechanisms that the students used to support each other, it would be useful to define exactly what is meant by 'support'. In the context of what follows, support refers to action taken by the children to help other participants at their endpoint to successfully present their ideas to the participants at the other endpoints. It should also be noted that the examples used below are not isolated occurrences, but selected examples of frequent occurrences.

The support that the children offered to each other was more than just supporting the decisions that had been made and much of it was practical. Frank, for example, talked in his interview about working as one of a pair with a poorly behaved child from Fieldhaven School. Frank told me his teacher had said she was happy to have this child out of her class to do video conferencing as it gave the rest of the class a chance to do some work. Frank did not get on well with this other child and

we talked about one occasion on which this child had waited for Frank to start presenting his answer

over the video conference before announcing it was wrong. On another occasion, this child did not

know the answers to the questions that I was asking him because he had not been concentrating.

Yet, despite Frank's dislike of working with the child, he still helped him out by telling him what the

correct answers were. This is a good example of the practical support that the children have been

offering each other.

The most common form of support discussed by the children involved standing out of sight from the

camera and whispering hints and solutions to whichever child happened to be presenting at that

time. The following extracts from the stimulated recall interviews give a fair reflection of this

'whispering' support that the children were offering to each other along with some further

discussion about the different types of support.

Adam: Did your friends help you out when you had to talk?

Amy: Yeah. They whispered things to me and they controlled the camera.

The extract above is a good example of technical support. Rather than leave one child to present

and to control the camera simultaneously, the rest of the group helped out by taking responsibility

for the technical aspects of the presentation. When Amy said that the children whispered to her, it

was not immediately clear what the content of these whispers was. For example, this might be

related to the technology with comments such as "look at the camera" or "use a darker coloured

pen". Alternatively, the children could be providing help with the mathematics as shown in some of

the other examples below.

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Adam: Somebody whispered then to help you out. Did that happen any other times?

Brian: Yeah, loads of times. Whoever is talking, then we help them out if they get stuck and we use the calculator for answers they don't know. Then we whisper the answer to them.

Adam: Does this happen in class if you have to do presentations?

Brian: A bit, but not as much as in the video conferences. It's easier with this because we can hide from the camera when we are helping.

The above extract is a good example of numerical support. The child presenting to the camera was not always able to present and to work on solving calculations at the same time, so the other children in the group sometimes took on this responsibility instead.

Adam: Your friends were helping you by telling you what to say. What did you

think about that?

Charlotte: It was good, because sometimes I didn't know the answer so they were

helping me.

The above extract is an example of emotional support. It is, perhaps, easy to imagine that being in front of a camera and not knowing what to say can be an emotionally draining experience. In such instances, the children did not leave the presenting child to struggle alone and they often tried to tell the presenting child what to say.

Adam: It looked like you were helping out [child] there. Why was that?

David: He had missed out some of the rectangles.

Adam: Was that his solutions or somebody else from your group?

David: Normally, we get a solution as a group and then whoever gets it best explains it. If

they get it wrong then we try to help them out.

The above extract is an example of cognitive support and shows that the children did not always tell

the presenting child the answer. Sometimes, they said things like "this doesn't look right" or "we've

missed some out" which helped the presenting child to get back onto the right track. It could be

argued that this is also emotional support since the presenting child was made to feel like they were

part of a group and not alone. The same could be said about the extract below, which could be

considered as emotional support, cognitive support or both.

Adam: When your friend was presenting, what were you doing?

Emma: I was watching with everybody else in case he got stuck.

Adam: Did you give him any help from off-camera?

Emma: Sometimes, but we all help each other out when we get stuck.

I did not tell the children whether they should work on the problems I set them individually or in

groups. Interestingly, the children chose to work either as a group or in pairs almost all of the time.

There is lots of video evidence to support this. Some of it shows the children having lots of

discussion and pointing at their work booklets whilst some of it shows two or three children working

together to draw a diagram on their whiteboard or flipchart. There were, of course, some occasions

when the children were working alone and these tended to be when a difficult calculation was being

worked out or when a child was concentrating hard on something.

**Apprehension** 

Before beginning the video conferencing, many of the children were nervous about taking part. I

know this through both informal comments made by the teachers at the schools involved and

through comments made by the children in their stimulated recall interviews. This is not surprising,

since one would expect children, and perhaps even adults, to be apprehensive about using new

technology. However, the children's nervousness was not as simple as being concerned about using

the new technology, since some suggested that it was more to do with being in front of the camera

when presenting their solutions. One could perhaps draw an analogy with the nervousness that

might be experienced by somebody appearing on television for the first time. Brian summed up the

feeling quite nicely in his interview:

Adam: How do you feel when you're presenting you ideas?

Brian: I like it and it makes me feel a bit nervous. It's like you have to do a PowerPoint to

the whole class, but it's a bit different to that.

Adam: What's different about it?

Brian: Well, you don't know the people and you can't see them.

Adam: Does that bother you?

Brian: Yes, because you don't know what they think.

Amy told me that she felt nervous when she was presenting her idea because she was worried that it

might be wrong and she didn't want to look stupid in front of the children in the other groups.

However, after she had finished presenting, Amy said that she always felt happy regardless of

whether she had got the correct answer or not. Charlotte and David talked about being worried

when they first had to present to the camera, but they said that they got used to this over time.

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Emma wrote in her diary, "I was a bit nervous because of it being the first session, but it was still very enjoyable". However, Emma was also nervous about something else. Emma's situation was different because of having another lesson going on in the same classroom as her during the video conferences. Emma suggested that these extra children in the room made her feel more nervous than the children watching from the other schools via video conference.

Adam: How did it make you feel when you kept getting the wrong answer?

Emma: I didn't like it. The rest of my class was watching and I didn't want to get it wrong in front of them.

Adam: What about the children who were watching from other schools?

Emma: I wasn't really bothered about them.

Adam: So why were you worried about your class seeing you get the wrong answer, but not the other children from the video conferencing?

Emma: I'm normally one of the best at maths in my class and so they would laugh at me if I get the wrong answers cos I normally get everything right.

Adam: Would you have preferred to be in a separate room for the video conferencing?

Emma: Yes.

# 4.3 Mathematical Experiences

### Frustration

The children enjoyed the mathematical challenge of the enrichment activities and some of them commented that this was a different experience to their normal numeracy lessons. However, the children also commented that the activities were sometimes too difficult. For example, Brian wrote in his diary "I enjoyed today's session and found the problems a challenge". The following week, Brian wrote "I found today's session extremely difficult and didn't enjoy it as much as last week" and in the penultimate session, Brian wrote, "this was quite a challenging session". In his stimulated

recall interview, David said, "the problems were hard and sometimes we couldn't do them". When the children could not solve the problems, the video data showed the children becoming frustrated. Emma wrote in her diary "[The *Nine Colours* activity] was making me angry because we couldn't find the answer". Emma also wrote, "[The *Knight's Puzzle*] was hardest because sometimes you get somewhere, but then you couldn't go anywhere". Charlotte was equally frustrated by some of the problems:

Adam: Was the maths easy or hard?

Charlotte: Both. Sometimes it looked dead easy, but then when we tried to do it, it

was hard.

...

Adam: Why did you slam your bottle down on the table?

Charlotte: Because we could have got an answer if only we were allowed to put two

milk bottles in the same place.

Adam: Did you feel angry like this at any other times with the video conferencing?

Charlotte: Yes, quite a lot of times. It's kind of a good feeling and a bad feeling because

I'm annoyed I can't get the answer and then excited to find out the answer.

Frank had similar frustrations when there were problems that he could not solve.

Adam: Were the activities that I set in the video conferencing easy?

Frank: No, they were quite hard. There were some questions that we couldn't do at all.

Adam: How did you feel when I gave you questions that you couldn't do?

Frank: It was good to have a challenge, but annoying as well because sometimes you didn't

tell us the answer in the end.

We know from chapter one that the activities were chosen on the grounds that they would be

mathematically enriching. Therefore, the children were not always directed as to what mathematical

skills they should be using and sometimes they had to use more than one skill for multistep

problems. This is something the children found difficult as indicated by the comments above.

**Mathematical Support** 

Sometimes, the children had questions that they wanted to ask me about the activities they were

working on. However, there were some occasions on which I was talking to another school and so

was unable to respond to their questions immediately. Indeed, I would not usually have known that

the children had a question until they told me so, which they could not easily do until I had finished

talking with the other school. This time period, during which the children were waiting for me to

become available, was sometimes a drawback and sometimes a benefit. It was a drawback if the

children wasted this time by not talking about the problem they were working on or by using the

time as an opportunity for poor behaviour. However, more often than not, the children used this

time constructively. By talking about the problem they were working on, some children figured

things out for themselves and so did not need to ask me a question after all. I am aware of this

happening from two sources of data. Firstly, some of the video data shows children preparing to ask

a question, but then not asking the question when I am available to talk to them. Secondly, was the

isolated evidence from Emma's interview:

Adam: Did you ever ask [teacher] for help if you got stuck with the video conferencing

activities that I set you?

Emma: Yes, we did a couple of times, but he just told us that we had to ask you if we were

stuck.

Adam: How did you feel about that?

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Emma: That was okay, but sometimes you were talking to another school, so we had to wait

for a bit before we could ask you anything.

Adam: What did you do when you were waiting?

Emma: We tried to do it ourselves.

Adam: Did you ever manage to figure out the answers without asking me?

Emma: A few times, yeah.

If the children had connectivity problems and could not join the video conference immediately, then

some of them looked through their booklet of problems to see what we would be working on and

tried to do them independently. However, this was not always the case. During his interview, David

talked about what the children at Daleway did on one of the occasions when they had connectivity

problems.

Adam: What did you do whilst you were waiting for the video conferencing to work?

David: We just had a look on the internet and then we were playing some games.

Adam: Did you and your group have the booklet with the rest of the activities in?

David: Yes.

Adam: Why didn't you use this to have a go at the activities?

David: We looked at it for a bit, but then we thought it was too hard, so we went on the

internet instead.

There is lots of video data which shows the children checking and correcting each other's work

without being told to do so. In my experience, this is not something that regularly happens in

traditional mathematics lessons without encouragement from the teacher.

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# Countdown

My own diary notes, the video data, the stimulated recall interviews and the children's diaries all suggest that *Countdown* was the most popular activity, particularly for the children who were winning at the time. In her diary, Emma wrote "Countdown was very fun" and "Countdown gets me really excited". Amy wrote in her diary that she liked *Countdown* because it was easy and that it was easy because she liked it. One could argue about which of these was a consequence of the other, but this is not something I will dwell on here. More importantly, Amy wrote about the activity being easy and likeable in the same week that Angelford School won the *Countdown* competition. Indeed, Amy wrote, "WE WON COUNTDOWN" in her diary. During the previous two video conferences, Angelford School had not won *Countdown* and Amy wrote in her diary that it was the hardest activity of the session as well as the activity she most disliked.

Charlotte behaved in a similar way. On those occasions when Churchill School won *Countdown*, Charlotte wrote in her diary that it was her favourite activity. On those occasions when Churchill School did not win *Countdown*, Charlotte did not normally comment on it at all. There was only one exception to this, which was when Charlotte indicated that she disliked the *Countdown* music. This was perhaps a reference to the time restraints since the music was used to limit how long the children could spend working out their answer. It is conceivable that Charlotte found the time restraints challenging and this is supported by an entry in her diary, "we need to get used to the time limits". Although, it is worth adding here that it is not clear in Charlotte's diary whether this comment relates specifically to *Countdown* or to the activities more generally.

The time factor of both *Countdown* and the other activities is something that troubled the children, since they would have preferred to have longer to work on the various problems that they had been set. Amy wrote in her diary, "countdown was hardest because it went too quickly" and Emma wrote

in her diary, "I disliked the *Take Ten* activity most because it was boring and we did not have enough time". I found Emma's comment curious since she thought the activity was boring, yet wanted to spend more time on it. Some of the informal feedback from the teachers in the primary schools was that the children did find the activities difficult to complete in the time available. This may have added to some of the frustration that the children experienced, which was talked about earlier in this chapter.

## 4.4 Technical and Practical Experiences

### **Notation and Resources**

The children were not usually given any guidance on how to present their solutions, but they used a variety of different approaches in terms of both the notation and the resources they chose to use. In terms of notation, the children used colours, shapes, symbols and numbers. In some cases the children used a key to make their notation clearer. For example, the children wanted to use colours to represent the red, orange and green counters used in the *Traffic Lights* activity. However, they realised that the orange pen would not show up very well and used blue instead, labelling it as orange in the key. To give the reader an idea of the various notations, figure 15 below shows some screenshots of the children's work.

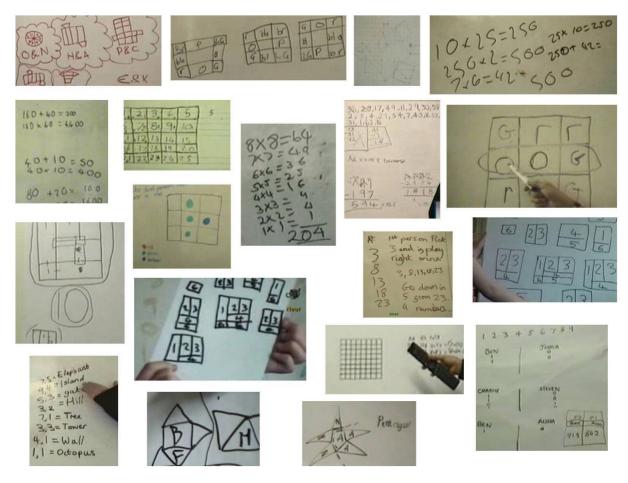


Fig. 15 – Screenshots of the children's written work and notation

In terms of resources, the children used multilink cubes, counters, coins, matchsticks, calculators, flipcharts, mini-whiteboards and their work booklets. Whilst this offers variety, one could argue that the children were steered towards these particular resources because of the nature of the mathematical enrichment problems and the equipment that they were provided with in their box of resources. However, the children sometimes used equipment that I had not provided. For example, graph paper and metre sticks were used by some children and they found this equipment themselves from the maths resources in their own school. For the *Squares on a Chessboard* problem, the children at Angelford sourced and utilised an actual chessboard which they could draw on with whiteboard pens. This chessboard is shown in figure 16 below, which also contains some other examples of the resources used by children as mentioned above.

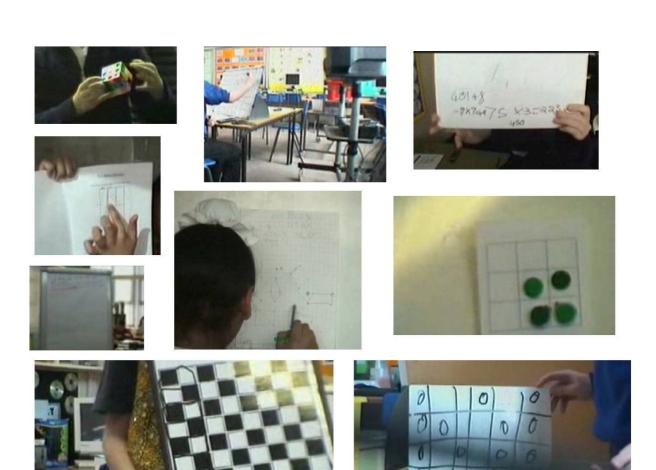


Fig. 16 – Screenshots of the resources used by the children

The children at Daleway tried to show me a solution that they had devised on their computer by zooming the camera in on their computer monitor. However, they had some problems with the refresh rate as David described in his stimulated recall interview:

Adam: Tell me about the problems you were having with squared paper?

David: We didn't have the grids or any paper in our box, so we chose to draw one on the computer. When we pointed the camera at the computer screen, it was just all blurry and you couldn't see anything. Then we drew it on the flip chart with a metre stick, but it took ages and it wasn't very accurate.

Camera Control

From observing the video data and looking at which child in each group is holding the remote

control, it appears that over time the same one or two children at each school were controlling their

camera more often than the other children. During his stimulated recall interview, Frank described

this situation at Fieldhaven School.

Adam: Who usually controls the camera?

Frank: We all have a go at different times depending on who is nearest, but [child] uses it

more than anybody else.

In some cases, this was because whoever was best at controlling the camera was nominated by the

rest of the children in the group to always control the camera. This is the experience of the children

at Eastport School as Emma described in her stimulated recall interview.

Adam: Who normally controls the camera?

Emma: We have all had a go at it, but [child] is much better than anybody else, so he

normally does it.

Adam: Is this okay with the rest of the group?

Emma: Yeah, because we can just work on the activities.

In other cases, the child controlling the camera was self-nominated and they refused to allow the

other children to use the remote control as much as possible. This is an experience shared by Amy

and some of the other children at Angelford School. Interestingly, the child that insisted on

controlling the camera ended up breaking the camera by forcing it to swivel around with his hand.

When I originally observed the problems that Angelford School were having with their camera, I had

initially assumed it was a battery problem as made clear by the notes from my diary:

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"Angelford were having some trouble with moving their camera to the correct position. I'm not sure what the problem is, but I suspect it may be the batteries in the remote control... It quickly became obvious that Angelford had not resolved the battery issues from the previous weeks as the children didn't appear to be able to move the camera with the remote control. This was despite the fact that I had contacted the school during the week to explain the technical problems of the previous session to them... The technical problems at Angelford continued, but the children waited for 15 minutes before asking a teacher for help. I wonder if perhaps I should have intervened earlier to encourage them to get some help? In the end, they were able to control the mute using the remote control, but not the camera, suggesting that the issue might be with the motor on the Tandberg unit rather than with the batteries. The Head Teacher for Angelford was present for a short while and the children did eventually manage to get the camera into the position they wanted it in, although this was a slow and delicate operation."

In Amy's stimulated recall interview, she explains how the other children at Angelford and she were not given much of an opportunity to control the camera until it was broken.

Adam: Did you ever control the camera?

Amy: Not really. [child] decided that he was in charge of that and he wouldn't give anyone else the remote control.

Adam: Was it him that broke the camera?

Amy: Yes.

Adam: Did you sometimes want to use the camera yourself?

Amy: Yes.

Adam: How did you feel when [child] wouldn't let you?

Amy: Really upset because it wasn't even fair on the girls.

Adam: Does he normally upset you in class?

Amy:

No. Only in the video conference, but after that he's like normal again.

Adam: One of the girls is controlling the camera here. Why is that?

Amy:

[child] didn't mind because the camera was broke and [teacher] told him that he

had to share.

Adam: Did [teacher] know that you were upset about it?

Amy: Yes, one of the girls in our class told her about it.

Minor Technical Issues

The children did experience a small number of technical issues during the video conferences and

given that they did not have a teacher physically in the room with them, they either had to resolve

issues for themselves or find a teacher to help them. During the 12<sup>th</sup> video conference, the children

at Benefactors School could not hear what I was saying, although the other schools and I could hear

what the children at Benefactors School were saying. Despite me trying to resolve the issue for the

children by using messages written on the whiteboard, they ultimately ended up having to contact

their teacher to turn the speakers on for them. Similarly, Emma had some technical support from a

teacher at Eastport School as described below.

Adam: Talk me through what is happening here.

Emma: We got stuck with the camera because the remote control wasn't working.

Adam: Is [teacher] helping you out?

Emma: Yes. He said it was because we were pointing the remote control at the screen

instead of the camera.

Adam: How many times has [teacher] helped you out with problems like this?

Emma: Only a couple of times with the camera, but he never helps us with the activities that

you set.

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David also described in his interview that Daleway School were unable to connect, so they contacted their Deputy Head Teacher for help. He came along to the room and switched the equipment on and off, but he was unable to get Daleway School connected to the video conference. However, he then left the room and a few minutes later, the children claim that the equipment just suddenly started working.

### 4.5 Discussion

The data presented in this chapter clearly demonstrates that the children involved in this study enjoyed their experience and were motivated by video conferencing. This agrees with the findings of numerous studies (Comber et. al, 2004, pp45-47; Thorpe, 1998, p401; Butler and Fawkes, 1999, pp46-47). Furthermore, the children in this study had similar experiences to those in Gage's study (Gage, 2003) in that, as Gage describes it, "video conferencing provided a sense of excitement, which is not normally a feature of mathematics lessons". However, the children were also apprehensive and nervous about using the technology, an attribute often associated with video conferencing (Carville and Mitchell, 2000, p44; Laouenan, 1999, p179). Some studies have discussed the idea that video conferencing can be a facilitating factor in the sense that the technology can empower some participants to take part more readily than they would in the face-to-face environment (Husu, 2000, p258; Thorpe, 1998, p402). In this study, the children were already able mathematicians and, from the face-to-face sessions that took place in the Autumn term, there was little to indicate that any of them were lacking in self confidence. Little has been published about how video conferencing technology can facilitate personal and social improvements when the participants are already deemed to have strengths in these areas and this is perhaps an area for further research.

This sub-chapter described how Charlotte and Emma could have been interpreted as being dissatisfied with the lack of equity between endpoints. This arose from the case of a teacher at Angelford School assisting the children during one of the video conferences. The idea of equity

between endpoints is not new and many studies have considered the differences in experience between face-to-face endpoints and remote endpoints (Freeman, M., 1998, p197; Carville and Mitchell, 2000, p44; Knipe and lee, 2002, p301). However, the particular concern over equity in this study is somewhat different in that it considers the equity between different remote endpoints. This is an area that is under-researched, yet is arguably an inherent consideration within video conferencing. Not only do the teaching and learning environments differ, there may also be multiple learning environments, which also differ from each other.

In chapter two, it was argued that video conferencing is a natural tool for dialogue, collaborative learning and group work (Hearnshaw, 1997, p52; Knipe and Lee, 2002, p307; Ertl et. al., 2005, p149). The implication in these studies was that participants should use the technology itself to collaborate with other participants at other endpoints. However, whilst the technology in my own study was used as a tool for dialogue, collaborative learning and group work, the focus was somewhat different. The majority of the dialogue between the children themselves occurred within endpoints and the technology was used primarily to have dialogue with me as their teacher. In this sense, the technology was used more to present the outcomes of the dialogue, collaborative learning and group work, rather than to facilitate these processes explicitly. It could be argued that if such process are mainly happening within endpoints, then this avoids some of the issues associated with a lack of interactivity as discussed in chapter two (Carville and Mitchell, 2000, p46; Doggett, 2008, p35; Anderson, 2008, p112). However, since little is known about what happened away from camera at the remote endpoints, it is problematic to draw any firm conclusions here.

In the literature review, the willingness of teachers and site-facilitators to embrace new technology was argued to be an important factor in ensuring a successful and effective video conference (Harris, 2002, p454; Doggett, 2008, p40). However, little has been written about the willingness of participants more broadly. This is perhaps because one willing teacher or site facilitator at each

endpoint may be sufficient to motivate other participants at the same endpoint. Indeed, this willing individual, described by some as an enthusiast (Comber et. al., 2004, p55) may be perceived by other participants to be more knowledgeable about video conferencing and hence be a natural leader when the technology is used. However, there were no such enthusiastic site facilitators in my study and the children had to develop a communal willingness.

Mercer (1995, p105) describes cumulative talk as discussion containing "constant repetition and confirmation of [each other's] ideas and opinions", and disputation talk as discussion "dominated by assertions and counter assertions". One of the consequences of building in unsupervised group work in this study was that the children engaged in cumulative discussion. Whilst this is a positive consequence, it should be acknowledged that lack of supervision might equally lead to disputational discussion in which the children are arguing and not managing to resolve any issues. These cumulative or disputational discussions were varied and covered the mathematics, about who would present the solution and about who would control the movement of the camera. When analysing the recordings of the video conferences, the children can be seen regularly engaging in cumulative discussion during almost every session about. There is also some disputation discussion, although this is limited. This may not have been such a strong feature of these video conferences had there been a teacher in the room. Indeed, it could be argued that the teacher would have stopped any disputation discussion mistaking it as arguing and carrying negative connotations. I asked some of the children about these discussions during their stimulated recall interviews, although it should be noted that when talking to the children I referred to the discussions as 'arguments'. These interviews revealed many different types of discussion taking place during the sessions. The extracts below are taken from the interview transcripts and they demonstrate this point well.

Adam: Why were you arguing?

Amy:

[child] was taking charge over the camera again, but he wasn't even moving it quick

enough.

Adam: Did you argue a lot during the video conferencing sessions?

Amy: At the beginning we did, but then after we got used to it, it was okay.

The extract above is an example of disputation discussion. These discussions occurred during most

sessions although they were relatively infrequent in comparison to the other types of discussion that

were taking place. The disputation discussions were mostly centred on the use of the technology

and were usually resolved quickly.

Adam: Did you argue a lot?

David: Sometimes, but it was kind of like a good argument.

Adam: How do you mean?

David: Well it was an argument about the work and not arguing with each other.

The extract above represents the most common form of discussion that was observed during the

sessions; that of cumulative discussion about the mathematics. When presenting their solutions, the

children could often be seen interrupting each other to correct what was being said and then this

cumulative discussion ensued. It was not possible to hear what the children were saying when they

were working away from the camera on their solutions, since the technology did not allow this.

However, I would speculate that such cumulative discussions would have also taken place then.

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Adam: There is some arguing going on here. Did this happen any other times?

Charlotte: Yes, all the time there has been arguments about the remote control and

the camera. We put [child] in charge of the camera, but he is a bit too slow

to move it.

Adam: Did the arguing cause problems between you and your friends?

Charlotte: No, because we all argued and we all liked it. And then we joked about it at

dinner time.

The extract above could be categorised as cohesive discussion in that the children were not arguing as such, but rather they were all commenting to each other about how a specific task was being carried out. They were pointing out inefficiencies in each other's methods in such a way that the situation became light-hearted and enjoyable. This type of discussion was not observed very often, but it is most likely that if this was happening then it would have happened away from the camera.

Adam: Who usually controls the camera?

Frank: We all have a go at different times depending on who is nearest, but [child] uses it more than anybody else.

Adam: Do you ever argue about this?

Frank: Yeah, quite a lot. I don't really care, but [child] and [child] argued all the time about it.

Adam: Did their arguing ever stop you from being able to do your work?

Frank: No, but it was just really annoying.

The extract above is an example of disputation discussion, during which no constructive outcome was reached. Such discussions were relatively infrequent and often centred on the technology.

Mercer (1995, p105) also talks about exploratory discussion between students as being the ideal in

facilitating a good learning environment. He describes exploratory discussion as "talk which combines challenges and requests for clarification with responses which provide explanations and justifications". This would have taken place away from camera and there was little evidence from the interviews with the children to suggest such talk occurred.

The frustration experienced by the children when they tackled the mathematical enrichment tasks was not unexpected and is arguably an important part of the problem solving process as discussed in chapter one (Mason, 1985, p109; Averbach and Chein, 2003, p1). When faced with frustration and the potential of failing to solve a problem, learners generally have two options. They can either quit or they can choose to work harder on the problem (Mayer, 1998, p60). This choice may depend upon the type of emotion that is being experienced. For example, Belavkin (2001, p8) argues that whilst frustration might encourage a student to work harder, anxiety might encourage the student to give up. However, Mayer (1998, p60) believes that the choice is more dependent on whether the learners believe their potential failure is due to a lack of effort or a lack of ability. The former obviously leaves much of the control with the learner, whilst the latter allows the learners to accept less responsibility in the case of a failure. My own study offers yet another alternative in the context of using video conferencing technology. If we take as given the conclusion that video conferencing is a motivating factor for learning (Comber et. al, 2004, pp45-47; Thorpe, 1998, p401; Butler and Fawkes, 1999, pp46-47), it could perhaps be argued, in the context of this study, that the technology encouraged the children to keep working on problems when they became difficult, rather than to quit. The evidence for this claim is partly based on the motivational claims from the literature, but we also know from the video recordings and the children's diaries that the children enjoyed presenting their solutions even if they had not achieved very much. This effect did not appear to dwindle over time, which suggests that it is not the result of the novelty of the technology.

In relation to learners' emotions when solving mathematical problems, it is worth considering the work of Markku Hannula. He argues that when learners' work is leading them towards a solution they experience positive emotions, which encourage them to continue (Hannula, 2002, p29). Furthermore, he argues that if learners encounter obstacles that hinder their progress, then negative emotions may be induced, including anger, fear or sadness. Certainly, these arguments are in keeping with some of the frustration experienced by some of the children in my study. My own experience in the classroom suggests that when students encounter such obstacles, they ask their teacher for help. Such support helps to dissolve the negative emotions discussed above and has a motivational impact for the learner (Mayer, 1998, p58). However, it is notable in this study that I (Adam the teacher) was not always available for help as I was sometimes helping other children. Unlike the traditional classroom, the video conference environment is such that the teacher may not be aware that another learner needs help and it may be some time before such help is given. Indeed, it could be argued that the lack of awareness of Adam the teacher, as a direct inhibitive result of using the technology, actually facilitated collaborative learning, since at the point of being stuck individually, the children's only choices were to give up or to ask others at their endpoint for help. This supports the view that video conferencing can be both an inhibitive and a facilitating factor (Husu, 2000, p258; Thorpe, 1998, p402).

Schoenfield (1992, p205) discusses teachers' beliefs in mathematics and makes the case that problem solving is valued by some teachers, yet often sacrificed for content-based drilling. He also argues that teachers' initial beliefs are derived from their own experiences as learners and the consequence of this is that generations of mathematics teachers are stuck in a "vicious pedagogical circle" of drilling rather than facilitating thinking (Schoenfield, 1992, p207). This raises an interesting question as to whether video conferencing could be a potential vehicle for helping to break the pedagogical cycle discussed by Schoenfield. The scope of this study prevents me from making any judgements here, but this is perhaps an avenue of further research.

The use of Countdown as an activity was a popular choice from the children's perspective and at this stage it is perhaps worth reflecting on the competitive nature of educational activities in a broader context. In his recent report on learning behaviour, Sir Alan Steer (2009, p103) highlighted games and quizzes as essential for keeping learners on task. However, it is not simply the case that competition is motivating for all learners. Indeed, it is argued by some that that in a competitive environment, one student achieving their goal inherently indicates that others cannot achieve theirs (Johnson et. al., 1973, p172). This is in contrast to a cooperative environment in which all students have a common goal and as such they either all fail or all succeed (Johnson et. al, 1973, p172). Furthermore, Johnson et. al. (1973, p173) go on to state that in a cooperative environment, students are less likely to dominate each other and more like to support each other. Earlier in this chapter, it was argued that there was one teaching environment and multiple learning environments in the context of using video conferencing in my case study. In considering whether or not the overall environment was cooperative or competitive, it is clear that there are elements of both, and this becomes particularly stark during the Countdown activity. Within endpoints, the environment was generally cooperative, but between the children's endpoints, the environment was generally competitive. Such an arrangement might perhaps allow the participants to reap the benefits of both the cooperative and the competitive classroom environments simultaneously. Indeed, this supports the view of Devries and Edwards (1973, pp315-316), who state that it is possible to have both a competitive and a cohesive environment if the competition is at group level and not at the individual level.

During the delivery of the video conferences in this study, I had to make a number of decisions about what resources to use (as Adam the teacher). However, it was not until reflecting on the study (as Adam the researcher) that I realised such choices also needed to be made by the children to prepare for the presentations of their solutions. Initially, one might think that this allows for a comparison between the children's choices and my own choices, but such a comparison would be inherently

biased since the children had limited access to resources relative to me. For example, a document camera is seen as an effective resource for video conferencing (Comber et. al., 2004, p68) and whilst this might have been a viable option for me, the children may not have had access to such technology. Similarly, a comparison between the children themselves would likely be fruitless, since the children primarily used resources supplied for them. A good comparison that can be made when considering teaching resources for video conferencing is with the props used for educational television. Stasheff (1966, p138) describes his rule that television props should be "no smaller than your fist and no bigger than the door". This fits well with the majority of the choices made in my study, although there were some exceptions, such as the use of small counters on larger grids or boards. The key point, though, is that unlike the traditional classroom or the stage, bigger is not necessarily better.

In thinking about additional resources that might not have otherwise been available, it is argued by some that video conferencing gives access to resources beyond the classroom walls (Comber et. al., 2004, p35). This might include interacting with real situations across the world or accessing materials that are restricted to specific locations, such as museum artefacts. In studies such as mine, primary school children can be given access to secondary school resources and expertise that might not be readily available in the classroom.

In this study, the children at each endpoint were left to work together as a group on solving problems. In such situations, status ordering is likely to occur, which involves the development of a hierarchy within a group (Cohen, 2000, p2). Furthermore, Cohen goes on to argue that in small groups, it is rare for each individual to contribute equally. The different roles that individual members could take could be categorised into task-orientated roles, social roles and individualistic roles (Borchers, 1999). Task-orientated roles include *initiators* (who come up with new ideas), recorders (who keep a record of group actions) and procedural technicians (who perform logistical

functions for the group, e.g. calculations). Social roles include *encouragers* (who praise the ideas of other group members) and *harmonisers* (who settle differences between group members). Individualistic roles are generally thought of a destructive and include *dominators* (who assert control over the group by manipulating the other group members). The examples chosen here are only a selection of those that appear within the categorisation of Borchers (1999), but they have been chosen because they best reflect the roles that I observed the children take at various points in the video conferences. However, I would like to explore the role of *dominator* more closely as this is perhaps less clear. Earlier in this sub-chapter, there was some discussion about children taking control of the camera and not allowing others to participate with this aspect of the video conference. This is an example of the dominator role in action and demonstrates the idea that perhaps the camera controller could be considered to be the group leader, albeit a dominating one. I do, however acknowledge, that in some situations the presenter or somebody with a separate role might be considered to be the group leader. The role of leader is important since research suggests that the mood of this individual may impact on the performance of the whole group (Sy et. al., 2005, p295).

In chapter two, it was argued that technical support was a factor delivering a successful video conference (Comber et. al, 2004, p38; Austin et. al., 2003, p61; Butler and Fawkes, 1999, p47; Gill, 2005, p574; Laouenan, 1999, p179; Freeman, 1998, p207). From the children's perspective, this study supports this wider view, since although the children resolved most minor issues independently, there were several occasions on which it was necessary for them to contact a teacher for assistance. However, it is worth noting that the technical support necessary to ensure success in this project did not require specially trained technicians, rather teachers with some basic technical knowledge that were present only when problems arose.

### **Summary**

This chapter has considered a wide range of children's experiences throughout this study. Whilst the video conferencing technology was a motivating factor, it also acted as an inhibitor, since some children were apprehensive about using new technology. As such, the willingness of the children to embrace video conferencing was seen as essential to the success of the project. The children valued not having a site facilitator, since this allowed them to work independently in their own style and at their own pace, although they were clear that there should be equity in relation to the support received at the remote endpoints. That is, the children in this study believed that if there was no site facilitator at one endpoint, then there should be no site facilitator at all of the other endpoints in the interests of fairness.

The children were generally supportive to each other and the various types of support were identified, although the key support mechanism involved whispering to the presenter. Similarly, an analysis of the children's talk using Mercer's categorisation showed that constructive discussion was taking place. The children found the mathematical enrichment tasks difficult and this was generally deemed to lead to frustration, which resulted in the students working harder and not giving up. More generally, the emotional aspect of problem solving was discussed and it was argued that video conferencing is an appropriate medium for mathematical problem solving.

There was some discussion about the multiple learning environments in multipoint video conferencing and it was concluded that this can facilitate both cooperative and competitive environments simultaneously. The resources used for presenting through the medium of video conferencing were deemed to be analogous to props that might be used on a television show rather than on a stage show. The chapter concluded with a brief analysis of the children's group dynamics and a positive discussion about the technical support that can be offered by teachers as non-specialist technicians.

#### **CHAPTER 5 – COGNITIVE TEACHING STRATEGIES**

"To the cognition of the brain must be added the experience of the soul"

**Arnold Bennett** 

This chapter considers the cognitive teaching strategies that were used by me during the video conferencing sessions. That is, it looks at those strategies that might impact on how the children think about mathematics or about their experience of video conferencing more generally. The chapter is broken down into four sub-chapters; instruction and guidance, non-verbal communication, skill development and discussion. This categorisation is based on the revised teaching strategies framework described in chapter three.

The instruction and guidance section will look at how I presented the mathematical enrichment problems to the children. In particular, consideration will be given to the total time spent on instruction as well as the proportion of this time spent talking over PowerPoint slides. My use of open and closed questions will be analysed and a cyclic flowchart will be presented to summarise my observations in relation to the structure of the sessions. The non-verbal communication section considers the importance of body language in the context of effective communication through the medium of video conferencing. The third sub-chapter looks at how the teaching strategies being used can affect the development of the children's mathematical and interpersonal skills. Particular attention will be given to the idea that the video conferencing environment naturally facilitates the independent learning of mathematics and problem solving.

# 5.1 Instruction and Guidance

This chapter section focuses on the interaction between the children and me during the video conferences with a particular emphasis on the teaching strategies used. For clarity, it is worth taking a moment to explain what is meant by the terms *instruction* and *guidance*. These terms are used to divide the video conference into two chronological sections for each mathematical task set. Figure 17 below is helpful in illustrating how such a video conference might be partitioned.



Fig. 17 – Partitioning of a video conference

Instruction refers to the initial phase of the teacher introducing a mathematical task to the children. This phase consisted mostly of the teacher explaining what the children had to do, although sometimes it involved the teacher asking questions and filling any gaps in knowledge necessary for the children to attempt the task. For example, if the mathematical task was an investigation based around prime numbers, the teacher might first check that the children knew what prime numbers were and then provide a definition or go through some examples if required. However, on another occasion, the teacher may have not asked the children anything at all and simply begun immediately with a definition of prime numbers as part of the *instruction* phase. The key thing about the instruction phase is that it encompasses everything that happens from when the teacher outlines the mathematical task up to the moment when the children attempt the mathematical task.

Guidance refers to the second phase of working on a mathematical task. In this phase, the children worked on ideas either individually or as a group and then presented their ideas to the teacher. The teacher can then gave the children feedback on their work so far and guided them towards obtaining a better or more refined solution. This guidance sometimes came in the form of very direct suggestions such as "Try the multiples of 8 and see if that works", but mostly it came in the form of questions. More details on the kinds of questions that were asked at this stage are discussed later in this chapter.

In total, the recordings of 15 video conferences were analysed, which included 39 sets of 'instruction and guidance'. The recordings spanned from video conference five to video conference 13. The mean average time spent on the instruction phase was 100 seconds. However, the range of instruction times was marked with the shortest instruction phase lasting only 10 seconds and the longest instruction phase lasting 200 seconds. It should be pointed out here that the shortest instruction phase occurred when technical problems were being experienced. Such issues usually consisted of connectivity or audio difficulties, but these are discussed in more detail in chapter six. The longest instruction phases occurred during the sessions on strategy games. Having explained the rules of the games to the children, they had several questions that they wanted to ask me to clarify the rules. This interaction took some time and involved me giving examples of keys points and as such the instruction time was greatly increased.

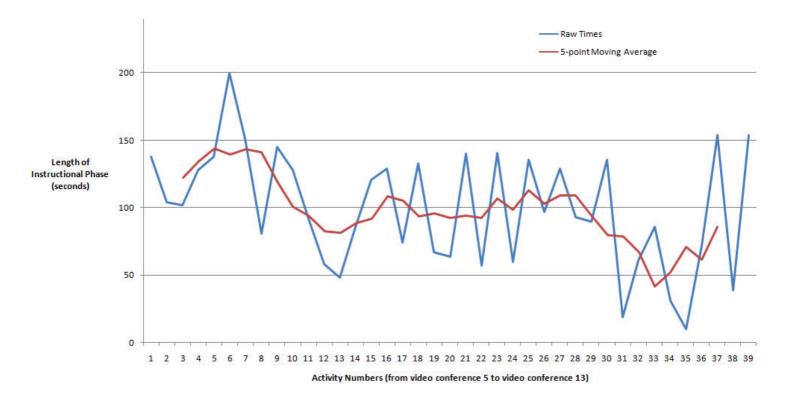


Fig. 18 – A graph to show the average length of the instruction phase

Looking at how the length of these instruction phases have varied over time can be problematic if looking at the raw data, since the extreme values make it difficult to identify any trends. Utilising a five-point moving average for the data yields the graph shown in red in figure 18 above. This graph shows that more time was spent on the instruction phase during the early video conferences in comparison with the later video conferences, but it does not give us any indication of why this might have happened.

Looking again at the video recordings of the instruction phase revealed that over time I omitted more and more generic information. For example, many of the early instructions include me advising the children to set their solutions out in a particular way or to use specific resources. Practical information has also been omitted over time. For example, when the conferences first began, the children were often reminded to put their microphone onto mute or to point the camera at the

correct place on the board so it showed their work. This diminished over time, perhaps as the children naturally adapted to the technology and became more competent with its use.

During the instruction phase, the children generally saw two different things. The first was the transmitted video and audio of me and the second was an animated PowerPoint presentation with my voice commentating over the top of it. As Adam the teacher, I gave no thought when delivering the sessions as to what proportion of the instruction phase would show the video and what proportion would show the PowerPoint. Retrospectively, I was able to obtain the percentage of time spent talking over PowerPoint during each instruction phase by observing the video data and timing the relevant sections. The results are shown in figure 19.

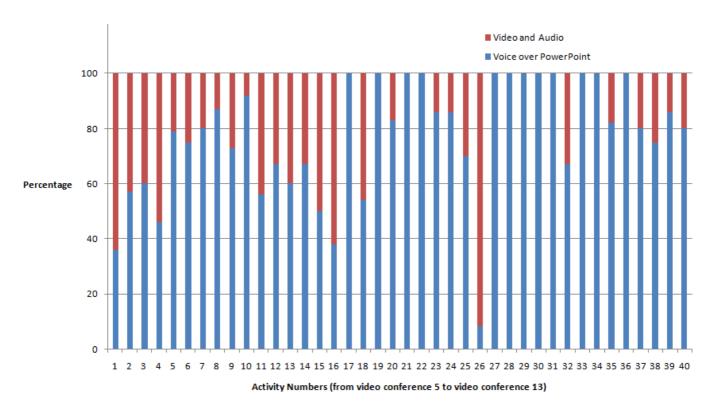


Fig. 19 – A graph to show the proportion of the instruction phase utilising PowerPoint

It can be seen in figure 19 that 'voice over PowerPoint' was used most often with only four occasions on which 'video and audio' was used for more than 50% of the instruction. Furthermore, it is clear

that 'voice over PowerPoint' was being used increasingly over time with 12 occasions on which this method of delivery was used exclusively. A more detailed look at those 12 occurrences does not reveal anything further, which might be significant here. There are no obvious reasons why these occurrences should have PowerPoint shown for 100% of the time and the others should not. Indeed, some of these instructions are repeated with vastly different proportions when the same problem is explained to the first group of schools and then again for the second group of schools.

On reflection, I do not recall being aware of such extensive use of PowerPoint, but this is clearly a teaching strategy that has developed naturally over time. It could be argued that those explanations that involved diagrams or mathematical notation lent themselves to using 'voice over PowerPoint' since PowerPoint itself acted as a visual aid for the children. However, there were many occasions on which I was displaying only text on the screen and so the purpose of using PowerPoint here was not clear.

I shall now move on to consider the analysis of the guidance that I gave to the children. Interestingly, I gave very few actual instructions to the children about what they needed to do. Instead, as indicated earlier, more than 80% of the overall sentences spoken by me whilst guiding the children came in the form of questions. Over the 15 recorded conferences, the total number of questions that I asked the children was 474. This works out at approximately 32 questions per video conference and 12 questions per mathematical task set for the children. These 474 questions were recorded as either open or closed questions and the results showed that 155 of them were open questions compared with 319 of them that were closed questions. Interestingly, I had planned to ask open questions rather than closed questions when planning and delivering the sessions since my rationale, As Adam the teacher, was that open questions lent themselves more naturally to independent learning and to mathematical enrichment problems. As such, I was surprised to

discover, when I viewed the video data, that only one third of the questions that I had asked were actually open questions.

A closer look at the interactions between the children and me revealed that closed questions were generally asked when the children were stuck with a particular problem. When the children had managed to solve a problem or they were finding it relatively easy, I stretched them by asking open questions. In particular, the children were often asked to explain why their solutions were correct and they were asked to justify their ideas.

Some of the questions that I asked involved repeating what the children had said back to them to ensure that I had understood them properly and had not misheard them. In addition to seeking confirmation, there was very often a period of clarification using closed questions to establish the details of the children's solutions. Once I had grasped what the children's ideas and arguments were about, I then used open questions to ask the children to explain why their solutions were correct. From reviewing the video recordings and considering questioning in particular, I was able to produce the following flowchart, which is an abstraction from the data (figure 20). This flowchart models the typical behaviour that occurred during the video conferences and it should be made clear that this is descriptive in demonstrating what has occurred rather than prescriptive in suggesting what others ought to do.

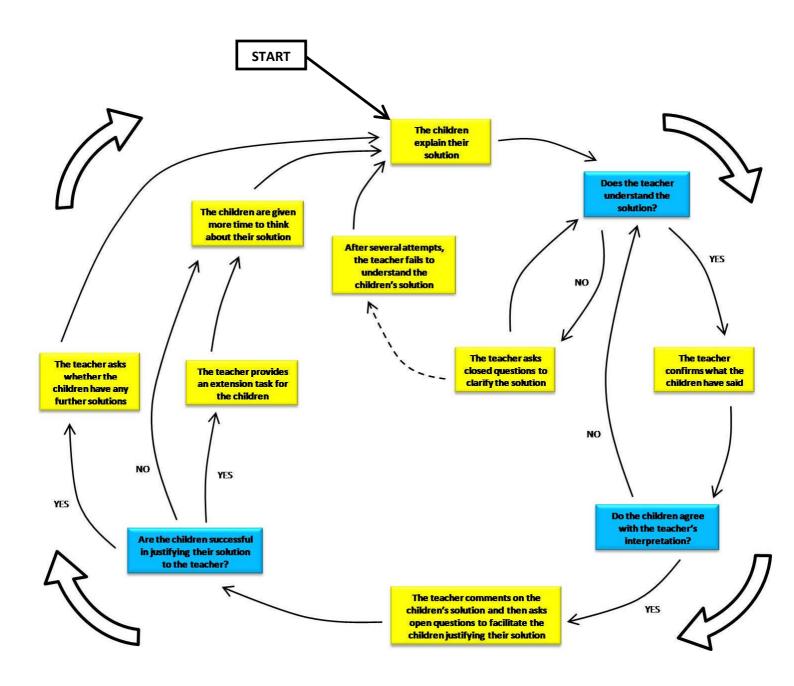


Fig. 20 – A flowchart to summarise observations from the video recordings

The model above is cyclic in nature and could continue indefinitely until the cycle is broken by the teacher moving onto the instruction phase of a completely new mathematical task. One could argue that when the teacher is setting an extension task, this is itself an instruction phase. However, in this context, the extension task was closely related to the first task such that little instruction was required on the part of the teacher. For example, if the original mathematical task involved an

investigation into the properties of the multiples of three, then the extension task might involve seeing whether the same properties hold for multiples of six. The main thrust behind this model was that the children presented their solution to the teacher and then guidance was given so that the children could refine their solution. This new and improved solution was then presented to the teacher again and the same process was repeated.

Returning to the description of open and closed questions, it was interesting to observe that despite me asking closed questions, the children still answered some of them as if I had asked them an open question. On other occasions, when I did intend to ask closed questions, the children again answered as if they had been asked an open question. This open response from the children did not happen very often, but it happened often enough that it became noticeable when coding the data. Moreover, it happened more in the later video conferences than in the earlier ones.

Below are some examples which demonstrate the open and closed questioning styles discussed above.

## Extracts from video conference 11

Here is a closed question with an open response...

Daleway: It's not on the cards, so we don't think it would work.

....

Here the children answer a different question to the one being asked...

Did you manage to have a look at 3-digit numbers?

We think that it works for 3-digit numbers.

On this occasion, the teacher sought for clarification, but the children responded with a justification... Angelford: We think that the answer is always in the nine times table, but we're

not sure why yet.

Adam: Is that for 3-digit numbers or for 2-digit numbers?

Angelford: 3-digit numbers. We've just tried lots of different ones and they've

all been in the nine times table but we haven't worked out why yet.

After the instruction phase, the children were generally given approximately seven minutes to work

on obtaining a solution for the mathematical task that they had been set. About two minutes before

the children were due to present their solutions, I would give them a reminder such as "two minutes

left". In the early video conferences, this reminder was accompanied by brief suggestions that the

children should "start writing something on their board" if they hadn't already done so or that they

should "decide who is going to present" their solution. By the time video conference seven was

taking place, I was only giving the children these suggestions at the end of the instruction. During the

later video conferences, the reminder about how much time was left remained present for the

majority of the tasks, but the suggestions about preparing for the presentation had gone completely.

All the children were set the same initial mathematical enrichment problem and they all listened to

the same explanation of the task from me. By the time the children came to present their solutions

they had sometimes approached the problem in different ways. However, more often than not, the

children would come up with similar solutions or use similar methods. This was usually dealt with by

providing each school with a different focus for their extension task.

If the children came up with a solution that was incorrect it was rare for me to tell them directly that

this was the case. Instead, my approach was usually to tell the children that I was "not convinced" by

their solution and then to lead them along another route or have them rethink their solution. It was

rare that I gave the children a full solution to the mathematical problems they were working on and

there were two reasons for this. Firstly, the enrichment nature of the tasks was such that they were

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low-threshold/high-ceiling as was discussed in chapter one. This suggests that it could take some time to discover a full solution to a problem if indeed there was a full solution. Certainly the amount of time needed to explain such a solution would have exceeded the limited time available during a video conference. Secondly, if the children had approached a problem in a different way than I had anticipated, then giving a full solution using the children's approach was not always easy or possible and changing to my own approach was not always appropriate.

One interesting observation was the infrequency with which I used the children's names. During the face-to-face sessions that took place prior to the video conferencing sessions beginning, I used the children's names frequently, but this changed once the video conferencing sessions began. I was unaware of this at the time and indeed the only mention of using the children's names in my diary was after video conference 11 when I wrote the following:

"I did feel that I was using the children's names more during this conference than I usually do. ... this was not intentional, but something I realised afterwards."

What was happening during the video conferences was that I was using the names of the schools rather than the names of the children. In this way, each group of children was being considered together rather than as an individual. On those occasions when I did use the children's names it was primarily for managing the children's behaviour and this will be discussed in more depth in chapter eight. It is worth reflecting for a moment about how groups would normally be addressed in the traditional classroom environment. Indeed, if I had a class with four groups named red, yellow, green and blue, I would consider it to be quite natural to address the children by referring to the colour rather than the individual names of the students and also to address those behaving poorly on an individual basis.

### 5.2 Non-verbal Communication

This sub-chapter is mainly concerned with the body language that I used, both consciously and sub-consciously, when delivering the video conferences to the children. Within the broad grouping of non-verbal communication, the use of colour and lighting is also considered. The aim of this sub-chapter is to establish what non-verbal communication was used, how this evolved over time and its impact on the success and effectiveness of the video conferencing sessions.

The analysis was done by watching all of the recordings and looking primarily at my own body language, but also considering the choice of colours and the use of lighting. Originally, I considered looking through the video without the audio playing so that the body language could be considered in its own right without distraction. However, this proved problematic since it was difficult to consider the body language in the context in which it was being used without the audio.

One might ask why non-verbal communication is of any importance for a study on video conferencing. When teachers are working in a standard classroom environment, it is likely to be much easier to build rapport with the children than in a video conferencing environment. The teacher can position themselves in different places in the room and they can control the environment. Building rapport through a video conferencing environment is arguably more difficult and non-verbal communication has a key role to play if the teacher is to be successful in this area. In the context of this study, the rapport building process has been assisted through the face-to-face sessions that took place prior to the video conferencing sessions and this should be acknowledged from the outset.

To build rapport non-verbally, smiling was one of the techniques that I observed myself using. Nodding my head was also often used to acknowledge that I had understood what the children were saying to me during the presentations of their solutions. Looking through the video data yielded a

number of other techniques that were used simultaneously along with the nodding of my head. The first technique involved resting my chin on the palm of my right hand with my first finger covering my lips. My right elbow was resting on my left hand and my left arm came across my chest. My head was also tilted to one side. Figure 21 below shows what this position looks like. This image did not come from the video recordings, but was created afterwards to illustrate this position for the reader.



Fig. 21 – An illustration of body language typically used during the video conferences

To analyse the meaning of such body language, one could consult a wide range of books or internet sources and all might have variations on the precise meanings. For the purposes of this study, I have referred to a pair of leading authors on body language analysis, Allan Pease and Barbara Pease (Pease and Pease, 2002). However, it should be noted that their interpretations of body language are used only as a starting point since my analysis will also take into consideration the context in which the body language is being used. It is already clear from the video recordings that the overall body language of the position demonstrated above reflects my acknowledgement of what the children are saying. However, this will now be broken down to consider the role played by each individual element of the position.

Firstly, let us consider the head being tilted to one side. Pease and Pease (2002, p76) state that this is the "interested position". They continue to state that "when others are speaking to you, all you

need to do is use the head-tilted position and head nods to make the listener feel warm towards you". This description of tilting and nodding is clearly similar to what can be seen happening on the recordings of the video conferencing.

Let us next consider the meaning of the left arm that crosses the chest with the left hand gripping the right elbow. It is commonly believed that the positioning the arm in this way is a defensive motion, but there are many different interpretations. Pease and Pease (2002, pp59-65) include a wide variety of arm-crossing and arm-gripping gestures and although none of them match this position exactly, the nearest match is that of the arm fold in which the hands grip the opposite arm. This is said to be a "waiting gesture" rather than a "defensive gesture" and is described as being similar to what might happen in doctors' or dentists' waiting rooms. In the context of this study, whilst acknowledging what the children are saying, this position might have communicated to the children that I was waiting for them to make their point and to finish speaking.

Finally, let us consider the positioning of the hand rubbing the chin with the first finger covering the mouth. Pease and Pease (2002, p57) describe this as an "evaluation gesture" in which the person is evaluating what is being said and making a decision simultaneously. When the children were explaining their solutions to me, I was evaluating their solution and making a decision as to what guidance I would give to them. It should be pointed out here that the information in this study does not allow me to make any strong claims about what would happen if such body language was not used, but there is no evidence to suggest that using this body language has caused difficulties for the children. Further research would be required to know the fuller extent to which these gestures can impact on the overall success and effectiveness of a video conference.

It is worth noting that there were two significant variations on the position discussed above. The first variation included a scrunching of the eyes and a raising of the cheeks. In every case in which this

occurred, I was feeling doubtful about the solutions that the children were presenting to me or about how they had answered certain questions. As such, this gesture might be used as a tool to communicate doubt to the students without verbally interrupting their presentation. In the second variation, the arm coming across the chest was dropped and the right hand was rubbing the back of my neck. Pease and Pease (2002, p57) suggest that this gesture is a sign of anger and frustration and can be taken quite literally to mean that somebody is being "a pain in the neck". In this study, there was no video evidence to suggest that this gesture coincided with the children causing a problem or with me getting angry or frustrated. Furthermore, my use of this gesture appears to be somewhat random.

The use of eye contact is an obvious skill for building rapport (O'Connor and Seymour, 2002, p20) and as such is worthy of consideration in this study. Indeed, I would go further to say that eye contact is particularly difficult to achieve using the majority of existing video conferencing technologies since the camera is usually located above, below or to the side of the screen being used to view other endpoints. That is, if a child looks directly into the camera, then it would appear as though he was looking directly at me as I view him on my screen. However, to the child, it would appear as though I was looking past him because I am not looking directly into the camera. This is not helpful when trying to establish rapport as it is equivalent to somebody looking at your ear whilst you are trying to have a conversation with them. This is a known issue with using video conferencing technology and there are already some initial solutions to help in tackling this problem. A common feature of these solutions is to have the camera and the screen in the same place. Some have achieved this by using a pin-point camera and placing it right at the centre of the screen, which allows children and teachers at the endpoints to look directly at the screen and at the camera simultaneously. A second solution involves the clever use of a two-way mirror such that the camera is positioned behind the screen. Figure 23 gives an idea of how this might work. The green arrows demonstrate how the received video is reflected on the mirror side of the two-way mirror such that it can be seen by the person at the endpoint. The camera is positioned behind the screen and can see through the other side of the two-way mirror, but cannot be seen by the person.

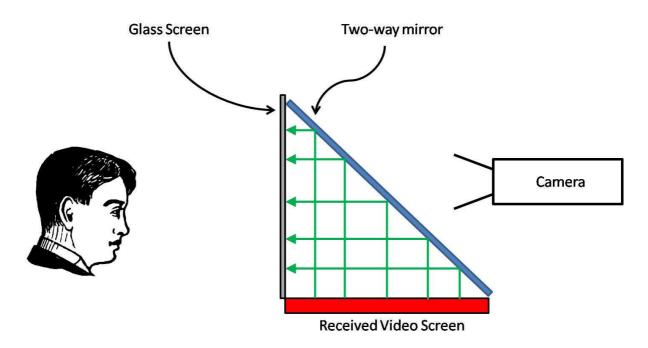


Fig. 22 – An example of how eye contact can be maintained during a video conference

Such technology was not available for use in this study, and so I created eye contact artificially. This was achieved by me intentionally looking directly into the camera when interacting with the children and only occasionally glancing at the screen. To the children, it appeared that I was looking directly at them, but it was not the same experience for me. This is the only eye contact strategy that I can be seen to be using in the recordings of the video conferences. When this strategy was not being used, I was looking directly at the screen.

The next observation that arose from the analysis was that I almost always stood to deliver the video conferences. This is in contrast to other video conference providers, for example Motivate, whose presenters tend to be seated when interacting with the children. On those rare occasions that I did

sit down, this tended to coincide with technical issues although it is not clear why sitting down was helpful in such circumstances.

One of the key constraints to analysing the body language in this study was the proportion of my body that could be easily observed from the video recordings. In the majority of the recordings, the children could see the top-half of my body from about the bottom of my chest to the top of my head. This was a conscious decision made by me at the time of delivering these video conferences and the two major alternatives would have been to show my whole body or to show just my talking head. The advantage of showing the whole body is that the children can see more of my body language and so this can help with rapport building and communication in general. The advantage of the talking head is that the detail of my facial expressions can help with communication. I originally chose to show the top half of my body because I felt that this would encompass hand gestures, but would not show so much of my body that the detail in facial expressions would be lost. There is no evidence to suggest that this decision to show the top half of my body has caused any difficulties for the children, yet there is limited evidence to suggest it has benefited the children. Showing the top half of my body did allow the children to view any hand gestures that I used to emphasise key points. One of the most effective uses of hand gestures in this study was to emphasise the meaning of key mathematical words. The recordings show me using my fingers to represent various numbers and positioning my arm accordingly when using the words "vertical", "horizontal" or "diagonal". The decision about what proportion of the presenter should be visible will be discussed in a wider context towards the end of this chapter.

There were some movements and gestures that I observed regularly throughout the video conferences in a variety of different circumstances. The first was that I was holding the remote control almost every time that I presented to the camera. Although psychologists might have their own opinions on this, my initial rationale (as Adam the teacher) was that holding the remote control

allowed me to make changes to the camera position and volume easily without disappearing from the screen on which the children were watching me. I would go even further and say that it reduced my nervousness by helping me to feel more in control. A second observation was that I kept on stroking and straightening my tie at random intervals throughout the video conferences. On every occasion that this happened, I was able to see myself in the picture-in-picture image that appeared in the bottom corner of the screen. As such, perhaps this was related to self-image. In the same way that one might straighten their tie in front of a mirror, one could use the live video feed to do the same thing. This action did not appear to distract the children and there was no evidence to suggest that they had even noticed it was happening. The final movement that occurred constantly throughout many of the video conferences, both when I was presenting and when I was listening, was me subtly bouncing up and down on the spot using my tip-toes. Having considered the many meanings of this type of movement, such as being impatient and trying to make myself taller, I have still yet to settle on any that would make sense of what I observed in this study.

In addition to the body language that has been discussed, there were other forms of non-verbal communication that were observed. The first was that I frequently looked at my watch and showed the classroom clock to the camera whilst the children were working. The second observation relates to the colours used in the video conferences. On occasion, I wore a similar colour to my background and so I was not easily visible to the children through the camera. The same was true for resources that were a similar colour to other resources or to the background and these too were problematic. The most clear and visible combination observed in the video recordings was that of strong dark colours for the presenter and the resources against a lighter background, in this case a whiteboard.

## 5.3 Skill Development

The final part of this chapter concentrates on the skills that the children have developed over the course of video conferences. As was stated at the beginning of this chapter, it is the micro-strategies associated with skill development that are being considered here and the best place to begin is to discuss the skills that the children have developed throughout their involvement in this study. It should also be made clear here that this discussion about the development of skills encapsulates my observations and as such are from my perspective.

The skills being referred to here can be broken down into two distinct areas. The first is mathematical skills and concepts, for example mental arithmetic, properties of shape and the use of logic. The second is interpersonal skills, for example communication, leadership and team working. There will also be some discussion about the children's use of mathematical language and, in particular, consideration will be given to how this has developed over time.

I will first consider the mathematical terminology that was used by the children when they were presenting their solutions to the camera or asking questions through the technology. There may be many interpretations of what is meant by 'mathematical terminology', but in the context of this study this broadly refers to words that the children would not normally use in a non-mathematical context. For example, words such as *factor*, *prime*, *perimeter*, *quotient*, *conjecture* and *Cartesian* would be considered mathematical terminology, but numbers were not. A complete list of the mathematical terminology used by the children is included in appendix two.

In some instances, I provided the children with a definition during the instruction phase of a mathematical task. On other occasions, I asked the children to tell me the definition of a particular word. The video data shows that if a word was new to the children or if previous activities had overrun, then I provided a definition. However, on those instances when the children should have

already known the word and there was plenty of time left, then I asked the children for a definition. The children often made use of any new mathematical words when presenting their solutions and they did sometimes ask about the meaning of words that had not been explained. A good example of this was the word *quotient*, which appeared in video conference 11. Although I defined the word quotient in the first video conference that day, the children still asked me to explain it as they were not sure of the meaning. In the second video conference that day, I provided a slightly more detailed definition to the children and this was included as part of the instruction phase. This time the children understood immediately what the word meant and no further clarification was needed.

Video Conference 11a -

"The quotient is the answer you get when you divide two numbers."

Video Conference 11b -

"Just like the *product* is the answer you get when you multiply two numbers together, the *quotient* is the answer you get when you divide two numbers."

In order to describe and analyse the mathematical terminology being used by the children, a tally chart was constructed from observing the video data. The chart recorded any mathematical words that the children used and the results are presented below in the form of a bar chart. Initially, there was some discussion about whether or not the number of schools participating in the video conference should be taken into consideration, since it could be argued that more endpoints might use more mathematical terminology. However, the video data showed this was not the case as when there were fewer schools participating, the children had more time to participate.

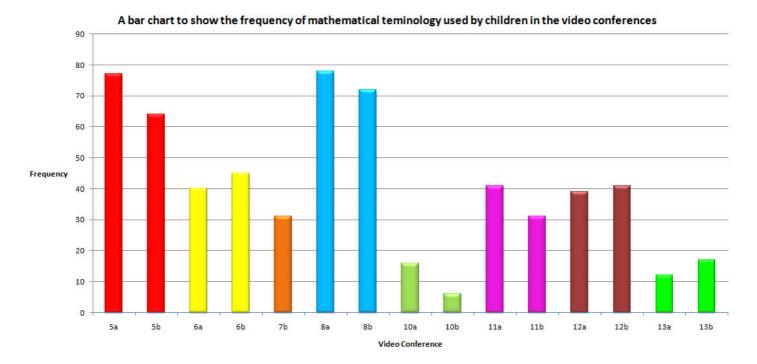


Fig. 23 – Bar chart of the frequency of mathematical terminology used per video conference

On the bar chart above, bars that are the same colour are based on the same lesson plan delivered to the two separate groups of children. It can be seen from the chart that the frequency of mathematical terminology being used might be related to the topic of the video conference, since similar conferences had similar frequencies. This is, of course, purely speculative and further research would be required to establish whether any such connection exists. However, given that this data suggests that there may be a link, I will take a moment to briefly look at this in more detail. In particular, I would like to order the sessions in a list from those with a high frequency of mathematical terminology being used by the children down to those with a low frequency. To achieve this I will take the mean average frequency of any sessions that were repeated (i.e. the same colour on the bar chart) and then list them in order in the table below.

Video Conference	Mean Average Frequency	Topic of Video Conference				
8	75	Squares and Rectangles				
5	70.5	Factors and Multiples				
6	42.5	Strategy Games				
12	40	Problem Solving				
11	36	Number Magic				
7	31	Milk and Chess				
13	14.5	Strategy Games				
10	11	Co-ordinates				

Table 3 – Mean average frequency of mathematical terminology used per video conference

Whilst there may be a link between the frequency of mathematical terminology being used by the children and the focus of the session, the two video conferences related to strategy games would be evidence to the contrary. The first pair of video conferences on strategy games had a mean average frequency that was almost three times as large as the second pair of video conferences on strategy games. The table and the graph also show that there is no obvious increase or decrease in the frequency of mathematical language being used over time. As such, it would appear from looking at this data that such a connection does not exist, but as explained earlier, further research in this area would be necessary to draw any firm conclusions.

Another avenue for further research might be to establish whether there is any link between the mood of the teacher and the quality of learning experienced by the children. Looking in my diary reveals that on the day of video conference eight it was Comic Relief and the children were dressed up in their own clothes and wearing red noses. There were some children off-task, perhaps due to the excitement of the day, but overall they performed well in tackling the mathematics. There were also some technical minor issues with controlling the camera at Angelford School due to an apparent problem with batteries in the remote control. Video conference five had only Benefactors School during the first conference and all schools during the second conference. This was the first pair of video conferences that had been successfully recorded following the technical issues of video

conferences one, two and three. At the end of the conferences, I wrote in my diary that I was "really pleased" and happy that both video conferences were "recorded successfully". This could indeed suggest that my mood was better than usual during video conferences five and eight, both of which incidentally had the highest frequencies of mathematical terminology from the children.

Now let us consider the two pairs of video conferences with the lowest frequencies. Video conference ten was the first session after the Easter holidays. A number of changes to the regular structure of the video conferences occurred during this session. The theme tune was changed from BBC Athletics to The Crystal maze; Countdown was replaced with Who wants to be a Millionaire; a request was made for the ICT technician to change the screen layout using the JVCS booking service. An indication of my mood on this day could be taken from my diary again about the probability of the much needed technical modifications occurring, "I don't hold out much hope for any change". Although the children did well in tackling the mathematics, it took them some time to get used to using the equipment again. One student commented that I was wearing a nice shirt. In both conferences on this day, I ran out of time and was not able to deliver the full lesson as planned. In video conference 13, my diary shows that I am unhappy about two specific issues. The first was that the screen layout changed unexpectedly and I was not happy with how it looked. The second was that I had facilitated a swap between Angelford School and Benefactors School to help with timetabling issues at Angelford School. This was difficult to arrange and I had to call in a favour at Benefactors School to make this possible. As such, I was not particularly pleased when Angelford School failed to join the video conference. In my diary I wrote, "I was slightly annoyed that I had arranged for Angelford to swap with Benefactors".

Again, there is not enough data or evidence in the scope of this study to make any claims. Furthermore, the data was not coded to consider the mood of the teacher and this would be crucial if such a link was to be established. As such, whilst I could speculatively suggest that there might be

a link between the mood of the teacher and the learning experience that the children have, this claim would only be strengthened or weakened through further research.

The mathematical concepts that the children were working with during the video conferences were wide ranging. Sometimes, these concepts were introduced by me for the children to think about and other times, the concepts came about by me correcting misconceptions that the children had. For example, there were two misconceptions during video conference five; all odd numbers only have two factors; all numbers that are consecutive to multiples of six are prime. When such misconceptions occurred, my usual method for dealing with them was to give the children a counter-example to consider. This was a useful approach, since it backed up the concept that only one counter-example is needed to show that a statement is false, whilst proof is required to show that a statement is true. This concept of proof and counter-examples was then formally used in video conference 11 when the children had five mathematical statements and had to decide whether these were true or false.

Sometimes, the mathematical concepts formed a fundamental part of the problem. For example, one of the activities in video conference eight asked the children to decide "Is a square a rectangle?". One or two children had already grasped the idea that a square is a special case of a rectangle, with one child saying "a rectangle is a family of shapes and a square is a member of that family". The majority of the children had not considered this before and it took them some time to grasp this concept. However, once they understood the concept, it was clear that some of them felt a sense of achievement. Other mathematical concepts covered within these video conferences are included in the list below, although this is not an exhaustive list.

- the correct use of brackets in calculations
- the difference between combinations and permutations
- maximisation of area using a fixed perimeter
- properties of odd and even numbers
- logical thinking for developing strategy
- the difference between rotation symmetry and reflection symmetry
- properties of prime numbers
- the idea that problems can have multiple solutions
- trial and improvement (although the children referred to this as trial and error)

In relation to the children's mental arithmetic, *Countdown* is perhaps the best mechanism I have for considering whether this has improved or not. This shows that over time the children's solutions generally contained fewer mistakes. However, even if it was possible to demonstrate an improvement in mental arithmetic using this data, it would be impossible to say whether this was a result of the mathematics they were using in the video conferences or a result of their natural progression as they move through school, prepare for their key stage two SATs and academically and personally mature.

## 5.4 Discussion

I would like to begin this discussion by reflecting on the cyclic model for video conferencing presented towards the beginning of this chapter and to consider how this compares to teachers providing guidance in the traditional classroom environment. In order to make this comparison, we must consider the features of a mathematical problem solving lesson. Such a lesson would normally involve children 'specialising' and 'generalising' (Mason, 1985, p109). That is, the children would discover that a particular mathematical result holds for one or more specific sets of circumstances

and they would then set about proving that it holds for a wider set of circumstances. Specialising and generalising is represented in the above model in that the children's initial explanation of a solution was usually a specialised solution and then the extension task represented a move towards generalising their solution. The traditional classroom model also involves three stages of the children justifying their solutions; 'convince yourself, convince a friend, convince an enemy' (Mason, 1985 p48). This is again represented in the video conferencing model. The key difference, however, is that the initial two stages of convincing yourself and convincing a friend take place away from the camera, whilst the final stage of convincing an 'enemy' (i.e. Adam the teacher) takes place in front of the camera.

A second difference between the classroom model and the video conferencing model is the point at which teacher intervention takes place. In the classroom, teachers can more easily monitor the progress of the children and intervene at key moments, which they deem to be the most appropriate times to provide some guidance for the children. In the video conferencing environment, the teacher cannot monitor the progress of the children as easily and it is the children themselves who effectively decide when such teacher interventions take place.

The final difference between the two models is the pressure of time. In the classroom, it is fair to say that the pace of problem solving lessons is generally slow since it is about exploring new ideas and mathematical concepts. However, in this study, the pace was quicker in the video conferencing environment. That is, the activities changed more frequently and this was perhaps reflective of my inherent concerns about remotely maintaining control of the children's behaviour.

Below is an extract from a video conference, which shows how the cyclic model can look in practice.

Additional commentary is provided to make the links between the extract and the flowchart as clear as possible.

## Extract from video conference 6 (traffic lights)

Fieldhaven:

The children explain their solution...

We think it's best to go in the middle because all the opponent can

do is change it to orange.

Closed questions are asked to clarify the solution...

Adam: So you think that you should place a red counter in the middle?

Fieldhaven: Yes.

The teacher asks questions to help the children refine their current solution. These should ideally be open questions, but often they are closed as with the second question here.

Adam: Why do you say they can only change it into an orange?

Fieldhaven: If they put it [a counter] anywhere else then you've won.

Adam: Okay. Does that mean it's better to go first or second?

Fieldhaven: First.

The teacher asks about further solutions

Adam: Is there anything else that you've discovered?

The cycle begins again with the children explaining another solution.

Fieldhaven: If you start with red in the corner, and they swap to orange, you can

swap to green.

The teacher asks questions to help the children refine their current solution. It should be noted here that the confirmation stage of the model has been omitted because it is clear that the children and the teacher are already in agreement about the interpretation

Adam: So is this a winning strategy is it?

Fieldhaven: Yes.

Adam: Have you tried it out?

Fieldhaven: Yes.

Adam: And does it work?

Fieldhaven: Yes.

The teacher sets an extension task for the children to work on and gives them more time to think about their

existing solutions.

of the solution being

discussed.

Adam: Try the winning strategy you have developed on somebody else [in

your school] to see if they can beat you.

Fieldhaven: Okay

Adam: Also think about whether it is easier to get three red, three orange or

three green counters.

It should be noted here that 'Fieldhaven' represents the words of more than one of the children in this school and the flowchart was produced by considering all of the recorded video conferences. As such, individual interactions, such as this one, will not always follow the flowchart exactly.

The use of PowerPoint slides was a key factor in the delivery of the video conferences in this study, yet little thought was given to the impact that these slides would have on teaching and learning. Qvist (2007, p1) makes the point that PowerPoint slides are used in thousands of classrooms all over the world every day, which raises the question, "Do PowerPoint slides support learning?". It is true that PowerPoint slides can help presenters to organise themselves (Qvist, 2007, p4), but it is argued by Tufte (2003, p4) that this can also bring with it much unnecessary "PowerPoint Phluff", such as automatic hierarchy and inappropriate data presentation. In particular, Tufte disagrees with reading aloud from PowerPoint slides and suggests that they should only be used to display images / graphics that cannot be reproduced as printed handouts (Tufte, 2003, p24). He further argues that the core ideas of teaching are explanation, reasoning, finding things out, questioning, content and credible authority, which he claims are contrary to the "market-pitch approach" of PowerPoint (Tufte, 2003, p13). In response to Tufte's criticisms, supporters of the software would argue that whilst it is often misused, it should be recognised that PowerPoint is a medium rather than a method and that it can be used effectively with effective instructional methods (Atkinson, 2004, p2). This allows us to draw an interesting analogy with video conferencing, which itself can be considered as either a medium or a method. Given that the answer to the earlier question about whether PowerPoint supports learning is arguably that it can if the correct teaching strategies are used, then it could further be argued that the same is true for video conferencing.

In this study, PowerPoint was used to display both textual and graphical information and made use of built in features such as sound effects and motion paths to emphasise key points. Some have argued that using graphics supported by brief text can enhance learning (Fox et. al., 2004, p6) and we know

that Tufte is in favour of using visual materials (Tufte, 2003, p12). The children interviewed in this study all commented positively on this use of PowerPoint, although one child did make the point that it was sometimes difficult to read the PowerPoint slide and listen to what was being said simultaneously. When asked why, the child said that it was because he could not see the person who was talking (i.e. Adam the teacher) and he could not concentrate on two things at once. This is an interesting observation, since it subscribes to the idea that only a limited number of cognitive processes can occur at any one time and too much multimedia input could result in cognition overload (Qvist, 2007, p5). This is referred to in the literature as Cognitive Load Theory and writers provide guidelines to assist in the presentation of information in a manner that encourages learner activities that optimise intellectual performance (Kirschner, 2002, p1). The central idea of this theory is that there is a limited working memory made of several channels. Information is processed through these channels and connected to an unlimited long term memory (Kirschner, 2002, p3). In order to optimise learning, the channels should not be overloaded with information; rather they should process limited information from multiple sources in different forms. For example, Patty (2007) suggests that speaking to a diagram is effective since it presents information in different forms, yet speaking to the same words that are written is not effective since it uses two channels to present identical information, which could have be done more efficiently with only one channel.

Reflecting on this, it is perhaps worth considering Cognitive Load Theory in the context of video conferencing. There is arguably as much information being presented as there would be in a face-to-face environment, but the information can only be presented on two channels simultaneously, namely audio and visual. A feasible alternative would have been to use chroma-key technology, which would allow the presenter to appear in front of the PowerPoint slides in the same way that a television weather forecaster would appear in front of their map. This is demonstrated in figure 24 below and it could be argued that this now opens a third channel, since there is an additional visual channel.

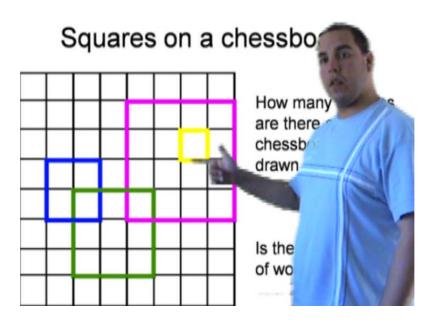


Fig. 24 - A demonstration of chroma-key technology to show both PowerPoint and the teacher

The use of chroma-key technology in video conferencing is an area in which little research has been done and based on the discussion above, it is not clear whether it would increase or reduce the cognitive load on the participants. On the one hand, it could be argued that the multiple sources of information on the same screen would increase the cognitive load since more information needs to be processed. On the other hand, it could be argued that the different forms of information (e.g. body language and imagery) complement each other, resulting in a reduction in the cognitive load. This latter result is described by some as the split-attention effect and it is said to be effective in avoiding cognition overload (Tabbers et. al, 2004, p72).

In comparing the load that might be added by various type of multimedia, it might be helpful to consider the old adage that a picture is worth a thousand words. Indeed, some would argue that this does not go far enough (Wellington and Osborne, 2001, p6). Either way, the point is clear that images are arguably richer than words. Building on this premise, it could further be argued that

video is richer still, thus making it easier to create a cognition overload. For this reason, it is perhaps crucial that Cognitive Load Theory should be considered in a study about video conferencing.

The factors contributing to cognitive load are the learner, the task, the environment and the interactions between the learner and the task (Kirschner, 2002, p4). However, in considering the potential consequences of chroma-key technology to display both the presenter's body language and the PowerPoint slides, it is necessary to consider what proportion of body language will be viewable to the participants. More specifically, I would argue that in video conferencing the interaction between remote sites is an additional factor of cognitive load that needs to be considered. One needs to decide whether it is more important for the students to be able to see the teacher's facial expressions or their overall body language as both are not possible within the standard constraints of video conferencing. Whilst this might appear to problematic, it could be argued that the teacher now has a choice of what the students see, which they would not generally have in the traditional classroom environment, and this is perhaps an opportunity.

Although chroma-key was not used in this study, when the children did see me, I chose to show the top half of my body rather than just a talking head. Reflecting on this decision, it could be argued that this allowed me to more easily express my identity through both the clothes I chose to wear and my use of body language (Suler, 2002, p459). Indeed, there were a small number of occasions on which the children commented on my choice of tie for example. It was perhaps not so easy for the children to recreate their identity in the same way since they were constrained to wearing school uniforms, although they did take the opportunity to express themselves on those days when they were allowed to wear their own clothes, such as Comic Relief.

If there was any doubt about the importance of using body language in virtual environments, one could consider the extensive use of emoticons in text-based environments (Redfern and Naughton,

2002, p204) and avatars in gaming environments. Perhaps the equivalent emotions in a video conferencing environment are expressed more directly through eye contact, facial expressions and through body language.

## **Summary**

This chapter considered breaking down each mathematical task within a video conference into the two key chronological sections of instruction and guidance. The instruction phase consisted of outlining the mathematical task that the children needed to solve and mostly involved my voice talking over animated PowerPoint slides. However, another important aspect of this phase was that the teacher ensured the children had enough knowledge to tackle the task. This was achieved by asking questions or reminding the children about key mathematical concepts and processes they might need to use. The instruction and guidance was cyclic in nature and consisted of interaction between the children and the teacher with the aim of refining the solutions that the children had already discovered.

This chapter discussed whether video conferencing alters the nature of teaching and its impact on monitoring and intervention in comparison with face-to-face classroom teaching. The use of PowerPoint as a tool for learning was considered since this formed a central part of the delivery for the material in this study. Whilst there were some harsh critics of this software, the discussion suggested that that PowerPoint could be effective if used as a visual aid. However, there was some disagreement in respect of whether the learners' cognitive load would increase or decrease as a result. The use of non-verbal cues including body language and eye contact were argued to be of particular importance and a chroma-key solution that would allow both body language and mathematical content to be displayed on the same screen was presented.

#### **CHAPTER 6 – COMPENSATION TEACHING STRATEGIES**

"When things go wrong, don't go wrong with them"

Doyle Brunson

This chapter is about what strategies were employed when things did not go as planned. The chapter is broken down into four sub-chapters, each of which will discuss a different set of compensation strategies. The first sub-chapter will consider the various issues that can arise in relation to video and audio. Particular attention will be given to the problems associated with recording video conferences and the lack of technical support available to assist with this. Issues such as not receiving any audio or experiencing blockiness on the screen will be described along with the strategies used to resolve these issues. Furthermore, consideration will be given to the importance of the physical location of the room that was used for delivering video conferences and the impact of background noises will be described. The second sub-chapter will discuss concerns about connectivity, which prevented endpoints from successfully transmitting and receiving video and audio data. The role of JVCS will be described and some of the child protection safeguards specific to video conferencing are considered.

The third sub-chapter will describe the mathematical extension tasks that are set for the children and describes what happened when the children did not understand what they were being asked to do or if they got stuck and could not progress any further. Whilst the setting of mathematical extension tasks is a teaching strategy, it should be made clear that this sub-chapter has a wider context. That is, it also encompasses strategies arising from the setting of mathematical extension tasks. The final sub-chapter discusses the findings in the context of the wider literature, in particular technological determinism.

#### 6.1 Video and Audio Issues

This sub-chapter discusses the technical concerns that affected either the video or the audio during the delivery of these sessions. A full description of each of the issues and the compensation strategies used to resolve these issues is included, with some consideration given as to whether the strategies used were appropriate and effective.

I would first of all like to consider the issues involved with recording these video conferences in relation to both teaching strategies and the research analysis. However, before beginning this description, it is appropriate to justify the need to focus on the technological problems that occurred. In the traditional classroom, technology is sometimes heavily relied upon to deliver high quality lessons. Technical problems can impact on the delivery, and hence the quality, of these lessons in that the number of strategies available to the teacher may be reduced. Similar consequences could occur in a video conferencing environment, although it could be argued that the impact on teaching and learning will be more significant since the environment was more technologically rich to begin with. The point is that technological failures can affect the teaching strategies used and it is primarily for this reason that they are considered in this chapter.

During the pilot phase of this project, the sessions were recorded by connecting a composite video/audio lead from the video conferencing equipment to a hard disk video camera. This saved the recorded sessions in .mpeg format, which is suitable for editing on a PC and is easy to convert to DVD if required. There were no issues with recording during the pilot phase of this project and so I was confident that there would be no issues during the main data collection phase. However, there were significant recording problems that were not anticipated in advance, which caused disruption in the early stages of collecting the data. When I attempted to set up the recording equipment for the first session, no signal was being received by the video camera. I asked the technical team at Osborne Road Secondary School for assistance. I was informed that the video/audio composite lead

had probably been damaged over the Christmas vacation, since it had been working at the end of the Autumn term, but was not working for the first session at the beginning of the Spring term. I was further informed that there were no spare leads and so no recording could take place this week. I was not satisfied with this outcome, but as the beginning of the first session was imminent, I had no choice but to continue without recording. I did make some notes about the first two sessions in my diary, but in comparison to the richness of the lost video data, this was far from satisfactory.

Having spoken at length with technical team at Osborne Road Secondary School during the week, it became clear that the recording issue involved more than just a problem with the composite video/audio lead. I was able to purchase a replacement lead in advance of the second set of video conferences, but I experienced the same issues as described above in that the video camera was not receiving any signal. The technical team advised me that a 'switch' of some kind was needed to record the sessions and that this had to be ordered. I was informed that this 'switch' would convert the video and audio data so that it could be recorded directly onto a laptop as the problem might be with the video camera itself. The switch had not arrived in time for the second conference and despite trying other video cameras, the issue of no signal being received remained a problem. I did attempt to record the sessions in the second week by literally recording the screen with the video camera. However, the audio was difficult to hear because of background noises and the video quality was too poor to make it of any use at all. This was four video conferences (from the first two weeks) that I had not been able to record.

At this stage, I spoke with the Deputy Headteacher about my concerns and I was assured that the problems would be resolved in time for the next session. Indeed, the Deputy Headteacher had asked the technical team at the school to make this a priority. I was pleased when the sessions in week three did record successfully, but my joy was short-lived. When watching the video data back, the video quality was good and the children's audio quality was good, but the recording had failed to

capture any audio from me. This video data was of limited use for the description and analysis in this project. When I approached the technical team about this, I was told that there was nothing further they could do as they had a whole school to look after and that helping teachers in the classroom was a priority over recording issues related to educational research. This is an understandable view, although I would argue that such research would ultimately benefit teachers in the classroom. At this stage of the project I was feeling unsupported as both a practitioner and as a researcher and I was frustrated with the technical difficulties I was experiencing. I would say that this was the most challenging part of the research project for me and the point at which I was thinking it might not be possible to continue with this project without the missing video data. Indeed, I am not a technical expert and I had no idea how I was going to resolve these issues.

Given that the technical team at Osborne Road Secondary School were no longer able to help me to resolve these recording issues, I spoke at length with the technical manager from the Local Authority. He was able to provide me with the technical manual for the Polycom unit that I was using, but stated that he too was unsure why the recording was not working. I also spoke with a technician supporting the Motivate project, who thought the issue might be to do with a setting inside the Polycom unit. However, he was not able to help me any further than this. I needed some way to add my audio to the existing video and audio that was being successfully captured and recorded. My solution involved obtaining a separate microphone and mixing the audio from the Polycom unit with my own audio using a mixing desk. I then merged the newly combined audio signal with the video signal from the Polycom unit through a DVD recorder. This allowed me to record the sessions directly onto DVD. A separate television screen was attached to the recorder so that I could monitor the recording during the sessions and address any problems immediately. One of the downsides to this approach was that the DVDs then needed to be ripped using *Magic DVD Ripper* software to allow for editing on a PC. This was time consuming, but acceptable given the circumstances. Figure 25 below shows a revised configuration of the room that I was delivering the sessions from to allow

both recording and video conferencing to occur simultaneously. The diagram is colour coded such that the equipment related to the video conferencing is coloured blue and the equipment related to recording the sessions is coloured green. Other equipment is coloured yellow. It should be noted that this diagram is slightly different to the original configuration for this endpoint as shown in figure five in chapter two.

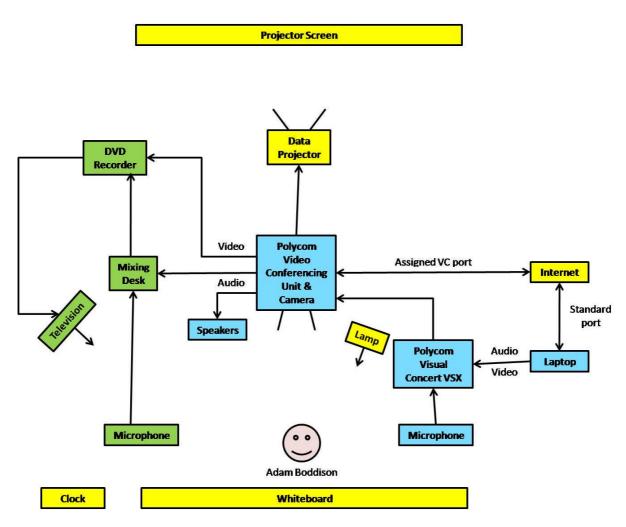


Fig. 25 – The studio endpoint (revised recording configuration)

Operating the recording equipment, the video conferencing equipment and delivering the sessions was challenging, but achievable. There are clear drawbacks to such a 'one-man show' approach, particularly when technical problems are encountered. However, it could be argued that this approach gives you more control over the sessions.

This new approach to resolving the recording issues worked well and there were relatively few recording issues from this point onwards. In what should have been week four for the video conferencing sessions, there was a problem with flooding due to excessive snow and many primary schools in the area were closed. The result was that the sessions had to be cancelled. However, this did give me the opportunity to fully test the new recording solution with a couple of teachers from the primary schools at two different end points. The recording test was completely successful. The first video conference of week seven did not record due to a damaged DVD. The video conferences in week nine were cancelled due to an internet issue, which is discussed in more detail later in this chapter. The only other issue related to recording was that occasionally some of the DVDs could not be ripped and would only play on the DVD recorder. This video data had to be transferred from the recorder to a video camera, which resulted in a small loss of both video and audio quality. However, the data was still good enough for inclusion in the discussion and analysis. In total, 15 video conferences were successfully recorded with good quality video and audio from the 22 video conferences that took place altogether. This means that the video data used for the analysis in this project captured 68% of sessions. However, it is worth reminding the reader that both the children and I kept a diary, and as such the missing video data is not as problematic as it might at first appear.

It could be argued that audio issues are of more concern than video issues when video conferencing, since temporarily losing video can be worked around more easily than temporarily losing audio. One of the audio issues in this project was related to the group of children that were being taught in the same room as the endpoint at Eastport School. When the children involved with the video conferencing sessions were trying to present a solution to one of the mathematical tasks, there was the risk that the teacher in the room with the endpoint would also be talking to his group at the same time. This happened several times and the result was that the microphone would pick up the teacher's voice more the children's voices making it particularly difficult to hear the children's solution. Similarly, it was difficult for the children to hear me if the teacher was talking as we would

then both be talking at the same time. There was very little that I could do about this situation, since Eastport School did not have any other rooms to relocate either of these two groups. The choice to be made here was that this endpoint either operated in this way or it did not operate at all. It was possible to work through this issue and on those occasions when hearing the audio was a problem, these sentences were repeated. Ultimately, I decided not to discuss this issue further with Eastport School as it did not appear to cause concern for any of the children at the other schools. I was also of the opinion that all of the schools involved had their own individual set of circumstances that needed to be catered for and that this was something I should try to support whenever possible.

There were some occasions when the children could see me, but could not hear what I was saying. This was not usually a connectivity issue, but was often a problem with the speakers at the endpoint experiencing problems. Typically the speakers were not plugged in, the volume was not turned up or the speakers were not switched on. This was a problem because the children did think it was connectivity issue and so they did not realise that their microphone was not muted and everybody else in the conference could hear them talking. The second video conference of week 12 was a good example of this issue.

"Today's session started with a problem, since the children at Benefactors could not hear me (although I could hear them). I wanted to get the other groups started and then to deal with these sound problems afterwards. However, this was difficult as I couldn't easily communicate to Benefactors what my plan was and the children kept shouting out, "we still can't hear you". In the end, I put up the *five quick problems* for Eastport and wrote a message on my whiteboard for Benefactors asking them to turn on their speakers, which I believed was likely to be the cause of their problems. They replied that their speakers

were already switched on. In the end, the children decided to get some help from their class teacher, who is also the ICT co-ordinator."

Extract from Adam Boddison's Diary

The strategy of writing messages to the children was usually my first approach in trying to tackle this issue when it occurred. The messages would normally suggest that children switch on their speakers or turn up the volume and mostly this would resolve the issues. However, as in the extract above, sometimes the issues were more complicated and local technical support was required. In the third week of the video conferences, the children at Angelford experienced an audio issue similar to what is described above. In fact, they did not have their television switched on and so they did not know that their endpoint was live. That is, the children at Angelford were not seeing any video or hearing any audio, but everybody else in the conference was clearly receiving their transmitted video and audio. The messaging system described above is useless in this situation and so the strategy here was to telephone the school and inform them of the situation. Whilst waiting for the school to take the appropriate action, I tried to deliver the instruction phase of the *Nine Colours* problem to the other children in the video conference. However, my efforts were hampered because the children at Angelford were unknowingly talking over me and making it difficult to hear me. Indeed, one child was spinning the live microphone in his hands at the same time as explaining to the other children how sensitive the microphone was.

This issue of the sensitivity of the microphones is worth further discussion here. On numerous occasions, the children handled the live microphones in some way or they inadvertently knocked into them with objects that were on the table. The result was a loud thudding sound emitting from the speakers at other endpoints. The difficulty here was that the children did not hear the loud sounds themselves and so they were often not aware that there was a problem. Occasionally, the children would forget to put their microphone onto mute when they were not presenting. This resulted in

the children at the offending endpoint inadvertently talking over the children at other endpoints. Also, the video conferencing technology is designed to automatically show on screen the endpoint emitting the maximum audio signal, which resulted in the video switching between the offending endpoint and the endpoint with the children trying to present their solution. The most effective way to resolve such a situation is to remind the children at the offending endpoint to mute their microphone. The argument against this is that it disturbs the children who are presenting, but I would say that they are already being disturbed and that this intervention actually minimises the disturbance.

The room used for delivering these sessions at Osborne Road Secondary School was located next to the children's toilets. This was problematic because the hand drier in these toilets was very loud and affected the audio conditions in the room I was using. The problem was compounded since the timing of the second session coincided with the break time of Osborne Road Secondary School. To tackle this problem, I first talked to the school's maintenance team, but was told there was no way to make the hand drier function more quietly. I put up signs asking students to use other toilets, which helped a little, but the problem was still causing significant disruption and the hand drier could be heard on the recordings of the sessions. In the end, I had no option but to turn the hand drier off by the mains and provide paper towels. This was not an ideal solution to the problem, but effective as a short term measure. The key point to make here is that when planning to deliver video conferences, care must be taken to ensure that the venue is as quiet as possible and care should be taken to consider the impact of background noises that would normally not create an issue.

Very occasionally, some children struggled to move their camera with the remote control and this was usually because the batteries had run out. This might seem like a small point, but actually the implications can be significant. The lack of control of the camera meant that the children could not zoom in on their work or mute their microphone; the latter of which we already know can cause

significant problems. In one case, the children at Angelford experienced a loss of battery power in their remote control and so tried to turn the camera manually. This resulted in the camera head being turned more than it should be and hence it was damaged due to some cables becoming detached. These cables were later reattached by a technician from the Local Authority, but at a significant financial cost to the school. My suggestion would be that schools involved with video conferencing ensure they have spare batteries to hand to prevent such situations from occurring and to ensure that any problems do not escalate as they did at Angelford.

In the last chapter, it was stated that I was particularly reliant on using PowerPoint animations to help me in delivering the instruction phase. Occasionally, this was not possible since there were problems in maintaining the connection between my laptop and the video conferencing technology. One way of resolving this was to point the camera directly at the laptop screen. This was helpful as an immediate measure, but it should be noted that the picture quality is poor. If you wish to transmit something big, bold and clear then this approach may be reasonable if the connection fails, but otherwise, this is unsuitable as an alternative. There are two key problems with this approach. Firstly, the refresh rate of the laptop screen causes flickering when the video is transmitted and so it is not comfortable to watch. Secondly, the backlight from the laptop screen often results in bright glow being transmitted making it difficult to see the actual content of the screen. I used this approach only once throughout this project and I experienced both of the problems described above. It is worth noting here that the children's Tandberg units did not have a VGA input for connecting a PC and so they tried to use this approach themselves on occasion. They also experienced the same problems. Reflecting on this issue with the benefit of hindsight, it would seem sensible to have to hand a very low-threshold mathematical task that is easy to explain verbally without the aid of a diagram. This could then be used to buy time to resolve technical issues such as those described above.

Occasionally, there was blockiness affecting the video received from the other endpoints. This happens when the internet traffic is so busy that not all of the video and audio signals can be sent and received successfully. It was described above that in such a situation, the audio is considered to be the priority and some it is the video that suffers in the form of blockiness. This blockiness causes most concern during the instruction phase particularly if I am relying on the use of visual PowerPoint animations to aid my explanation of the task. When the blockiness occurs during the guidance phase, it is usually less disruptive since at this stage I already have an idea of what the children might say and the majority of my guidance is given verbally. This is no real solution to the blockiness issue as it is to a large extent beyond the control of the person delivering the video conferences. However, there are some steps that could be taken to reduce the likelihood of blockiness occurring. Firstly, try to have the session at a time when internet traffic is not likely to be too busy, for example early in the morning. Secondly, ensure the connection speed is appropriate for the technology being used and the local circumstances. For example, if the video conferencing technology being used in a school is capable of transmitting and receiving data at a rate of 1056 kilobytes per second, but the school's internet connection is only able to transmit and receive data at a rate of 768 kilobytes per second, then there is little point in operating the technology at its top speed. This may cause blockiness and perhaps even prevent a successful connection from being made at all.

# **6.2 Connectivity Concerns**

In the context of this study, connectivity concerns relate to issues involving the connection of video conferencing endpoints through the internet. One of the most obvious problems that can occur when using internet-reliant technology is the failure of the local network resulting in no connection to the internet. This problem occurred only once during this project and this was in the ninth week of video conferencing. Upon realising that there was a problem, I immediately contacted the technical team at Osborne Road Secondary School and the technical manager in the local authority. Both responded in the same way by informing me that their primary concern was to get the wider

network up and running again and telling me that there was no way of knowing how long this would take. As a result, these video conferences had to be cancelled.

Some networks have firewalls and other protective software to prevent intruders from hacking in, which could be problematic for video conferencing technology since it requires relatively insecure access in order to operate with ease. Some institutions tackle this issue by having the video conferencing technology located outside of the firewall, which helps to keep the remainder of the network protected. Schools can be particularly challenging environments to set up video conferencing in this respect since there are child protection safeguards in place that prevent using the internet in certain ways. For example, streaming video data is often banned in schools since it is not known what this video data might contain. Such restrictions make it difficult, but not impossible to operate video conferencing technology in schools. Usually, the technical team at the Local Authority will need to be involved to ensure that appropriate access is given and this is indeed what happened in this study, as was described in chapter one.

It is generally considered good practice by regular users of video conferencing technology to establish a connection some time before it is needed. In this study, the connection was made ten minutes before the sessions were due to start. This allowed time to resolve any connectivity concerns as they arose. Such concerns might incorporate the audio being successfully transmitted and received, but a failure in the video resulting in a black screen. Switching off the video conferencing unit and then trying to reconnect sometimes resolved this issue, but more often than not, such problems were not local to the endpoint and were somewhere else on the network. I found that the best way to resolve such issues was to contact the JVCS helpline. They could connect and reconnect endpoints remotely as well as vary the connection speeds as discussed earlier. Sometimes, the problems were related to the endpoint not connecting to incoming calls. In such circumstances, JVCS were able to give me a number to dial out and then once a connection was

established they were able to reconnect my endpoint with the video conference. I ensured that the key contact at each endpoint had the JVCS helpline number in case of any connectivity problems occurring either before or during the sessions.

In the preparations for one of the video conferences, I experienced a connectivity issue which involved the connection being established, but then immediately disconnecting again. This was difficult to resolve for two reasons. Firstly, JVCS were unable to help me since they said the issue was with the endpoint and not with the network and was to do with the configuration of my endpoint. Secondly, all of the children's endpoints had successfully connected and it was only my endpoint that had not. Following the advice of JVCS, I looked through the options on my endpoint to try to discover what the problem might be. This was difficult as there were lots of menus, some of which were completely unfamiliar to me, and I was not sure exactly what I was looking for. After around ten minutes I had managed to resolve the issue, although on reflection I would admit that this was more a case of good luck than knowledge. It transpired that another teacher had unsuccessfully tried to use the video conferencing technology during the week and had changed a number of settings in the process. The setting that was causing the connectivity problems was a change from the H.323 protocol to the H.239 protocol, which needed to be changed back. H.323 allows multimedia communication through IP networks and is particularly well-suited to voice over IP video conferencing. H.239 allows multiple signals to be transmitted from the same endpoint so that, for example, video data and a PowerPoint presentation could be sent simultaneously. This is clearly beneficial, but my understanding is the H.239 protocol only works if the other endpoints in the conference are also using H.239. Since they were not, my endpoint was automatically disconnected whenever I tried to establish a connection. This was all resolved in time to begin delivering the conference as scheduled and is evidence that connecting in advance is a good strategy in relation to delivering a successful video conference.

At this stage, it is appropriate to point out the lack of technical support in primary schools to support the implementation of new technologies such as video conferencing. Small primary schools in particular generally have limited funding and can perhaps only afford to employ a technician to come in for one day per week. In this project, five of the six schools shared the same technician and so it was difficult for him to offer support to everybody during the video conferences. Indeed, he could only physically be at one of the schools at any one time. Over time, this technician did try to help out those schools with connectivity concerns by setting up their equipment for them the night before, for example, and this strategy worked well. However, there were some occasions on which the equipment was inadvertently tampered with by teachers, children or domestic staff.

The final point for discussion in this sub-chapter is in relation to far end camera control. If far end camera control is enabled, then in theory I could control the cameras in other schools remotely. This could be moving the camera around or zooming the camera in and out. This was particularly useful for monitoring the children's progress and for helping them out when they have technical issues that prevent them from operating their own camera. However, JVCS-managed video conferences do not currently allow far end camera control, since they are managing and hosting the conference rather than me with the Osborne Road endpoint. It is possible to manage the conference directly without going through JVCS such that far end camera control is available, but then schools would not be able to access the JVCS support described earlier when experiencing problems. There is clearly a choice to be made here and this will depend on the experience of the users at the various endpoints. My own opinion is that the loss of far end camera control is not ideal, but it does force the children at the endpoints to take more control and ownership of the session. Given the limited technical support available in schools, I believe the JVCS support is essential and I would not feel comfortable about taking this support away from schools.

#### 6.3 Mathematical Extension Tasks

Generally, the mathematical enrichment tasks worked well. This is supported by the fact that I rarely had any need to change the tasks that were listed on my lesson plans, although it should be noted that the order in which the tasks were delivered was sometimes amended. In chapter four, it was stated that the children enjoyed working on these tasks, but in this chapter, I will consider the reasons why these tasks appealed to the children and why some tasks were more successful than others.

The open-ended nature of the mathematical enrichment tasks sometimes resulted in the children approaching the same problem in different ways. One example of this was in the *Sweet Shop* task in video conference 12. To remind the reader of the task, the notes from the lesson plan are included below.

# **Sweet Shop**

Explain that five children went into the sweet shop after school. They looked at the things that cost under 50p. There were choco bars, chews, mini eggs and lollypops.



Some information will be placed on the board and the children will need to find out the cost of each item.

Fig. 26 – Sweet shop lesson plan notes

The children in each group considered the information that they had been given and then used it to work out the price of the individual sweets. However, not all of the groups worked out the same price first; they found the prices out in different orders. This is equivalent to solving a set of

simultaneous equations and each group working out a different unknown first and then using this new information to work out the remaining unknowns. A second example was in the *Block 4* task in video conference five. Again, the notes from the lesson plan are included for reference.

# Block 4

For this task, I will show a pre-prepared animation using the built in features of power-point. The children will begin with a 25-square (as shown) with 4 number cards; 1, 2, 3 and 21.

1	2	3	4	5				
6	7	8	9	10				
11	12	13	14	15				
16	17	18	19	20				
21	22	23	24	25	1	2	3	21

The card can only be placed on a square if the number in that square is a factor or a multiple of the number on the card. Using these rules, the children must try to line the cards up so they make a row, column or diagonal or four cards together. How many winning lines can they find?

Fig. 27 – Block 4 lesson plan notes

In one group, the children decided to first find all of the horizontal solutions they could and then to find all the vertical solutions that they could. In a different group, the children decided that the number 21 card was most difficult to place so this was positioned first. From this card, winning lines were formed in any direction possible. Both groups then modified their own solutions having been through the guidance phase described in the previous chapter and having observed the guidance phase of other schools.

Mathematical enrichment tasks that allow the children to easily approach them in different ways are particularly well suited to the video conferencing environment since this means that the children can learn from each other's solutions. More importantly, it means that when the children struggle with a problem, it will often be at a different time and perhaps with slightly different issue than the children

at the other endpoints. As such, any guidance given by me to one particular group does not prevent the other groups from discovering their own solutions independently. In this study, the nature of the mathematical enrichment tasks meant that there were often multiple approaches and methods that the children could use. However, the children did not always discover these alternative methods and sometimes the children in different schools used the same methods. If it was possible to somehow encourage different groups of children to use alternative methods, then this might be a useful strategy to use in video conferencing. However, no such strategies were used during the video conferences in this project. Indeed, this is a retrospective and reflective thought that did not occur to me at the time of delivering the conferences.

To be clear here, the point is that there was some inherent and predictable unpredictability in how the children approached the mathematics enrichment tasks. This did not need to be addressed using compensation teaching strategies since it was expected. However, compensation teaching strategies may have been helpful for those occasions on which there was unpredictable unpredictability as this was when I had to adapt during this study.

In some instances, I felt that the mathematical enrichment tasks were too difficult for the children and this was usually for one of two different reasons. The first was when the children understood what they needed to do, but they were not sure how to do it. In some cases, this was because some unknown algebra skills were needed to solve the problem further and in other cases it was because the children had used a trial and improvement method and were not sure whether the solution they had was the optimum solution for the problem. Such issues occurred frequently, and more specifically in the following tasks; Fence It, Multiplication Square, Area and Perimeter, Never Prime, Number Rules OK, Nine Colours, Trick or Treat, Consecutive Seven, Special Sums and Products, 8 Queens, Cartesian Puzzle, Ten Hidden Squares, Five Quick Problems. This is an important issue for consideration here since in many cases I could not easily give the children any guidance without

revealing the actual solution to the problem. In observing the video data, the most effective strategy that was used to tackle such a situation involved solving only part of the problem for the children. For example, in *Five Quick Problems* the children had to solve  $[(-1) + (-1)^2]$  and  $[(-1) - (-1)^2]$ . This was difficult because the children did not know the rules about multiplying positive and negative numbers together and had not seen brackets around individual numbers before. To explain these concepts in the context of this problem would require virtually solving the problem for the children. What happened in this instance was that I solved the first part of the problem for the children,  $[(-1) + (-1)^2]$ , explaining my working as I went, and the children were then asked to solve the second part of the problem,  $[(-1) - (-1)^2]$ . This approach was well received by the children and they did successfully manage to put these new mathematical concepts and process into action immediately.

The second reason for a problem being difficult was when the children did not understand at all what the problem was about. That is, at the end of the instruction phase, one or more of the children would say something like "I don't understand" or "I'm not really sure what to do". This did not happen very often and usually a result of an incomplete explanation of the mathematical task on my part. When such difficulties were encountered during the sessions about strategy games, it was because the children were not sure about all of the rules of the game. For example, in *Attack or Defend*, the children were asking questions about whether more than one counter could be taken at the same time and whether counters could 'jump' more than one square during the same turn.

On those occasions when I thought that the mathematical enrichment tasks were not too difficult for the children, there were still times when they either got stuck or falsely claimed that they had solved the problem and had completed the task. In these instances, my response was usually to provide some guidance to help the children get back on track or to extend them further as shown in the guidance model in chapter five. These hints and tips included comments such as "have you tried..." or "have you thought about...". For example, in the *Milk Crates* task in video conference seven, the

children struggled to find a solution for the 6x4 milk crate problem. The children were trying to fit 18 milk bottles into a 6x4 crate such that each row and column contained an even number of milk bottles. My guidance to the children was "have you thought about where the holes should go rather than where the milk bottles should go?" This helped the children at one of the schools to discover a solution and then the children at the other schools based their own solutions on this. With the benefit of hindsight, I have since noticed that a good solution to this problem is to superimpose the 3x3 solution onto the 6x4 problem. To explain, the 3x3 problem involves placing six milk bottles into a 3x3 grid such that each row and column contains an even number. One solution to this problem is shown in figure 28 below.

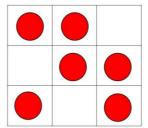


Fig. 28 – Solution to the 3x3 milk crate problem

Superimposing this solution onto the 6x4 grid and supposing that the red spots are now where the spaces are rather than where the milk bottles are solves the 6x4 problem as shown in figure 29 below.

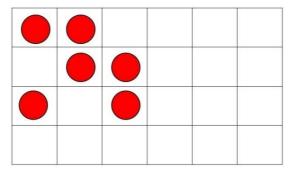


Fig. 29 – Solution to the 6x4 milk crate problem

I did not spot this connection between the two solutions at the time, but if I was using this task again, I would use this as part of the guidance phase to help the children to discover the second solution once they had discovered the first solution. This idea of using a partial solution to guide the children towards discovering a full solution was something that I used on several occasions. These 'hints' had the effect of motivating the children based on the success of the partial solution, which they seemed to take ownership over. On some occasions, the children were very close to discovering a full solution, but had gotten stuck. This provided me with a dilemma; if I helped the children at this stage, I would effectively be telling them the solution and so take away all of the satisfaction and joy that is felt when a problem is solved, but if I did not tell them, then they may not discover the solution at all. My usual response to this situation was to give the children more time to think about their solutions in the hope that they would suddenly discover what they needed to know. However, in practice, this was not a particularly effective strategy, since the children very rarely made this discovery. Occasionally, the children did have a breakthrough and they came up with a solution, but mostly the children did not get any further with completing the task.

It should not be surprising that the children found some of the tasks easier to work on than others without receiving any immediate guidance. That is not to say that the children could always solve these 'easier' problems completely without guidance, but rather that they could begin to attempt to solve these problems straight away. Utilising tasks with this property is particularly useful in a video conferencing environment, since the children are working more independently. This allows the children to begin work on a task and then the guidance phase can begin when the children are uncertain of how to progress further. Ideally, the children will get stuck at different times, thus increasing the efficiency of the delivery of the guidance phase. For example, in *Squares on Chessboard*, the children easily spotted the 64 squares and the one big square and so they were able to access the problem easily. The trickier part of the problem came later when the children had to think about overlapping 2x2 or 3x3 squares. A second example is *Treasure Island*. The children

figured out what was at each of the coordinates very quickly, but then the trickier part of the problem came when trying to identify the location of the buried treasure. It should be noted that the differing pace between groups is such that they often reach the trickier part of these problems at different times. This again helped in terms of improving the efficiency of the delivery of the guidance phase.

The following can be categorised as tasks in which the children were able to make progress very quickly: Make 21, Block 4, Traffic Lights, Os and Xs, Milk Crate Problem, Squares on a Chessboard, Treasure Island, Sweet Shop, Cut Nets, Make 15, Got It. The common feature of these mathematical tasks in relation to the tasks not listed is that the low-threshold, initially discussed in chapter one, is much lower, relative to the other tasks in this project, allowing the children to access these tasks more easily. This is a key point since in the standard classroom environment, the teacher is able to monitor which children are not able to easily access the mathematical problems and to provide them with appropriate further support accordingly. In a video conferencing environment, such monitoring is more difficult and so to compensate for this, the teacher could choose a task with a very lowthreshold. Assuming that the child in the group with the lowest ability is able to access the task, the teacher could be reasonably certain that all of the children are able to access the task. One could argue that the same strategy could be used in the classroom environment. However, this would not be ideal since it unnecessarily limits the choice of task and as described above, any issues can be dealt with relatively easily on a more personalised level. It could further be argued that very lowthreshold tasks are good for increasing confidence since the children are able to make progress quickly. Making a good start on a problem might give children the momentum and motivation to continue to work on tasks when they get more difficult. I would agree with this argument, but would be cautious in the sense that children might be building up a false sense of confidence.

In this study, I observed three specific teaching strategies being used to compensate for the difficulties in relation to intervention and monitoring. The first was to choose a very low-threshold problem that all of the children can immediately begin to solve with relative ease using some existing mathematical knowledge. The second was for me to provide guidance when the children reached a tricky stage to the problem, which helped the children to get closer and closer to finding a solution as was described by the cyclic model of instruction and guidance in chapter five. The third strategy was to choose open-ended tasks that were easy to provide extension work for. Using the *Squares on a Chessboard* for example, having found the number of squares on an 8x8 chessboard, the children were asked how many squares would be on rectangular boards of different given sizes and how many rectangles are on a chessboard.

From chapter four onwards, a common theme has been that strategy games have worked particularly well in this study. It seems appropriate to consider why this might be the case and given the three strategies described above, I will now demonstrate how well strategy games fit within this model. Firstly, the children had to figure out how to play the games and establish some basic ideas such as whether it is best to go first or second. This was the first strategy in action since many strategy games have simple rules, which were equivalent to the teacher to choosing a very low-threshold problem. The children then had to pull these ideas together to develop a strategy (or partial strategy) for winning the game. The children's ideas were then challenged and developed through guidance from the teacher, which was equivalent to the second strategy described above. Finally, the children needed to try their winning strategies out against each other and then develop them further by learning from their opponents. I thought that the idea of developing your own ideas based upon your opponent's ideas was fantastic, since every child automatically had an extension task, which often resulted in unique, yet relevant, solutions.

Having considered some of the positive and negative aspects of the mathematical tasks, it is now worth considering what changes I might make if I was delivering similar sessions again in the future.

## 6.4 Discussion

This chapter was concerned with the compensation strategies used when things did not go to plan and so it is perhaps inevitable, given that this study is about video conferencing technology, that much of the discussion was about the technical issues that arose. It is not a simple task to predict the outcome of using new technology in the classroom, and the only certain outcome is that things will change (Bigum and Rowan, 2004, p216), although it is not possible to be sure what these changes will be and whether the consequences will be good or bad (Pederson, 2001, p63). This uncertainty emphasises the importance of research into the impact of educational technology so that such changes can be analysed with the aim of improving teaching and learning. One of the difficulties associated with research involving educational technology is that due to the rapid advances in technology, studies are often outdated by the time they are completed (Hoyles and Noss, 2006, p324). This is perhaps something that ought to be acknowledged in this discussion since it may be that some of the technical difficulties requiring compensation strategies to be employed are of less importance by the time this research is completed.

In chapter two, the reliability of video conferencing technology was identified as an emerging theme in the existing literature and the evidence presented in this chapter builds on this. In this study, some time was spent dealing with technical difficulties during video conferencing sessions, which might otherwise have been used for teaching and learning. This resulted in a reduction in learning time and echoes the findings of several other studies (Carville and Mitchell, 2000, p44; Knipe and Lee, 2002, p310). Pederson sums this up well when he states that "the handling of technology consumes time intended for the learning process itself" (Pederson, 2001, p63). However, in this study the source of the technical difficulties was rarely due to connectivity issues related to video

conferencing. The majority of technical difficulties occurred at my endpoint and were in fact issues associated with recording the video conferences for the purposes of the research. This adds a new dimension to this discussion, which is that the difficulties of the research itself may have had an impact on the quality of teaching and learning that the students received. A small number of issues were due to incorrect usage of the technology by the children, such as failing to replace the batteries in the remote control or failing to switch on their speakers.

Much of the literature makes it clear that technical support is an essential requirement for ensuring a successful video conference (Freeman, M., 1998, p207; Gill, 2005, p574; Laouenan, 1999, p179, Doggett, 2008, p40). However, this study has demonstrated that the option of running video conferences with limited technical support should not be discounted. In most cases, the children were able to resolve technical difficulties independently or with the support of a teacher. The need to make use of qualified technicians was limited and in many cases such issues were resolved remotely with the support of JVCS. One of the consequences of having no technicians or site facilitators present was that additional pressure was placed on the participants when there were technical difficulties. Given the description of techno-stress that was discussed in chapter two (Mason, 1994, p107) it could be argued that this additional responsibility resulted in an increase of techno-stress for the children. Certainly, in many of those cases where there were audio problems, but the video was connected and recording, there is evidence of the children frantically trying to reconnect the correct cables or running to get help from a teacher, but the wider evidence is limited.

The literature review in chapter two discussed the fact that willingness is needed on the part of teachers to ensure that new educational technology is used effectively in the classroom (Doggett, 2008, p40; Harris, 2002, p454). In this study, it could perhaps be argued that the technology itself encouraged the use of new teaching strategies, since some face-to-face strategies, for example monitoring, cannot be implemented remotely in the same way. Others have argued that a teacher's

enthusiasm for new technology can often drive maverick approaches (Bigum and Rowan, 2004, p214). In order for such "maverick approaches" to be considered, it is a pre-requisite that the technology itself must be available to teachers. However, in schools, there is often a gap between those that do and those that do not have access to new technology and this is defined by some as the "digital divide" (Gunkel, 2003, p499). In the context of this study and the discussion above about technical support, the digital divide is of particular relevance. Better video conferencing systems, improved networks and increased technical support would all perhaps reduce the quantity and impact of technical difficulties. However, the primary schools involved in this study were only just able to participate following a network upgrade and by using the cheapest, middle-end video conferencing systems available to them. On the other hand, lucrative businesses may be able to afford higher quality equipment and improved technical support. This raises the question as to whether the compensation strategies that have been the focus of this chapter are necessary as a consequence of using video conferencing for educational purposes or because of the digital divide between what is realistically available to schools and, for example, lucrative businesses. It may be that the answer is not as binary as the question suggests, but if it is assumed that in general schools do have inferior technology and support in relation to businesses, then the associated increase in technical difficulties may determine to some extent how teaching and learning takes place.

The idea that technology somehow determines the way in which individuals behave is not a new idea, but Jordan (2009, p1) offers some current examples:

"Does electronic voting change the nature of democracy?

Do peer-to-peer file distribution systems fundamentally change the political economy of music?"

In the context of this study, one could perhaps ask whether video conferencing fundamentally changes the nature of teaching and learning. Whilst some believe that in education there is a neutrality associated with technology and its use is largely determined by the user (Bigum and Rowan, 2004, p218), others believe that technology is an impersonal force with its own internal logic and a trajectory that its users must follow (Ceruzzi, 2005, p585). The former belief that technology is just a tool is consistent with social determinism, whilst the latter argument that technology drives change is known as technological determinism.

The term technological determinism was first coined by the American sociologist and economist, Thorstein Veblen, who claimed that technology was the major fundamental cause underlying changes in society (Chandler, 1995, p2). The central idea relates to free will and the argument is that there is diminished human choice and responsibility in controlling technology (Pannabecker, 1991, p45). The key issue for this study is whether video conferencing technology inherently determined the way in which teaching and learning occurred or whether I autonomously shaped and moulded the technology to suit my purpose.

In considering this question, it is worth remembering that as with any educational resource, there are practical constraints that will influence how those resources are used. Reflecting on the data collected, it is feasible that there were some instances in which my teaching was determined by the technology. Two such instances, in which technological determinism may have been observable, are discussed below.

The pace of the video conferencing sessions was quicker than it would have been if I had delivered an equivalent face-to-face session. It is perhaps difficult to argue that video conferencing technology increased the pace of the lessons, but there was a sense that a change in behaviour was suggested by the attributes of the technology. As a result of using video conferencing technology, there were

lengthy periods of time (perhaps 30 minutes of a one-hour session) during which I was not interacting with the children. Throughout these periods, I was able to loosely monitor the progress of the children, but it was uncomfortable for me to allow the children to work independently without any certainty that they were on task. This perhaps reflects my own instinctive style in the traditional classroom, which is to intervene to help keep students on the right track. A consequence of being uncomfortable with my lack of intervention when using video conferencing was the amount of time given to the children to work on tasks was relatively short (about seven or eight minutes) since I wanted an update of what the children had been doing and to have the opportunity to advise them of what to do next. In the traditional classroom environment, I would not have stopped the whole class as regularly for progress updates and here is a strategy determined by the technology, since having a more private one-to-one discussion with a child was not an option through video conferencing.

In relation to questioning, it could be argued that my questions were more 'genuine' in that they were designed to address an information gap. This may appear at first to be an odd statement, but in the traditional classroom environment, it is not uncommon, certainly in my own lessons, that when I do ask for whole class feedback, I already have a clear idea of what the answers are likely to be. Indeed, if I have been walking around the classroom and talking with individuals about their mathematics, then I have a reasonably good idea about the progress and misconceptions that are occurring. I might then ask questions to which I already know the answer in order to help the children in the classroom to reflect on their own work. In the video conferencing environment, walking around is not an option so I did not know what the children had been talking about or working on. As such, when I asked questions about their work, I was asking to genuinely discover what mathematics they had been working on.

The two examples given above are perhaps more determined by the nature of distance learning than the technology itself. However, this is not a simple problem to overcome since video conferencing is inherently a distance learning technology. What can be said is that the technology did suggest a different type of interaction between the participants and myself than would not otherwise have been the case. That is, rather than having relatively unstructured learning conversations, the children and I generally interacted through semi-prepared presentations of mathematical explanations and justifications.

There are some that would argue that by using technology as part of the learning process, students can begin to socially construct the technology to meet their needs (Pannabecker, 1991, p51). Indeed, Pederson (2001, p62) states that viewing technology as being socially constructed might bring the discussion of ICT in schools back to the broader political and pedagogical arena. The use of video conferencing technology in this study was powerful in the sense that it facilitated the process of intellectual exchange between the children and me, albeit in the format of semi-prepared presentations. This is of particular importance since whenever a new educational technology is introduced, care ought to be taken to ensure that reformers do not configure it in such a way that such intellectual exchange becomes impossible (Feenberg, 2001, p83).

Within the field of education, it is widely believed that technology can be used to address a range of pedagogical problems (Pederson, 2001, p61). The key point here is that the technology should be primarily used to address pedagogical problems rather than logistical or financial problems. Reflecting on the motivations for this study that were discussed in chapter one, it was argued that this video conferencing programme would help the children to become more independent as learners. Whilst there is little doubt that the children have become more independent, both individually and within their school groups, care must be taken to identify why this has occurred. For example, it may be a result of careful planning, the organisation of the classes, the distance learning

aspect or the technological aspect of these sessions. In this instance, I would like to offer a plausible explanation that technology plays an intervening role. Had the same programme of sessions been run in a face-to-face format with me leaving the room when students were working on the tasks, the children would not have had to worry about controlling the technology and the presentational aspect of their mathematical findings would have been less important. In essence, I am arguing that the children had to take steps to address the constraints imposed by the video conferencing technology, but that this in itself created the opportunity for the students to become more independent as learners. This example encapsulates some of my broader thinking about video conferencing, which is that some of the constraints have the potential to become opportunities for both teachers and learners if addressed appropriately. Further evidence for my claim that the children became more independent comes from looking at the number of interventions that they made over time. That is, the number of times that the children un-muted their microphone and asked questions about the task when they were working decreased in the later conferences.

For all of the problems that it brings, including expense, demands on space and technical difficulties, teachers are still expected to embrace new technology (Pederson, 2001, p62). The argument from those that are pushing for the new technology to be used is generally one of flexibility and increased opportunities. The term 'flexible' when used within schools increasingly means 'educationally good' for the students, but it seems that little thought has been given to what such flexibility means to teachers in relation to the demands of new technologies (Bigum and Rowan, 2004, p214). In conclusion, it is clear that the argument for the way in which teaching and learning takes place should be built on experience, knowledge and discussion and not just on the more or less accidental qualities of the technology (Pederson, 2001, p64).

### **Summary**

This chapter considered the strategies used when things did not go as planned. When setting mathematical problems for children to solve, the children sometimes did not understand the problem or were unsure of how to approach it. In such circumstances, it was useful for the teacher to solve part of the problem for the children, but to then leave the children themselves to complete the solution. The use of strategy games appears to have worked particularly well in the video conferencing environment. This may be due to the fact that they naturally exhibit the very low-threshold properties described above and they make it relatively easy to provide personalised extension work. However, further research in this area would be helpful in exploring such a connection in more detail.

Recording video conferences was sometimes problematic and there was little in the way of technical support available since such resources tended to be put more directly into supporting practitioners rather than researchers. Throughout this study, I was seen by the school as Adam the researcher and not as Adam the Practitioner who happened to be conducting some research. The result was that I received little support from the technical team at Osborne Road Secondary School. Ultimately, it was necessary for me to tackle the recording issues in person and this eventually worked out well, although some video data was effectively sacrificed during this process. When there were audio issues, but the video was fully functional, messages were sometimes written to help the children resolve their issues. However, on some occasions, there were problems with both video and audio. In such circumstances, it would have been ideal to have technical support at each endpoint in the form of a knowledgeable teacher or a technician. The location of the room used for delivering video conferences was also considered to be an important consideration since background noises that would not ordinarily cause problems may affect the transmitted audio as well as affecting any recordings made for research purposes.

Connectivity concerns were particularly frustrating since they often involved not being able to establish a successful connection between the various endpoints involved in the video conferences. Schools themselves were also deemed to be problematic when it comes to connectivity of video conferencing technology because of firewalls and internet restrictions related to child protection issues. However, these issues are avoidable if the technical team at the Local Authority are aware of what is happening, as was the case in this study. When the networks did fail preventing access to the internet, there was little that could be done to connect the endpoints together and so cancelling the session was sometimes the best and only option. JVCS were able to provide technical support for schools through their dedicated video conferencing helpline, although came at the cost of losing far end camera control. Careful consideration is needed to decide which is more important between JVCS technical support and far end camera control. Based on my experiences of this study, I can say that it was valuable to have the support of JVCS, but I cannot say whether this is the best option since I have no experience of managing or hosting a video conference myself in similar circumstances.

This chapter also included a discussion of technological determinism in the context of video conferencing. That is, it considered whether the technology itself determined the way in which teaching and learning took place or whether there was some degree of autonomy on the part of the teacher. The conclusion of this discussion was that whilst some teaching strategies were determined by the technology, other opportunities for flexibility were created.

#### **CHAPTER 7 – METACOGNITIVE TEACHING STRATEGIES**

"Take care of the beginning and the end will take care of itself"

Grant M. Bright

Before outlining this chapter, it is worth clarifying what is meant by metacognitive teaching In the context of learning, cognition refers to the process of thinking, whilst strategies. metacognition refers to the process of thinking about thinking (Blakey and Spence, 2006). The underpinning idea of the metagognitive process is that the learner becomes conscious of their thinking and so is able to monitor and evaluate their progress with a view to improving their learning. Indeed, one could refer to metacognition as an individual's awareness of his or her cognitive strategies (Flavell, 1979, p909). In the context of teaching, my understanding of metacognition is more difficult to articulate. Based upon Livingston's description of metacognition, it could be argued that any knowledge that is actively used as part of a strategy to meet a cognitive teaching goal can be considered as metacognitive (Livingston, 1997). In the context of this study, a cognitive teaching goal might, for example, refer to thinking about how to ensure all of the children remained on task or thinking about how I could use my experiences from one video conferencing session to improve the learning in the next session. The problem with this description, and perhaps with the descriptions of metacognition more broadly, is that the distinction between cognition and metacognition is not always clear. Indeed, this is not a new problem and has been identified by others (Flavell, 1979, p907; Livingston, 1997). Whilst it is not an ideal solution, for the purposes of this study I have chosen to distinguish metacognitive teaching strategies from cognitive teaching strategies by defining the metacognitive processes as those that occurred when teaching was not taking place. That is, the planning and evaluation that took place outside of the video conferencing sessions.

The first part of this chapter is about the decisions that were made when planning how to deliver the video conferencing sessions to the children. The effectiveness of the mathematical enrichment tasks has already been discussed in chapter six and this will not be repeated again here. However, some time will be spent considering the choice of the themes for the mathematical tasks and the reasons behind these choices with a particular emphasis on those activities that were planned but not delivered. The lesson plans will be scrutinised in detail with a view to establishing how closely I adhered to them during the delivery of the sessions. This will be helpful in establishing which of my decisions were planned and which were spontaneous. The teaching resources that I used are discussed and some thought is given as to whether resources that are considered effective in the standard classroom environment are also effective in a video conferencing environment. Differentiation is a standard classroom tool used for planning high quality personalised lessons, but again, the extent to which such tools are used within a video conferencing environment will be looked at.

The second part of this chapter will consider the technical preparation that took place. This includes my choice of music at various times within the sessions as well as my choice of screen layout. The inclusion of online support mechanisms for the children, such as web applets, is looked at and some thought is given to those ideas that occurred in the planning, but were not put into practice because of the technical difficulties associated with implementing them.

The third part of this chapter will focus on the strategies that were put into place to evaluate the children's learning. The objectives for each video conference will be revisited to establish whether or not they were met. This should prove helpful in determining how effective each individual video conference was and, more importantly, the effectiveness of the sessions overall. The choice to use or not to use various forms of assessment will be considered with a view to ascertaining whether the

children benefited from participating in this study, and if so in what way(s). The chapter will conclude by discussing the findings in the context of the wider literature.

### 7.1 Lesson Planning

The choice of the mathematical activities was discussed briefly in chapter one. To remind the reader, it was stated that the themes for the sessions were defined somewhat arbitrarily since the tasks were discovered in the first instance and then grouped together afterwards. Whilst we already know that the tasks were chosen because of their low threshold – high ceiling properties, it is also worth making it clear that the tasks were designed to cover a range of different curriculum areas. The targeted areas were probability, pattern spotting, number properties, area, perimeter, algebra and coordinates. It was felt that developing skills in these areas would be of most use to the children when they went to secondary school the following year. Reflecting on the project at this stage, I am confident that these curriculum areas did provide both a good focus for the sessions and a wide variety for the children. However, it is worth considering whether the children made sufficient progress in all of these curriculum areas to have made them worthwhile for inclusion. For example, the children looked at the properties of number and were able to practise using prime numbers, factors and multiples in different contexts. This progress was in part because similar number properties appeared in multiple sessions. The same was true for pattern spotting, which featured in sessions one, three and eight. On the contrary, coordinates were only covered once, which was during session ten. The implementation of repeated concepts might be deemed to have provided the children with less variety overall, although on the other hand it could be argued that this helped to embed key mathematical learning points.

At this stage, it may be helpful to discuss the decisions made in relation to the structure of the sessions. Generally, there were three mathematical tasks in each session, which provided the majority of the content and these were usually arranged in ascending order of difficulty. The result

was that the final task in each session was sometimes too difficult to complete within the given time. An alternative would have been to choose tasks that were equally as difficult as each other, but this was not attempted in this study. Reflecting on this, the escalation in the level of difficulty of the tasks worked well in principle, but the tasks became too hard too quickly. For example, in video conference five the children found it difficult to move from *block 4* to *Helen's conjecture* as the latter was much more difficult. The result was that the children failed to find the counter-example needed to disprove the conjecture and quickly went off task. Recordings show the children beginning to play noughts and crosses and to surf the internet.

This idea of setting tasks that increase in difficulty is perhaps helpful in catering for the needs of children with different levels of ability. One might argue that this was unnecessary since these children were similar in ability levels and they were all predicted the same SATs level at Key Stage two. However, I would disagree with such a view since it was clear in this study that some of these children had much stronger mathematical skills in comparison with the others in their group. In general, each group had one or two children that were more advanced than the others and these children were challenged by the harder tasks as was made clear by the comments they wrote in their weekly diaries. I will not discuss these comments in further detail at this stage as they have already been considered in chapter four. However, it would appear that for the participants of this study the predicted SATs levels at Key Stage two do not appear to be a good mechanism for distinguishing between the children's mathematical abilities at the more able end of the spectrum.

Differentiation is another similar standard classroom strategy that is used by teachers to personalise learning. At this stage it is worth reflecting on what forms of differentiation were used in planning and delivering the video conferencing sessions. Differentiation by task is one of the most common forms of differentiation used in the standard mathematics classroom. This involves setting different tasks to children and is usually dependent upon their ability. This form of differentiation was not

used in this study since all of the children were set the same initial task. However, when setting extension work for the children, different tasks were used depending upon how the children coped with the original task. For example, in the *Squares on a Chessboard* activity, one of the extension tasks involved looking at different sized boards, whilst another extension task involved looking at the number of rectangles that could fit on the board rather than the number of squares. The latter of these extension tasks was more difficult than the first and so generally it could be argued that I used differentiation by task for the extension activities. Similar choices for extension were planned for many of the mathematical enrichments tasks, although the irony is that very few were actually set for the children to do. Generally, it is fair to say that I moved on to the next task rather than extending the original task and this appeared to be associated with time constraints.

Differentiation by outcome involves setting the same task to a group of children, but the nature of these tasks is such that they will each produce something different or approach the task in a different way. Such differentiation is not as common in mathematics lessons as it is in arts or humanities based lessons. However, it is clear that the open-ended, mathematical enrichment tasks used in this study were inherently designed to facilitate differentiation by outcome. There is no evidence in this study to suggest that differentiation by outcome was less effective when used through the medium of video conferencing than when used in the standard classroom setting. Indeed, it could be argued that such differentiation is more suitable for video conferencing since I had less ability to monitor and intervene. The result of my lack of intervention was that the children were perhaps more compelled to establish their own approach and direction in completing tasks.

Before moving away from differentiation, it is worth noting that some differentiation in the classroom is designed to address the special educational needs that a child may have. This might include visual or hearing impairment, mobility issues or speech difficulties, and there are many others not included in this list. It would be naive to assume that able children do not have such

difficulties, yet within the teaching profession there are some who only associate special educational needs with lower ability children. Forward planning is required to cater for these needs and this is particularly important when delivering through the medium of video conferencing. For example, if a child has a visual impairment in the traditional classroom environment, resources can be enlarged for them to use, and this might be prepared as late as just before the lesson is actually delivered. However, in a video conferencing environment, extra time must be factored in to either get the adapted resource to the required endpoint or to allow time for the staff at that endpoint to adapt the resource themselves. Such detailed forward planning can clash with the spontaneity of differentiation by outcome. That is, it would be easy to imagine a situation in which a child with special educational needs approaches a task in an unexpected way such that the natural extension task has not been adapted to cater for their needs. In this study, I did not have to worry about such concerns, since the children involved did not have any serious needs. However, this is not something that should be casually overlooked by those planning to deliver similar sessions by video conference in the future.

I would now like to scrutinise the lesson plans in more detail. These lesson plans were different to the standard lesson plans one might see in that the structure was not that of the usual three-part lesson, but one in which the tasks became progressively more difficult, as discussed above. However, there were some similarities such as the list of resources required, the objectives and the detail of the tasks themselves. As part of this research, I considered how well these lesson plans were adhered to. Interestingly, I did not refer to my lesson plans at all whilst delivering these video conferences, which is in contrast to what I would do in the traditional classroom environment. Indeed, when delivering some of the sessions, it was several months since I had actually looked at the lesson plans. This came about because I used the lesson plans to create the PowerPoint presentations that were later used to help deliver the instruction phase. The detail of the tasks, the music and examples were all included in these PowerPoint presentations and as a result, I based my

delivery around the PowerPoint slides and not by considering the original lesson plans. It is worth noting that the extension tasks were rarely included in the PowerPoint presentations. This is perhaps evidence to suggest that my reasons for moving onto new tasks rather than extending the children with the existing tasks were not only a consequence of the time constraints, but perhaps also because I did not have the extension tasks in front of me at the time.

On two occasions, the consequence of not having my lesson plan in front of me resulted in me failing to deliver the task in the way that I had planned. The first of these two incidents occurred in the 11<sup>th</sup> week of video conferencing during the task *Guesswork*. This task was based around the idea that positive integers can be made uniquely by using different combinations of the powers of two. Using this property, it was possible to produce a magical effect. Six cards were presented as shown in figure 30.

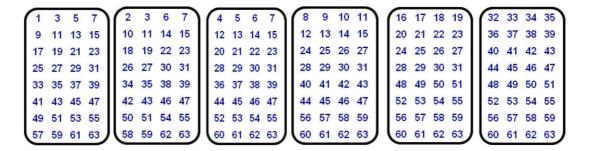


Fig. 30 - Number cards used in the guesswork task

The idea is that I ask a child to choose an integer between 1 and 63, but not to tell me what it is. I then point to each of the cards above and ask the child if their number appears on the card. To find out the child's number, I secretly add up the number in top left-hand corner of every card on which the child's number appears (these numbers are the powers of two). The lesson plan made it clear that I should perform this trick with one child from each school and then give the children five minutes to see if they could figure out how the trick worked. If they could not solve the problem

within this time, I would show them how the trick was done using the number 21 as an example and then ask them to check that this worked for all the other integers.

However, because I was using the PowerPoint presentation as a guide rather than the lesson plan, I ended up just doing the 21 example straight away and then asking the children why they thought this worked. I was disappointed with this, since it spoilt the magic effect that I think the children would have enjoyed and which would have provided some motivation for the children to want to discover the underlying mathematics. To make matters worse, the second incident in which I failed to follow the instructions on my lesson plan was an exact repeat of this in the second video conference on the same day. The diary extracts below sum up my thoughts at the time of these incidents.

"The *guesswork* activity was explained, although I accidently rushed straight into the 21 example without giving the children a chance to explore this for themselves first. I'm not sure exactly why I did this. I think that I had just forgotten as I wasn't looking at my plan at the time.

• • •

Again, I dived straight in with the 21 example for this first activity. I obviously hadn't learnt my lesson from the first conference."

Extract from Adam Boddison's diary

### Resources

Throughout this study, a range of practical resources were used to assist in the delivery of both the instruction phase and the guidance phase for each task. These resources included 2p coins, a calculator, multilink cubes, 100-square, web-applets, PowerPoint animations, coloured counters, preprinted grids (various sizes) and dead match-sticks. These resources are not dissimilar to what one might expect to be used in the classroom. However, the video conferencing environment does have

some advantages when using basic resources such as those listed above. Firstly, the size of the resource is less of an issue. The camera can be zoomed in on the 2p coins or on the on the multilink cubes, for example, making them very easy to view from each of the endpoints. In the classroom environment, the teacher might have to think about using enlarged resources to make them visible. For some resources the use of a document camera might be appropriate, but this could limit how the resources can be used. This was something that I realised when planning these sessions and it was one of the reasons for including strategy games. Normally the small counters or matchsticks involved in these games make them difficult to demonstrate to a large group of children. However, the video conferencing technology lends itself to such tasks by resolving these issues.

A second advantage is something that was not considered when planning the sessions, but something that was observed when watching the recordings of the sessions. During the monitoring phase, the children would sometimes go over to the television or screen that was projecting the task (through PowerPoint) and then proceed to discuss the mathematics and how they would approach the task, using various parts of the screen in their discussion. Having six children gathered around the screen in this way worked well and the PowerPoint did act as a focus for the children to begin their work. However, this might not have worked so well in a classroom environment, since there would have been at least 18 children in the same room, who could not all have gathered around the screen simultaneously. Furthermore, beginning a constructive mathematical discussion between all 18 children would be difficult.

There are of course some constraints in relation to the choice of resources when video conferencing. For example, large resources that would be good to use in the classroom might be so large that the camera cannot zoom out far enough to capture the whole resource on the same screen. A second constraint is that interactive intervention cannot take place over video conference in the same way

as it can in the classroom. To explain this point, I will use the example of the multilink cubes again. In video conference three, the children had nine sets of three coloured cubes as shown in figure 31.

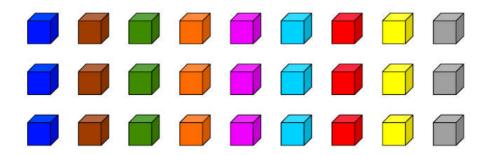


Fig. 31 – Cubes used for the 9 colours task

The children had to arrange these 27 cubes into a 3x3x3 cube such that every face of the cube showed every colour. The children used a variety of methods to tackle this problem and some managed to solve it, but many of them came close to the solution and then needed some guidance. If this situation had occurred in the classroom, then my intervention would have typically involved removing some of the cubes that were incorrectly positioned and asking them to think carefully about the position of these cubes. This was not easy to do using the medium of video conferencing and I had to describe to the children each cube that I wanted them to remove individually, which was time consuming.

Based on the evidence in this study, it is clear that some resources are more suitable than others for use when delivering sessions using the medium of video conferencing. Furthermore, the resources that are considered to be effective in a video conferencing environment are not necessarily the same as those that would be considered to be effective in the standard classroom environment. To get some idea of what the characteristics of an effective video conferencing resource might be, it would be useful to consider how the resources in this study were used. The following table summarises the use and effectiveness of specific resources in the context of this study.

Resource Details	Usage
Scientific calculators	These were useful for the children to use away from the camera, but they were not used to transmit any video data of the children's solutions. This is perhaps because the LCD display on the screen is too dark for those at other endpoints to be able to read.
Coloured pencils and scissors	These were not used by the children since they preferred to use coloured whiteboard pens on a whiteboard or marker pens on flipchart paper. Indeed, it is doubtful whether the colour of the pencils would have been recognisable from other endpoints.
2p coins, multilink cubes, small dice, playing cards, match sticks, coloured counters	It would normally be unrealistic to use these resources in the traditional classroom environment since the majority of the children would be too far away to see the detail of such small items. However, these worked well in the video conferencing environment as the camera could be zoomed in so that all of the children could see clearly what was being demonstrated by the teacher. This is perhaps comparable with a document camera being used in the traditional classroom environment. However, the video conferencing environment offered something more since the children themselves were able to perform close up demonstrations with ease and there was the capacity to have a 'close up demonstration conversation'.
Large playing cards, large dice, large Nim sticks	These were not part of the children's resources, but were part of my own teaching resources. I initially thought that it might be easier to use larger resources so that children could see the detail of my demonstrations, but these actually turned out to be more problematic. That is, the small size of the room and the good quality of the camera made it difficult to zoom out far enough to capture the whole image of the large resources.
Laminated Boards (e.g. 5x5 grid, blank clock face)	These were excellent resources since the children could write on them with a thick black pen, but still wipe them clean if necessary. Equally, time was particularly tight during the sessions and these pre-printed materials helped to maintain the pace of the session and to keep the children on task.
Exercise books, graph paper, squared paper	Although the students could zoom in on their work if they used graph paper and squared paper, there was an issue in that the lines were too faint and the children tended not to use thick enough pens when writing on them. However, these were good tools for children working away from the camera.

Table 4 – Summary of the use and effectiveness of resources

It can be deduced from the table above that those resources that can be used effectively in a video conferencing environment need to be useable both when the children are away from the camera and when they are presenting to the camera. A second consideration not discussed in the table above is the angle at which the camera views the resources. The Polycom and Tandberg units used in this study were such that they could not easily view items placed on a table from directly overhead. As such, resources that can be easily attached to a vertical surface, such as a wall, and viewed horizontally are ideal.

## **Balancing Talk and Activity**

When planning these sessions, I had to consider the ratio of 'listening' to 'doing' of the children. I wanted the sessions to be very interactive and to involve more doing than listening as I believe that good mathematical skills are developed by trying things out for yourself rather than being told about them. The video data clearly shows that the children did more doing than listening as they spent around 30 minutes of each session away from the camera working on activities. Furthermore, when the children from other schools were presenting their solutions, the children sometimes listened, but more often than not they continued to work on their own solutions.

### <u>Virtual Presence</u>

You will remember from chapter one that I had given the schools a recommended room layout, which is included again below for reference (figure 32).

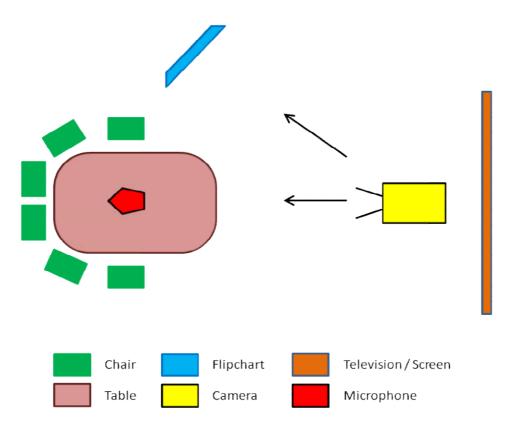


Fig. 32 – Recommended room layout for schools (repeated from fig. 1)

The reasoning behind this layout was both practical and pedagogical in that it gave all of the children a 'presence' in the video conference and also encouraged them to work together on the mathematical enrichment tasks. Of the six schools that participated in this project, five of them maintained a minor variation of this room layout throughout all of the sessions. In the sixth school, this was difficult because they were using their ICT suite, which did not easily lend itself to this room layout. However, even in this school, the children and the staff stayed as close to this layout as possible. Reflecting on this, it is clear that this was a good decision, since every child that wanted to did have a presence in the video conference. You will remember from chapter four that some children intentionally avoided being in front of the camera and this is why not all of the children had this presence.

Earlier in this chapter, I stated that one of the benefits of having only six children at each endpoint was that they could all easily gather around the screen to discuss the mathematics if they wanted to. It is now worth reflecting more generally about whether the decision to have only six children at each endpoint was justified. From viewing the video data and talking to the children, it is clear that all of the children had a role to play in these sessions, even if this role did not often involve being in front of the camera. Having six children at each endpoint allowed them to easily split into two smaller groups on those occasions when they had more than one approach to a problem. One example of this happening was in video conference six, when the children at Fieldhaven Primary School split into two groups (boys and girls) to look at the *Traffic Lights* task. There is also some evidence to suggest that smaller groups are not always better. For example, during video conference 13, there were only two children at the Daleway Primary School endpoint. I wrote in my diary that the children found the session "tougher" because there were only two of them present. Based on this, I would stand by my original argument that between four and eight children at each endpoint is the ideal number. However, further research would be required to strengthen or weaken this viewpoint.

# 7.2 Technical Preparation

Technical preparation is an important aspect of the planning for many lessons in the technology-rich classrooms that are commonplace in most modern schools. However, the nature of video conferencing is such that good technical preparation is paramount to creating successful and effective sessions. Indeed, it could be argued that more technical preparation is required for a session delivered through the medium of video conferencing than would be required for a session delivered using the more traditional face-to-face approach. What follows is a discussion of the unique technical preparation that took place for the video conferences in this study.

To begin with, I would like to consider music, which was used at three key points during each video conference; at the beginning of the session, during the *Countdown* or *Millionaire* activity, and at the

end of the session. The idea of using music at the beginning of the sessions initially came from the pilot project. The original thinking was that the music would mark a clear beginning for the session, since the endpoints had often been connected for about 10 minutes prior to the actual delivery of the lesson. However, some of the children in the pilot project commented that the music helped them to get into the right frame of mind. This observation was very interesting to me and it became one of the foci for the main study. The video conferencing technology allowed me to observe the children whilst the music was playing and it was clear that the children responded both physically and mentally. Before the music started playing, the children were chatting, walking around the room and surfing the internet amongst other things, but once the music started playing they quickly took their seats, got their pens and paper ready and were watching the screen ready for me to explain the first task. This did not happen just once or twice, but probably in every conference. The reason I say 'probably' here is that sometimes the camera was not pointing at the children so I could not be sure what was happening. However, on every occasion that I could see what was happening, the children responded as described above and in some instances they were also singing along to the music at the same time. In Neuro Linguistic Programming terms, this music could be described as an auditory anchor, which triggers a physical and mental response in the children.

Two different theme tunes were used to see whether a change in the auditory anchor would have any impact on the children's response. For sessions one to eight, the theme tune from the BBC Athletics was used, and for sessions 9 to 13, the theme tune from The Crystal Maze was used. The children responded in the same way with both theme tunes. Having used only two different theme tunes, I am not in a position to claim that the choice of theme tune is independent of the response. Indeed, it could be argued that both of these theme tunes were similar in rhythm and tempo. However, I can reasonably suggest that having a theme tune to clearly indicate that the session is about to begin does appear to encourage the children to prepare themselves for the session. This

could easily be compared with the theme tune of Coronation Street encouraging somebody in their home to sit down and start to relax by watching television for the evening.

Next, I will consider the various screen layouts that were used in different sessions. JVCS have a number of different options in relation to screen layout and figure 33 below (taken from the JVCS website) shows the choice available.

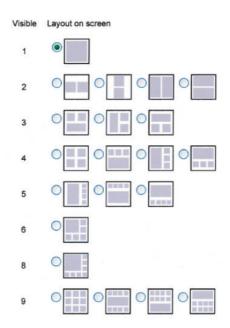


Fig. 33 - Choice of available screen layouts (extracted from <a href="www.jvcs.ja.net">www.jvcs.ja.net</a>)

The numbers down the left hand side of figure 34 represent the number of different endpoints that are visible to each endpoint. As discussed in chapter one, the video conferences in this study involved four endpoints but, as this included my own endpoint, I could only ever view three other endpoints at any one time. That said, the technical team at Osborne Road Secondary School who booked the video conferences on my behalf chose a variety of screen layouts from the top four rows of the above table, and these were sometimes different to what I was expecting. My initial plan was to use the last screen layout in row four for video conferences one to eight and the screen layout in row one for conferences nine to thirteen. The former of these screen layouts was to be set as

continuous presence, which means that the larger space at the top of the screen would show the end point that was talking, whilst the smaller spaces at the bottom of the screen would show the other endpoints. This was useful as I was able to monitor what was happening at each endpoint, assuming that the camera was directed towards the children. However, because this screen layout was designed to view four endpoints there was an empty space, which I generally used to place the picture-in-picture self view. The blurred image below (figure 34) shows how this screen layout would typically look to me as the teacher delivering the video conference.



Fig. 34 – Typical teacher view (repeated from fig.2)

There were also disadvantages that came from using this screen layout with continuous presence. You will notice that the rectangular shape of large area assigned to the presenting endpoint is not mathematically similar to the rectangular shape of the full screen. The result was that the top and bottom of the video from the presenting endpoint was cropped to fit into this space. This caused problems both for me and for the children, since the picture-in-picture self view was no longer a true reflection of what could be seen by the other endpoints. Constant questions such as, "Can you see our work now?" were being asked by the children throughout the sessions and constant instructions such as, "zoom out a little bit so I can see your work" were being given by me.

The latter of the two options shows only one endpoint at a time and tackles the disadvantages of the former screen layout by using the full screen to show the presenting endpoint. However, using this option, the continuous presence that enabled me to monitor the non-presenting endpoints is no longer available. Indeed, I could only see one endpoint at any one time.

During the final video conference, the technical team at Osborne Road Secondary School had selected a layout in which the screen was split into four quarters. It was during this session that I had an idea of what the ideal screen layout might be for a video conference; a screen split into four quarters as described, but without continuous presence. This would mean that whilst the children were away from the camera and working on the mathematical enrichment tasks, they could easily be monitored using the four quarters layout, but then once somebody began to speak, their endpoint would become full screen.

In the last chapter, there was some discussion about what strategies were used in the case of technical failure. In this chapter, we will now look briefly at what steps were taken in the planning stages to reduce the impact of a technical failure, should one occur. As described in chapter one, work booklets were printed with full instructions for all of the mathematical enrichment tasks. The idea was that if an endpoint was delayed in making the initial connection to the conference, disconnected during a conference or experiencing problems related to audio or video, then the children could look through the booklet and still attempt the tasks. Interestingly, I have been told informally by the teaching staff in some of schools involved with this study that two children actually took the booklets home with to look ahead to the tasks in the next session and perhaps make some progress in advance.

The tasks included in this booklet were also available to download from a dedicated website and were grouped by session. Since four of the schools had their video conferencing technology located

in their ICT suite, using the internet was a convenient option. Also on this website were useful links to accompany the tasks such as web-applets from the Nrich website and the PowerPoint animations used in the instruction phase.

## 7.3 Evaluation of the Learning

The final part of this chapter considers the strategies that were put into place to evaluate the learning after the video conferences. One way to evaluate learning would be to revisit the objectives at the end of each session and to see which were met and which were not. In this way, objectives that have not been met can be identified and perhaps included in later sessions. In the video conferences in this study, the objectives were noted on the lesson plans but, as was discussed above, the lesson plans were not referred to during the sessions. When introducing each of the sessions, I explained what the theme for the video conference was going to be, but the objectives were not explicitly shared with the children.

Using the wide variety of data collected in this study, it is now possible to reflect on the video conferences and to consider whether or not the objectives from the lesson plans were met. My complete set of reflections is included in appendix three. However, the key points are included below.

Reflecting on these video conferences retrospectively, even with the aid of video recordings and diary notes, it is difficult in some cases to be clear about whether the learning objectives were actually met. For example, in video conferences 1a and 1b, one of the learning objectives was 'writing probabilities as fractions'. One could argue that if the children wrote any probabilities as fractions, then this learning objective had been met. However, these same video conferences had 'pattern spotting' as an objective. Learning to spot patterns could be very simple or very difficult and it was not clear what level was required to meet this objective. Similar observations can be made for

other video conferences. For example, in video conferences 12a and 12b, one of the objectives was 'developing logical thinking skills', which is again difficult to define. Furthermore, there were sometimes occasions when some children met the given objectives, but others did not.

More generally, it could be argued that evaluating and assessing learning objectives is always difficult since they do not constitute simple, measurable gains. They are instead a mix of discrete knowledge and skills, generic mathematical skills and wider interpersonal skills, each of which could be categorised depending on whether a specific child demonstrated these skills independently, with support or not at all. For example, in video conference eight, one of the children knew what a prime number was with support from me. The same child was also able to independently demonstrate *specialising* skills and independently present his ideas to the camera. This gives a good insight into what this child has achieved during this session, but it was still difficult to say whether or not the learning objectives had been met. Appendix three brings together evidence from a range of sources to look at the overall situation for each video conference in respect of the learning objectives.

The use of assessment for learning strategies is a key consideration when planning and delivering traditional classroom-based lessons and at this stage it is worth reflecting on the assessment for learning strategies used for delivering the sessions in this study. Firstly, I will consider summative assessment, which is generally associated with taking a test and receiving a score or a 'pass' or 'fail'. Within the context of this study, the children were not asked to take any tests and they were not scored on how well they did when attempting the mathematical enrichment tasks. The only summative assessment that took place were the national key stage two SATs tests. Although this test was external to this study, the results are still worth reflecting on since a proportion of the children's numeracy lessons that would have ordinarily been used to prepare for these tests had instead been used for the children to be involved with this study. In total, each of the children involved in this study missed a minimum of 20 hours of their numeracy lessons out of possible

maximum of 195 hours. This means that the children missed at least 10% of their numeracy lessons in year six. The data received from the Head Teachers of the relevant schools shows all of the children involved in this study were predicted to achieve a level five in their key stage two mathematics SATs and all of them were successful in achieving this level. An important distinction to make here is that this data does not show that the video conferencing sessions were of benefit to the children's performance in their SATs tests. Rather that the children's participation in this study, and hence missing over 10% of their numeracy lessons, did not have a negative impact on their mathematics SATs results.

Next, I will consider the use of formative assessment in this study. Formative assessment generally involves providing detailed feedback, which can be acted on to improve future learning. In the context of this study, the use of formative assessment was ongoing since every session was modelled around the cyclic idea that the children present a solution and are given feedback to improve their solution. Whilst formative assessment was ongoing within individual sessions, it is worth thinking about how formative assessment was used across the range of sessions that were delivered. That is, I would now like to consider how the feedback given in one session has impacted on the learning taking place in a later session. The mathematical feedback given to children was mostly very specific to the particular task that the children were working on and so in that sense the feedback was not directly transferable to other sessions. However, sometimes the feedback was useful to the children's mathematical knowledge more generally. Furthermore, a small proportion of the feedback was designed to help the children more generally in tackling open-ended mathematical problems and sometimes this feedback was in the form of questions. Below are some examples of the feedback that the children might get during the sessions:

VC8a – "If you divide the length and the width of a square, you will get 1"

VC8a – "Two shapes that are exactly the same are called congruent"

VC5b – "How many solutions do you think there are?"

VC10a – "Triangle numbers are like square numbers, but we count the number of dots in a triangle rather than the number of dots in a square"

VC31b — "If you look at odd and even numbers, then to make 15 you either have to have 3 odd numbers or one odd and two even numbers"

To conclude this sub-chapter, I would like to consider the impact that participating in this study had on the children back in the classroom. The children's class teachers were not formally interviewed, but informal conversations about the impact of this study were noted. One of the teachers commented to me that the children involved in the study had adopted a new role in the classroom. The children were completing their own numeracy work and then going around the classroom and helping other children with their numeracy work. Such a comment has to be taken lightly, since it is impossible to establish cause and effect here and the children might have behaved in this way even if they had not been involved in this study. However, the comment is still worthy of mention. Two teachers commented to me separately that some of the children from their year six classes, who had been involved in this study, had become arrogant and overconfident during numeracy lessons. They reported that a small number of children would argue with the teacher if their work was marked as incorrect and would make unpleasant comments towards other children who generally struggled with mathematics. However, on the whole the feedback was generally positive and the Head Teachers of these schools reported some similar findings. Four of the six Head Teachers reported that there was an indirect positive impact on children that were not involved in this study. That is, those children who had ability just below that of the children in the study were able to be the strongest numeracy students in their class for one lesson every week. Furthermore, the reduction in class size for one lesson per week enabled the class teachers to spend more one-to-one time with the lower ability numeracy students. This reflects similar findings from the pilot project that were discussed in chapter one. Finally, it should be noted here that the Head Teachers from all six of the schools involved with this project stated that overall they felt the sessions were beneficial to the children that took part.

### 7.4 Discussion

An important element of this chapter was the planning that occurred prior to the video conferences taking place in the form of collating and grouping mathematical tasks, writing PowerPoint presentations and carefully selecting resources. This concurs with the wider literature discussed in chapter two, which supported the idea that significantly greater planning and preparation is required for video conferencing compared to face-to-face lessons (Couzins, 2004, p3; Freeman, M., 1998, p207; Gerstein, 2000, p178). It was further argued in the wider literature that presenting via video conference required a different skill set to face-to-face lessons (Doggett, 2008, p30; Heath and Holznagel, 2002, p7; Carville and Mitchell, 2000, p42; Jacobs and Rodgers, 1997, p294) and hence specialised training was necessary for presenters so that they could be adequately prepared (Comber at. al., 2004, p38; Gage, 2003; Harris, 2002, p453; Knipe and Lee, 2002, p311; Couzins, 2004, p29; Anderson, 2008, p120).

In the context of this study, I received no formal training for presenting by video conference and instead adapted my traditional face-to-face style of teaching in ways I thought were appropriate. Some of these changes related to the logistical constraints imposed by the video conferencing technology itself, such as not being able to walk around the room when teaching and having to use resources of an appropriate size and clarity for the camera. However, of greater interest are perhaps the pedagogical changes, some of which were intentionally implemented and others which naturally evolved over time. In the former category was my decision to maintain a high pace throughout the sessions (that is changing tasks frequently) and to retain the early structure of three chunked tasks

and a weekly activity of Countdown or Who Wants to be a Millionaire? Although this has already been discussed earlier in the thesis, I return to it now since there is more to say in the context of children's educational television, which arguably has some similar features to video conferencing. High-continuity television programmes are described as those which require temporal integration of successive scenes for full comprehension, whilst low-continuity programmes are described as those in which successive scenes are relatively independent of each other, and so such temporal integration is not required for full comprehension (Wright et. al., 1984, p653). Research into these aspects of television programmes suggests that whilst high pace is often used in commercials and educational television to hold children's attention, the result is that children actually pay more attention to low-paced programmes (Wright et. al., 1984, p664). Furthermore, it is argued that the consistency of the continuity of format in television programmes is more important than whether the continuity is high or low in relation to both attention and comprehension (Wright et. al., 1984, p665). In the present study, the video conferences could be described as low-continuity, high-paced sessions. That is, the tasks were changing quickly, yet they were relatively independent of each other (although arbitrarily based around a similar theme). In this new context, the retention of the early structure and hence ensuring a continuity of format, was arguably a strength in relation to the pedagogical choices that were made. However, it would appear that I fell into the pedagogical trap of commercialising the mathematical content with too high a pace. That said, the number of occasions on which the children complained about not having enough time to complete a task was negligible, although it should be acknowledged that they were not asked directly about this. Both the retention of the early structure and the high pace of the sessions will be discussed further in the final chapter of the thesis.

In considering those pedagogical changes that occurred naturally over time, it is worth pointing out two in particular. The first is that when the children were working on solving the mathematical problems they had been set, I often found that I too was having a look at the problem and

considering how best to generalise a solution. Interestingly this was not because I wanted to prepare something to show the children, but because I was interested in some of the mathematical problems in their own right. When teaching in the more traditional classroom environment, I had little time for this as much of my time was spent supporting the students, yet in the video conferencing environment there appears to be a shift in priorities as more 'not-contact' time is available. The second naturally occurring change, which was discussed briefly in chapter five, was that when the children asked me questions, I became more accustomed to responding with a question than giving an answer. Both of these changes are things that were observed retrospectively when considering the data and they are curious in the sense that they were not pre-planned. This evidence suggests there may be some teaching strategies, which do naturally evolve over time to adapt to solving mathematical problems in a video conferencing environment.

Returning to the training aspect of planning for video conferences, it should be made clear here that whilst I received no formal training for my teaching role in this study, this does not mean that training was not required. On the contrary, the fact that there were a series of changes in teaching style, whether pre-planned or naturally evolving, supports the idea that guidance and training could have been given at the outset to highlight these areas (Doggett, 2008, p30; Heath and Holznagel, 2002, p7; Carville and Mitchell, 2000, p42; Jacobs and Rodgers, 1997, p294).

One of the unique features of this research is the fact that site facilitators were not used at the endpoints, which is particularly noteworthy given the age and inexperience of the participants. In the literature review, it was reported that there was general agreement that site facilitators should be used at remote endpoints to ensure the smooth running of the video conferences (Lawson and Comber, 2005, p8; Gill, 2005, p576; Carville and Mitchell, 2000, p42; Jacobs and Rodgers, 1997, p293; Freeman, M., 1998, p208). In the context of younger participants, this refers at least in part to behaviour management, which is perhaps odd given that some believe video conferences can

actually improve behaviour (Comber et. al., 2004, p47; Thorpe, 1998, p401). The findings of this study are contrary to much of the literature in this area, since it has been demonstrated here that video conferences can be successful over a sustained period without the need for site facilitators. Furthermore, given the age of the participants, it is perhaps not unreasonable to suggest that the findings could be generalisble to more mature participants, although further research would of course be required to either strengthen or weaken such a claim. At this stage, I might perhaps go even further and state that some of the opportunities for the children to develop their independent learning skills arose as a direct result of the lack of physical supervision, although there were teachers on site nearby in case of emergency. Despite these successes, behaviour management, perhaps executed remotely, is still a necessary consideration for video conferencing and this will discussed further in chapter eight.

Critics of this study might argue that not using site facilitators worked primarily as a result of the limited number of participants at each of the endpoints. Whilst there may be some validity in their critiques, I would argue that the one-to-some endpoint configuration is yet another feature that unlocks some of the opportunities of video conferencing. The choice to have six children at each of the remote endpoints was made to give all of the participants a virtual presence so they could be individually identifiable (Hu, 2000, p381; Jacobs and Rodgers, 1997, p293; Hearnshaw, 1997, pp55-56). It was clear from the interviews with the children that they felt part of the video conference rather than just an observer. As such, this study concurs with the wider view in the literature that the one-to-some endpoint configuration allows the participants to be more interactively involved in the remote teaching and learning that is taking place (Austin et. al., 2003, p66; Butler and Fawkes, 1999, p47; Thorpe, 1998, p397).

Closely related to the endpoint configuration is the arrangement of the teaching room. It is perhaps common sense that a smaller number of participants allows for greater flexibility in what

arrangements are possible and the extent to which individuals can participate (Jacobs and Rodgers, 1997, p296). Two key considerations when arranging a room for video conferencing were discussed in chapter two and they were (i) to ensure that the arrangement maximised the visual experience for the participants (Comber et. al., 2004, p57) and (ii) to facilitate remote monitoring of the participants (Laouenan, 1999, p180). Both of these could be interpreted as referring in part to the screen layout as discussed earlier in this chapter. However, screen layout is an area that is particularly undertheorised within the literature and what follows now are my thoughts, based on the evidence presented in this study, which should provide the beginnings of a relatively new avenue of research within video conferencing.

In this study, my needs in respect of screen layout differed from the needs of the children. From my perspective, the screen layout needed to enable me to view the children's solutions and to pick up on their non-verbal cues when they were presenting their work as well as the facility to monitor the progress of the children when nobody was presenting. As was suggested earlier in this chapter, a non-continuous screen layout was effective in meeting such requirements. When the children were presenting, their endpoint was full-screen from my perspective, but when nobody was presenting, my preferred option was to have a screen divided into four quarters, since this allowed me to monitor all schools equally. Whilst there are options of other split screen layouts, these tend to prioritise one of the remote endpoints in some way. From the children's perspective, there was perhaps no need for them to monitor the progress of other children at other remote endpoints. However, the children required a sufficient level of detail so they could clearly see the written mathematics and diagrams when others were presenting. Therefore, the preferred screen layout for the children could be the same as that described above for me.

The link between children's educational television programmes and video conferencing has already been raised in the early part of this discussion and at this stage it is worth pursuing further. I would

argue that taking part in a video conference is similar to learning by watching television. It is similar because there is a sense of accessing knowledge from beyond the confines of the classroom, yet different because it is more interactive. More weight is perhaps added to the similarity argument with the interactive features of digital television that are now accessible by "pressing the red button". It is well documented that learning can occur from watching television and imitation is arguably a key factor of such learning (Barr et. al, 2007, p196). Given that video conferencing feels a little like television to the participants, it raises the question as to whether the imitation effects would become stronger or weaker than in the more traditional classroom environment. The wider research suggests that the ability to learn multi-step sequences of actions from a televised demonstration is significantly less than the ability to learn from a face-to-face demonstration and this is known as the video deficit effect (Anderson and Pempek, 2005, p518). In seeking to understand the video deficit effect, some have suggested a social contingency argument (Barr et. al., 2007, p196). This incorporates the idea that in a face-to-face environment, the presenter is able to pick up on non-verbal cues from the audience and adjust the pace and perhaps the content as appropriate. This, of course, is not an available option when the presenter is televising the material. However, as has been demonstrated in this study, the presenter does have the ability to pick up on non-verbal cues through video conferencing if the correct screen layout is selected. Based on this, I would argue that interactivity needs to be built into the experience of video conferencing, otherwise it is televisual.

The supporters of new educational technologies often make claims about pedagogical benefits, which are said to enhance children's learning and development, and such claims are often attractive to teachers and parents (Zimmerman et. al., 2007, p474). In considering the link between educational television and video conferencing, it has been argued that quality media can have benefits depending upon the structure, content and production features (Linebarger et. al., 2009). We have already discussed the structure and content in some detail, but so far little attention has

been given to the production features, which include, for example, the panning and zooming of the camera, sound effects, music and other special effects (Calvert et. al, 1982, p601). For the remainder of this discussion, the focus will be on the theme tunes that were used as auditory anchors, since they existed to signal important aspects of the video conferences (Wright and Huston, 1981). Many studies in this area have focused on infants and young children, but there is some evidence to suggest that the features observed are transferable to older children (Calvert et. al., 1982, p608) and the findings in this study support this view.

In this study, theme tunes were used to signal the beginning of the video conference as well as the weekly activity of *Countdown* or *Who Wants to be a Millionaire?* When observing the video data, it was clear that the students responded to these tunes, which acted as a trigger for them to take their seats and to prepare for the session. This supports the wider research, which suggests that music can have an influence on the brain (Stover, 2009). Much of the research into the effects of music on learning argue that music can be used as a trigger for recall of information (Brewer, 2005), but in the present study, the music became a trigger for the recall of a particular mindset. Whilst this brings a slightly different perspective to the existing research, it also builds well on Brewer's work on musical mood management (Brewer, 2005). Brewer argues that music can help to maintain a positive mood and increase learning effectiveness, which is in keeping with the work of several others (e.g. Isen, 2002, p536; Felix, 1993, p277).

In wider literature about video conferencing, little has been written about the use of musical cues to increase learning effectiveness, which is perhaps surprising since the technological knowledge required to stream audio is relatively simple in comparison to some of the other functions of video conferencing, such as application sharing, which are well documented. To conclude this discussion, it is clear from this study that the appropriate use of music can help to enhance the learning experience of the participants in video conferencing, but I would also offer note of caution based on

the work of Jensen (2002). Any music used should be done so selectively and purposely to ensure the video conference does not become saturated.

#### **Summary**

The evidence presented in this chapter demonstrated music being used as an auditory anchor to signal to the children what was happening at that particular time during the session. This was particularly helpful in establishing a firm starting point for the session since the schools may have established their connections at different times. The video data showed some of these auditory anchors in use both at the beginning and end of the session and for the *Countdown* and *Who Wants to be a Millionaire* activities. The lesson plans written for these sessions were followed, although some key points were missed as a consequence of transferring the lessons into PowerPoint presentations and then not referring to the original plans during the delivery of the session. It was difficult to ascertain whether or not the learning objectives had been met, since the criteria did not consist of simple, measurable gains.

There were many choices of screen layout available when booking a multipoint video conference through JVCS. There was a balance to strike between being able to monitor what the children were doing when not presenting to the camera and being able see the whole screen clearly and at a reasonable size when the children were presenting. In order to achieve this, the evidence presented in this chapter suggests that the 'continuous presence' option should not be chosen, but rather a screen layout comprising four quarters should be used. This configuration showed up to four other endpoints when nobody was presenting and automatically made any presenting endpoint full screen for the duration of their presentation.

During the discussion, it was noted that training is an important consideration both for those delivering video conferences and those participating. One of the novel aspects of this research was

the lack of site facilitators at the remote endpoints. However, this study has shown that video conferences can still run smoothly with site facilitators and furthermore, their absence potentially creates new opportunities for developing real independent learning skills. This chapter also highlighted the similarities between video conferencing and the production features of children's educational television. There is little existing research in this area and the discussion in this chapter has perhaps provided a starting point for others in this field. In particular, the use of music as an auditory anchor has a potential place in the video-conferencing tool-kit for teachers.

#### **CHAPTER 8 – AFFECTIVE TEACHING STRATEGIES**

"We work for praise and then dawdle once we have it"

Mignon McLaughlin

This penultimate chapter considers the affective teaching strategies used in this study. That is, those decisions made by the teacher that impact on the learners' attitude or behaviour. Firstly, I will look at the praise that was given to the children throughout this project. Particular attention will be given to the frequency and nature of the praise as well as the positive consequences that such praise had on the children's confidence levels. The analysis will look at when this praise occurred during the sessions and a revised teaching and learning flowchart for video conferencing will be presented. Secondly, I will look at how low level disruption from the children was dealt with during the sessions. The various behaviour management strategies used in this study will be discussed and then analysed to establish whether or not they were successful in managing poor behaviour from the children. A tree diagram will be generated to show clearly the decision making process behind these behaviour management strategies. Thirdly, this chapter will briefly look at the strategies that helped to develop the children's interpersonal skills, including leadership, teamwork and problem solving skills. This will be brief since some of these strategies and skills have already been discussed elsewhere in this thesis. The chapter will conclude with a discussion of the findings in the context of the wider literature.

#### 8.1 Confidence and Praise

In this project, praise was only given to the children verbally. This was either done directly by me during the video conference or it was done by indirectly outside of the video conference. This indirect praise involved me talking to the children's teachers or Head Teachers who would then pass on my comments to the children. There are a number of reasons why praise was only given verbally.

Firstly, not being physically present in the room made it difficult to give written praise in the form of comments on children's work or to give out stickers. There are, of course, ways around this issue such as asking the children to send their work to you (electronically or in the post) and then sending it back to them with comments. However, it was decided that this would distract from the main activity in this project, which is related to teaching and learning using video conferencing technology. Secondly, it would have been possible to operate some kind of points system, whereby children who made good progress were awarded points for their school. Such a system would allow a running total to be kept, which could be used to motivate the children to work harder. However, I decided against such a system on the grounds that I wanted to see where praise would more naturally occur before implementing an artificial praise structure.

In looking at how verbal praise was used as a strategy in this study, the first step was to look at how frequently praise occurred. The results show that on average, I verbally praised the children 22 times per session, with a standard deviation of 9 across all of the sessions recorded. The least praise given in one session occurred in video conference 10a, during which praise was given only 8 times. The most praise given in one session occurred in video conference 5a, during which praise was given 40 times. There were no obvious trends to show whether the amount of praise being given was increasing or decreasing over time and there was no evidence to suggest that there was any correlation between the amount of praise given and the mathematical theme of the individual sessions.

Having considered the frequency with which the praise in this study was given, the natural next step is to consider exactly when the praise was given and what the praise was given for. To address these questions, I watched all of the video conference recordings through again and noted down the nature of the praise given and when it occurred. I discovered that praise was always given at the same moment and the comments made generally took the same form. Praise was usually given to

the children after they had presented their ideas and the most common of these verbal comments made by me included "Excellent work", "I'm really impressed with what you've done", "Good" and "Some great ideas here". Such comments also tended to be repeated at the end of each mathematical task before moving on to the next task. For example, at the end of one of the tasks in video conference 6 I said "All 3 schools there came up with some great ideas". Comments that were used less frequently included "Spot on", "Well done", "That's absolutely right" and "I like that". It is interesting, although probably not too surprising, that the same phrases were used for giving praise throughout the duration of this study.

When observing the video data it became clear that praise was being given to groups of children and relatively infrequently praise was given to individual children. Also, on those occasions when the children had not produced a lot of work or had made very little progress, it is worth noting that praise was often still given to acknowledge their effort. Furthermore, I observed that after outlining the mathematical tasks for the children, I always wished them "Good luck". This is not a form of praise, but is worthy of mention since it occurred so frequently.

Looking at the children's reactions when they received praise was interesting. From the recordings, I could tell that the children were pleased since they sometimes smiled or even celebrated on occasion if there was a more competitive edge to the particular task, for example in the *Treasure Hunt* activity. However, the children's most common reaction could be described as apathetic. Occasionally they said "thank you" after being given praise, but mostly the children had little or no reaction. As such, it is difficult to try to analyse what the impact of praising the children might be. What I can say is that the children were confident enough to 'perform' in front of the camera in every session despite the fact that often they did not complete the mathematical tasks or fully understand the concepts involved. Under normal circumstances, a group of children who consistently fail to complete work are likely to lose motivation. On the contrary, the groups of children involved in this

study have remained motivated throughout. It could be argued that this is a result of the novelty of using new technology. However, I would counter this argument with the view that such novelty would wear off quickly and probably after the 3<sup>rd</sup> or 4<sup>th</sup> session. Indeed, I would further argue that praising the children has helped to keep them motivated throughout. The evidence for my views comes from two sources. Firstly, my informal conversations with the children's teachers revealed that the children often talked about how well they thought they were doing even though they thought mathematical tasks were difficult. Secondly, the children's diaries also contain comments that show they were finding the mathematical tasks challenging but enjoyable. For example, Brain from Benefactors School wrote in his diary, "I found *Squayles* the hardest because the game was very long and hard to crack". On the same page he wrote "[I found this session] very enjoyable".

In chapter five, a teaching and learning flowchart to describe what was happening in these sessions was produced. This can now be amended to include praise and the revised flowchart appears in figure 35 with praise shown in green. The fact that the praise occurred at similar times independently of the mathematical content of the sessions makes it much simpler to include praise in this diagram.

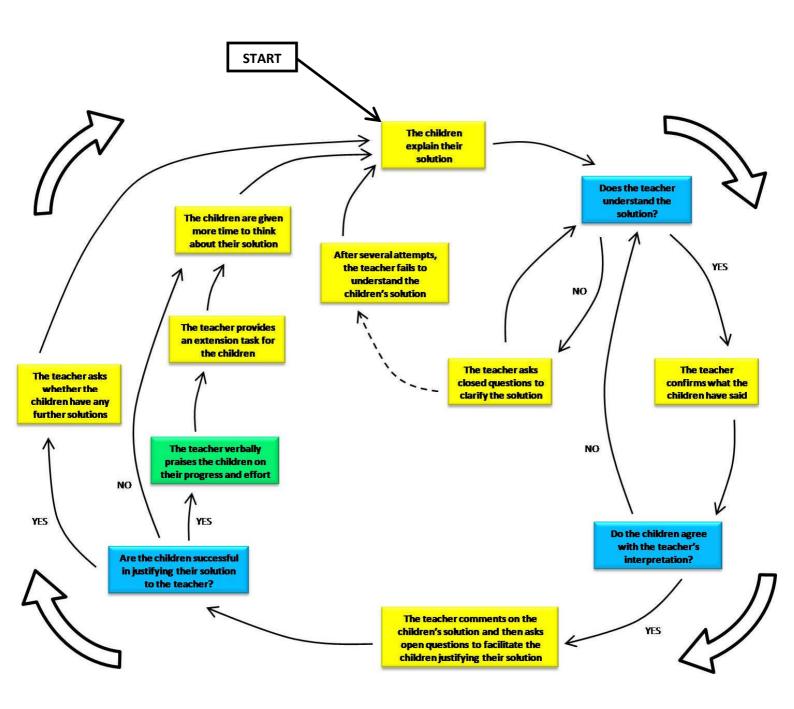


Fig. 35 – A flowchart to summarise observations from the video recordings (including praise)

At this stage, it is worth reflecting on the children's confidence and how this has developed over time. Confidence is of particular importance for the video conferences in this study since being able to present ideas to the camera is paramount to ensuring that the sessions are effective. For this reason, a lack of confidence from the children is likely to have more serious consequences in a video conferencing environment than the standard classroom environment.

At the beginning of the project, the children's confidence was established through a series of face-to-face sessions in which the children got to know each other and me. The result was that the children seemed to be confident enough to take part in the first video conference, although they were naturally apprehensive. A teacher from each of the children's schools was also around for the first session to ensure there were no major technical difficulties and again this helped the children to feel more confident. Looking at the video data, there are no clear indications that the children have lost any confidence over time. Such indications might include children refusing to present or not being able to complete a presentation. An increase in the confidence of individual children might be indicated by one or more children doing all of the presenting and not allowing others to be involved. There were some examples of individual children doing disproportionate amounts of presenting ideas to the camera, but this was inconsistent.

I spoke with several children informally about a year after they took part in this study and I asked them about whether they thought they were more confident with giving presentations. These children told me that they felt "protected" when presenting by video conference as they were in their own school using their own equipment. They also told me that they felt "in control" because they were operating the technology themselves.

#### 8.2 Behaviour Management

This sub-chapter considers what strategies were used to manage the children's poor behaviour. Before continuing with this description, it is worth briefly clarifying what constitutes poor behaviour, why it needs to be managed and what usually happens in the more traditional classroom environment. In the context of this study, poor behaviour referred to low level disruption such as talking when the teacher was talking, being off-task, distracting other children from their work or not concentrating 100% on the task in hand. It was important to manage this behaviour since it could

have easily begun to impact on the success and effectiveness of the session if allowed to continue. Behaviour management more generally allows the teacher to set clear boundaries for the children, which is important in terms of facilitating a positive learning environment and preventing more serious disruption from occurring. The reason for focusing on low level disruption rather than more serious disruption was because there was a relatively high frequency of low level disruption and there were no instances of serious disruption due to poor behaviour in this study. However, strategies were in place to deal with both types of disruption and these will be discussed during this chapter. In the standard classroom environment, teachers are able to intervene verbally to stop poor behaviour and this intervention can also take place through the video conferencing environment. However, the key difference between these two environments is that in the classroom environment, the teacher can escalate to a physical intervention, such as confiscation of equipment or removal of a child from the room, if the child fails to respond to the verbal intervention. Clearly this cannot be done in a video conferencing environment. As such, this sub-chapter will consider whether verbal interventions are still effective and will look at what alternative strategies can be used. Particular thought will be given to looking for any strategies that were used spontaneously that naturally lend themselves to a video conferencing environment.

Before considering the various strategies that were used, it is worth looking at the poor behaviour that occurred during the enrichment sessions in this study. The most consistently occurring issue was children talking whilst I was talking. In the standard classroom environment, this would be a significant problem since it would prevent other children from hearing what the teacher was saying. However, when video conferencing the children mostly had their microphone muted when I was talking, which means that any talking from the children will only affect others at the same endpoint. There were lots of occasions when I did not see the children talking and so took no action. However, I have seen this talking taking place retrospectively through watching the recordings of the sessions and there was lots of it. Occasionally, the children forgot to mute their microphone and the talking

then had a significant impact on the session. The audio would consist of a combination of me explaining the task and the children talking and the video would keep switching between my endpoint and the endpoint where the children were talking. Ironically, the children at the endpoint where the talking is happening would be least affected since their audio would remain unchanged and their video would show only my endpoint.

Another consistently occurring issue involved the children being off-task. Without a teacher physically present in the room with them, the children often decided to have non-mathematical fun. On one occasion, a child can be seen hopping from one side of the room to the other. On another occasion, a child can be seen pulling faces to the camera. Less consistently occurring issues included starting to work on a task before the instruction phase had been completed, tapping on the microphone, waving to each other, drawing and writing messages on whiteboards and zooming the camera in unnecessarily close on other children's faces.

Several strategies were used to deal with this poor behaviour. If the behaviour occurred whilst I was presenting and I was aware of it, then I usually made a comment to let the children know that I was aware. Furthermore, I tended to use the individual child's name. For example, in video conference 6, Charlotte from Churchill School was being silly with her pencil case and water bottle whilst I was talking. I saw this was happening and so I said "I hope you are alright there Charlotte?" and she stopped immediately. Essentially, Charlotte had forgotten that her behaviour was visible to the other endpoints and my comment acted as a reminder. Once Charlotte knew that she was being watched, it is clear from her reaction that she was a little embarrassed at being caught out. This is quite typical of how the children responded to this type of intervention in this study. If the poor behaviour occurred whilst I was talking, but I was not aware of it, then no action was taken.

Dealing with poor behaviour when the children were presenting was more difficult, since any immediate intervention would result in an interruption. In such circumstances, I had to make a judgement call as to whether the disruption was significantly affecting the children's presentation of their ideas. This was a personal judgement without any set criteria to decide how significant disruption was; each situation was considered independently. If I decided that the behaviour was preventing the children from being able to communicate their ideas, then I would interrupt and intervene to stop the behaviour. This time, however, my comments would be more direct. For example, if a microphone was being tapped or had been accidentally left unmated, I would interrupt and ask the children to mute their microphone. There were very few occasions on which such an interruption was required. If I could take no action, then this was my preferred option as I did not then need to interrupt anybody's presentation. A good example of this is in video conference 5. A child at Churchill School was clearly not on task as he was spinning around on his chair and messing about with his calculator. I took no action here and waited for the situation to resolve itself, which it eventually did. If the children were working on a mathematical task at the time of the poor behaviour, I would again make a judgement call as to whether my intervention would cause more or less disruption than the behaviour itself. Generally, my decision was not to intervene, although there were some exceptions to this. If I did decide to intervene in such circumstances, then this often took the form of a question related to the mathematical task that the children were working on.

I had planned to use some other verbal interventions in case any poor behaviour escalated, but this did not materialise in the end. One of the strategies was to remind the children that the conferences were being recorded and so any poor behaviour could be shown to their classroom teacher, Head Teacher or their parents if necessary. Another was to telephone to school during a session and to ask for a disruptive child to be removed if required. Whilst these strategies remained unused, it was helpful to have them there as in different circumstances, it is easy to see how they might prove to be invaluable.

The final behaviour management strategy that I used took place before the video conferencing aspect of this study began. When the children were being shown how to use the equipment, I reminded them that many of the children they were working with were likely to be in the same class as them in Osborne Road Secondary School in the following academic year. This is a form of positive peer pressure and was delivered in such a way as to suggest to the children that they would not want to embarrass themselves in front of their possible future friends.

To summarise the decision making process used in this study and to help other practitioners understand the strategies involved, a tree diagram has been constructed below (figure 36).

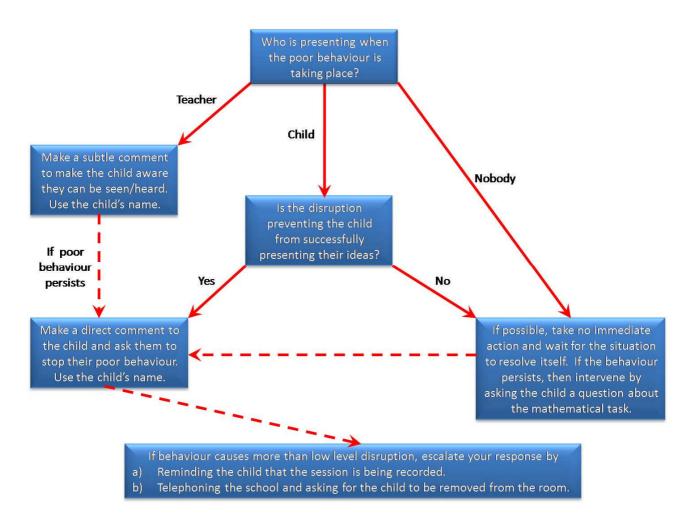


Fig. 36 – Behaviour management flowchart

#### 8.3 Inter-personal Skills

This final sub-chapter looks at the strategies used in this study to facilitate the development of the children's interpersonal skills, including teamwork, leadership, independence, problem solving skills, communication and self confidence. The geographical nature of the endpoints in this study was such that the children were automatically divided into teams. This encouraged the children to work together as a team. Generally speaking, the children did work well in teams and for the most part they worked as one complete team. However, there were occasions when some of the children wanted to work alone on a mathematical task. Having obtained a solution, they then shared this with the rest of the group before presenting the idea as a team. Indeed, there were some occasions on which the child presenting the idea had nothing to do the creating the idea. Occasionally, the children would split up into two smaller groups and work on different ideas. This happened only a small number of times and the divide tended to be by gender, with the male children and the female children in separate groups.

Having no teacher present in the room did perhaps encourage one of the children at each endpoint to take a on a leading role. Interestingly this was different for the various endpoints. At one endpoint the same child appeared to take on the leading role in every session. At four of the endpoints, the leadership role rotated between a few of the children. At the final endpoint, there did not appear to be any natural leader within the group.

The teaching and learning model for video conferencing described earlier in this chapter was implemented with the intention of developing the children's independence and their problem solving skills. The underlying idea was that the children should be allowed to solve mathematical problems themselves with the teacher only providing hints or ideas rather than answers or full solutions. This was discussed in detail earlier in chapter five, but it is worth noting here that this model did work in this study as a strategy for developing independence and problem solving skills. The evidence for

this claim is from informal comments made by the children's class teachers. Most of them told me that during their daily numeracy lesson, the children were likely to spend more time tackling a mathematical task themselves without asking for help than would normally have been the case. This doesn't necessarily mean that the children were better at problem solving, but they were more willing to try to solve the problem independently of a teacher and without asking for assistance as soon as the problem became a little tricky.

#### 8.4 Discussion

The focus of this chapter has been on praise and behaviour management, both of which are interrelated and widely recognised as legitimate considerations for classroom practitioners. The actual use of the term 'praise' can vary with some definitions stating that it could be either written or spoken (Campanella and Lombard, 2004, p25) and others suggesting that non-verbal cues such as body language should also be included (Brophy, 1981, p8). It was decided earlier that for the purposes of this study, only verbal praise should be considered. In particular, praise was recognised as that which commended the worth of or expressed approval or admiration for others, and this enhanced definition is consistent with a number of studies (Burnett, 2002, p6; Campanella and Lombard, 2004, p25; Brophy, 1981, p5).

The common perception within the teaching community is that praise generally has a positive impact on children, although the academic community appear to have mixed views (Henderlong and Lepper, 2002, p774). There are some studies that support the teachers' perception, which report that praise can enhance children's motivation and increase their desire to engage with tasks (Kalis et. al., 2007, p20; Dev, 1997, p12; Safarino et. al., 1982, p29). However, there are other researchers who suggest that praise can create excessive pressure for children to continue performing at a higher level and hence discourage risk taking (Kohn, 2006, p4; Birch et. al., 1984, p431; Gordon, 1989). Indeed, it has been argued that the most notable aspect of a positive judgement is not that it is positive, but that it

is a judgement (Kohn, 1993, p102). Lastly, there are some researchers who argue that the effects of praise are dependent on the type of praise that is given, claiming that "the wrong kind of praise creates self-defeating behaviour and the right kind motivates students to learn" (Dweck, 2007, p34).

Within the latter group of researchers, there are some who have chosen to categorise praise as either dispositional or non-dispositional (Campanella and Lombard, 2004, p25). They described dispositional praise as being the application of a positive trait label (e.g. clever boy) and non-dispositional praise as being the evaluation of a specific behaviour (e.g. accurate work). In the context of the present study, the praise issued was mostly non-dispositional and consisted of phrases such as "excellent work" and "some good ideas here" alongside guidance for the children to develop their solutions. This observation is interesting since the findings of Campanella and Lombard (2004, p26) were that dispositional praise was better since it had significant behavioural and cognitive and consequences in comparison with non-dispositional praise. The evidence presented in my study is not sufficient to argue that the praise implemented resulted in changes to cognition or behaviour. However, I can say with confidence that few behavioural problems were observed through the video conferencing cameras and, from the evidence presented in chapter four, that the children's experiences were generally positive.

It is argued that much teacher praise is determined more by teachers' perceptions of student needs than by the quality of student conduct or performance (Brophy, 1981, p5). In this study, it was difficult to assess the children's needs since the ability to remotely monitor them was limited. Furthermore, the recorded video data suggests that praise was given consistently irrespective of the children's conduct or performance as indicated on the revised flowchart presented earlier in this chapter. Critics might argue that such regularity was inevitable given that there was limited interaction with the children. However, it is worth clarifying that praise could have occurred at any point during these interventions, yet on the majority of occasions it was spontaneously used at the

same point within the explanation and guidance cycle regardless of the quality of the children's solution. In considering this analysis, it is perhaps helpful to draw an analogy to a theatre production. At the end of such a production, there is a general expectation that the audience will applaud the performance and this is arguably independent of the quality of the production itself. Throughout this study, it has been argued that interactions are more akin to a series of presentations than to a natural conversation and so in this context perhaps the use of praise with such regularity is not so surprising.

Returning to the different categorisations of praise, some have distinguished between praising students' effort and ability (Dweck, 2007, p36; Burnett, 2002, p7). From the students' perspective it is argued that they prefer to be praised for trying hard rather for having ability (Burnett, 2002, p7) and this supports the theory that those praised for effort rather than ability are more likely to chose harder tasks, which give them the opportunity to learn, rather than easier tasks, which might give them an error-free performance (Dweck, 2007, p36). In this study, the children were praised for effort more than ability and this was perhaps a strategy for keeping the children on task rather than encouraging them to take a particular approach to their learning. Indeed, it seems that on those occasions when the children were off task, this was mostly as a result of technical difficulties rather than mathematical difficulties.

During the guidance phase, the children were often given constructive encouragement in order for them to develop their solutions. It is argued by some that if such encouragement focuses on effort, it can enhance the self-esteem of the receiver, although student feelings may also need to be recognised and taken into consideration (Burnett, 2002, p6). Recognising student feelings in a face-to-face environment is arguably easier than in a video conferencing environment. Therefore, to increase the teacher's ability to recognise their students' feelings, both the screen layout and the production effects are important and need to be considered as discussed earlier in the thesis.

Having considered a variety of the academic viewpoints related to praise, it is clear that the effects of praise are both complex and diverse, ranging from beneficial to negligible to detrimental (Henderlong and Lepper, 2002, p791). Nevertheless, the role of praise in delivering the video conferences in this study appears not to have had a detrimental effect, although it is difficult to establish either the breadth or depth of the consequences given the number of uncontrollable variables involved. In considering further the benefits of praise, it is argued by some that the praise-giver benefits more than the praise-receiver, since it has more to do with the convenience of the praise-giver than the emotional needs of the praise-receiver (Kohn, 2006, p1). Whilst this may be true in the face-to-face environment, it is worth questioning whether or not such an argument is still valid in a video conferencing environment since physical praise interactions are impossible. Furthermore, this raises the question as to what alternative strategies can be used in place of praise to maintain students' motivation during video conferences. In this study, there was perhaps peer motivation from participants at other endpoints, although I recognise the difficulties of generalising here to wider video conferencing contexts.

Another interesting dimension to the use of praise through video conferencing technology is to consider whether it should be interpreted as human praise or computer praise (Campanella and Lombard, 2004, p22). Computer praise incorporates the idea that users interpret computers as having a personality and in some cases form a relationship with them. Indeed some people give names to their computers or refer to their computer as "he" or "she". The argument is that if the computer gives praise to the user (e.g. a message appears on the screen stating "congratulations, you have successfully installed your new software"), then this might be interpreted as praise, although differently to human praise. Furthermore, it is argued that computer users are more attracted to computers that exhibit similar personalities to themselves (Campanella and Lombard, 2004, p23). This is particularly interesting in the context of video conferencing as it could be interpreted as human praise being delivered through a computer. Indeed, one could consider

whether as users become more familiar with video conferencing technology, it too might develop a personality. These concepts go beyond the scope of the present study, but they are perhaps avenues for further research.

In social learning environments, it is argued that learners tend to assume that they are correct unless they are explicitly informed otherwise (Brophy, 1981, p6). Reflecting on this, it became clear that it was rare for me to inform the students explicitly if they had made a mistake. The recorded video data shows me using the phrase "I'm not convinced" to communicate the idea that the children's solution was not correct. In a minority of cases, this was because the children came up with a solution that I had not considered and the time constraints encouraged me to respond with a gut reaction rather than more rigorous mathematical reasoning. However, for the majority of cases, this phrase was used when students had made a mistake and, in contrast to Brophy's findings, this study showed that children did respond by revisiting their solutions in most cases.

Classroom management is one of the most common concerns of both newly-qualified and experienced teachers (Sokal et. al., 2003, p8). Arguably, an important aspect of classroom management is the classroom environment, which is known to be related to academic achievement (Burnett, 2002, p8). This is an important consideration in the context of video conferencing since the classroom environment is divided across a number of physical locations and somewhat out of the control of the teacher. Reflecting on this study, steps were taken to control some aspects of the environment at the remote endpoints, through a recommended room layout, with a view to giving the participants a virtual presence. This may have resulted in some unforeseen, yet positive, effects on academic achievement, although as was argued earlier, it is difficult to be certain given the number of uncontrollable variables involved. Similarly, it is suggested that a positive student-teacher relationship is an important aspect of a positive classroom environment (Burnett, 2002, p8), which

perhaps emphasises the importance of the face-to-face sessions that took place in the Autumn term of this study.

In relation to the behavioural aspect of classroom management, physical aggression towards others is one of the most prevalent forms of challenging behaviour (Adams and Allen, 2001, p335). Initially, it might be thought that this is irrelevant in video conferencing since the participants are at different endpoints. However, I would argue that physical aggression is perhaps more important in video conferencing since the teacher is not able to physically intervene if there are problems at a remote endpoint. Indeed, there is also the issue of bullying between endpoints that should be looked out for by teachers. Whilst this chapter has identified some of the strategies used for behaviour management in the context of this study, more research is needed to consider remote behaviour management tools in broader contexts. That said, it is clear that this study is one of the first to discuss remote behaviour management strategies in the context of having no facilitators at the endpoints and some valid recommendations and guidance have been outlined for practitioners.

The extent to which a teacher intervenes to maintain control of their classroom is a function of context and personal disposition, but it is clear that intervention is more limited in a video conferencing environment in comparison to a face-to-face environment. Figure 37 below demonstrates the link between the levels of intervention that can occur and the amount of control that a teacher has.

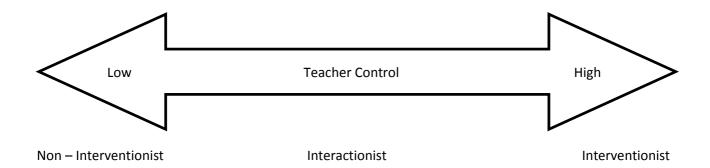


Fig. 37 – Continuum of Teacher Attitudes Towards Classroom Management

Reproduced from Sokal et. al., 2003, p9

During this study, teacher control was considered to be low and the level of interaction was also minimal. However, the wider context of video conferencing is interesting here from a technological determinist perspective. The constraints of video conferencing can determine what approaches teachers use and prevent them from maintaining high levels of control over remote endpoints without site facilitators.

In conclusion, it is clear that in the context of teaching and learning both praise and behaviour management are as important in a video conferencing environment as they are in a face-to-face environment. In this study, the opportunities and constraints of video conferencing technology have impacted upon how praise and behaviour management can be implemented and I would argue that both should be valid considerations for practitioners. Furthermore, the academic community should consider the concepts of remote praise and remote behaviour management as valid areas for future research.

### **Summary**

This chapter was mainly concerned with the use of praise and behaviour management in the context of video conferencing. In considering praise, the discussion in this chapter noted there were distinct discrepancies between the views of the teaching community and the views of the academic community. Whilst the former subscribe to the idea that praise has positive effects, the latter have mixed views. Some researchers have even argued that praise can have negative consequences. The literature in this area suggests that praise can be categorised in a number of ways, which were discussed in some detail, but a difference was noted between praise given for effort and praise given for ability, with the former being the preferred approach. It was suggested that praise is often a consequence of specific student behaviour or need, yet in this study praise appeared to have regularity in when it was used. However, there was some uncertainty as to whether this was a consequence of using a pedagogy appropriate for video conferencing or a practical consequence due to the constraints of the technology.

In considering the constraints of video conferencing technology in relation to classroom management, it was clear that the teacher had little control over the environment in the remote endpoints once the room layout had been agreed. Furthermore, some of the usual behaviour management tools of the traditional classroom teacher were lost as a result of the constraints of the technology. Such tools focused on physical intervention, which was no longer possible, although it was noted that there were some additional tools made available.

### **CHAPTER 9 – ANALYSIS, DISCUSSION AND CONCLUSIONS**

"Teaching is evidently and inevitably uncertain. No teacher can be sure how a lesson will go or what a student will learn. No one can be sure which teaching approach will be most successful with a particular group of students"

Robert Floden and Christopher Clark (1988, p1)

This study has focused on the innovative use of video conferencing technology within mathematics education and has taken the form of a case study. Based on the descriptive data and my own personal and professional values as both a teacher and a researcher, this chapter will address why and how the teaching strategies have evolved in the way that they have. Furthermore, this chapter will bring together all of the individual strands of descriptive data and analytical evidence from the previous chapters so that the analysis can be holistic.

Whilst this research has not directly focused on comparing teaching and learning in the video conferencing environment with the more traditional classroom environment, comparisons can be made, since I can compare my experiences in this study with my wider experience of face-to-face teaching. These comparisons will not be as rigorous as if I had used a control and experimental group, but nevertheless they provide a useful benchmark and a valuable context for the analysis.

By the end of this chapter, this study will have been positioned within the field of existing research and there will have been some discussion surrounding the contribution to knowledge generated. In particular, the importance of routines in video conferencing to reduce teacher uncertainty and techno-stress will be highlighted. Some of the literature referenced in this chapter in relation to routines is dated, but it is still relevant and sets out frameworks for the commentary. One of the

aims of this chapter is to consider these routines from a new technological perspective that is specific to using video conferencing.

## 9.1 The Success of the Technology and the Effectiveness of the Pedagogy

Ertmer (2006, p37) suggests that as schools acquire more technology, students can only benefit if teachers are skilled in using it. However, teachers are unlikely to make the effort to develop their video conferencing skills if the use of this technology does not fit with their existing pedagogical beliefs. This emphasises the importance of this study at this time since many teachers believe that video conferencing is constraining and do not believe it can provide additional opportunities even if appropriate teaching strategies are used.

In chapter two, a successful video conference was defined as one in which the technology works and effective video conference was defined as one in which the learning objectives are met. In the traditional classroom environment, there are some teachers who are reluctant to use technology in case there are technical problems, which may require them to have pre-prepared alternatives. My own experience in schools suggests that it is not uncommon for teachers to worry about technological failure and this perhaps is the reason why video conferencing is not as widely used in schools as might be expected. Some studies reported an increase in stress for presenters delivering material using video conferencing technology (Freeman, M., 1998, p208; Husu, 2000) and this certainly agrees with my own experiences whilst undertaking this research. Techno-stress, as defined in chapter two, is arguably inherent within video conferencing, since a technical failure could have potentially catastrophic effects relative to a technical failure in the traditional classroom environment. The lesson may not be able to continue or the teacher delivering by video conference could lose all control of their virtual classroom. It could be argued that having no facilitator at the children's endpoints increases the techno-stress for the teacher since they are still remotely responsible for the behaviour of the children in the case of a technical failure. However, this needs

to be balanced with the unique opportunities for learning that could be made by the children. This brings the reliability of the technology sharply into focus and demonstrates that the success of the technology can impact significantly on the effectiveness of the pedagogy. Equally the need for technical support and training are areas of importance that should not be overlooked or considered lightly.

Gill (2005) made it clear in his account of video conferencing that two of the key factors for success are technical support and site facilitators, which echoed the findings of numerous studies related to schools (Comber et. al., 2004, p38 and p62; Doggett, 2008, p40; Lawson and Comber, 2005, p8). This study is interesting in that there was minimal technical support available during the sessions and there were no site facilitators. Reflecting on the study and on Gill's account, as discussed in chapter two, there are a number of conclusions that can be drawn. Firstly, we have seen in this study that successful video conferences can occur with minimal technical support and without site-facilitators, but this will increase the techno-stress of the teacher as they have to take responsibility for both the technology and the pedagogy. Whilst this can work, my experience is that techno-stress does not diminish over time. In fact, when video conferences have been running smoothly without any major connectivity problems, then there can exist an expectation, from both the technicians and those at the receiving endpoints, that the teacher should continue to deliver successful video conferences.

Secondly, some teachers are already reluctant to use technology in the traditional classroom environment because of relatively low-level techno-stress. When I use technology, such as interactive whiteboards or voting systems, to teach in the classroom, I experience less stress now than I did previously. This is perhaps because I now have a better understanding of how much techno-stress I can cope with through my video conferencing experiences and so consequently I have a greater appreciation for the safety of the classroom environment. Thinking beyond the scope of this study, it could be that supporting those teachers, who are reluctant to use technology generally,

to deliver some video conferences might actually increase their confidence with technology in the classroom. Perhaps this is an avenue for further research, although it is believed by some that, for such interventions to work, flexibility and a positive attitude are required on the part of the teacher (Carville and Mitchell, 2000, p45; Miller and Glover, 2002, p18), which may be difficult to implement if the teacher is already experiencing techno-stress in the face-to-face environment.

The last point to make here is that of control. Gill's suggestions, that there should be site facilitators and technical support, shift the control of the teaching and learning environment from the children to other adults. I can empathise with this need for control as was demonstrated in chapter five when I discussed how I changed activities more frequently than I would in a face-to-face lesson, so that the pace of the lesson would be fast, and hence there would be less opportunity for the children to go off-task. However, reflecting on this study, one of the positive outcomes was that the children had some autonomy over their own learning. The children decided who was going to present their work, what they were going to present and how they were going to present it. They had control over much of the technology and the pedagogy, and whilst this was uncomfortable for me and increased my techno-stress, it was beneficial for the children, since it helped them to develop their own mathematical thinking skills as discussed in chapter five.

There was some discussion in chapters one and two about the configuration of endpoints that should be used for this study and generally about good practice in relation to endpoint configuration. The decision to use a one-to-some endpoint configuration was taken before the pilot project began and this has remained the case throughout. In chapter two, we discussed the idea of the virtual presence of participants affecting the effectiveness of a video conference (Austin et. al., 2003, p66; Butler and Fawkes, 1999, p47; Jacobs and Rodgers, 1997, p296). Choosing a one-to-some configuration helped all of the children at each endpoint to have a virtual presence as each of them could be seen and heard at any point. However, the observations in chapter four showed that some children

intentionally chose not to have a virtual presence and instead decided to provide 'whispering' support from off-camera. On some occasions, this was because I had asked for a specific individual to present, but on other occasions, the children had decided themselves. That is, the child who had made the most progress on the mathematical tasks was not always the child who was most confident in presenting their ideas. The children sometimes chose their best presenter and then provided 'whispering' support from off-camera, which was categorised into emotional, numerical, technical and cognitive. In the context of Hu's research, I would argue that virtual presence is important and I would agree that it does impact on the effectiveness of a video conference. However, this study demonstrates that perhaps it is only the option to have virtual presence that is important since some participants may use alternative methods, without the need for virtual presence, to achieve the same outcome of an effective video conference.

I would now like to consider the screen layouts that were used in this study and discussed in detail in chapter seven. This is of particular importance, since at the time of writing, the existing research related to screen layouts in this context is minimal, and so perhaps this study may provide a starting point for others. The screen layouts can be broadly divided into 'continuous presence' and 'non-continuous presence', and this is determined by whether or not you can see all of the endpoints all of the time. The choice that is made here could have a significant impact on the effectiveness of a video conference. However, it is not as straight forward as some screen layouts being better or worse than others. Instead, there are clear benefits offered by the various layouts and the teacher delivering the conference should choose the most appropriate option. It should be noted here that it is the teacher that should choose the layout, and not a technician, as this choice will impact on the effectiveness of a video conference rather than its success. When I began this study, I choose to use the continuous-presence option so that I could monitor the children's behaviour at the other endpoints. This worked well in terms of behaviour management, although it was not ideal that the presenting endpoint did not fill the whole screen. By the end of the study I had used a number of

screen layouts and I found that my preferred option was to use non-continuous presence such that the presenting endpoint filled the screen and I could view all other endpoints, and such that all endpoints could be seen by all of the participants when nobody was presenting as discussed in chapter seven. Also, when the children were presenting, they could view their whole audience rather than just one endpoint, which I believe was helpful for the children. This is in contrast to Thorpe (1998) who argues that one of the advantages of video conferencing is that it "eases social interaction through being one step removed from reality".

In chapter two, I discussed how Thorpe (1998) believed that no significant changes were required in teachers' practice and knowledge. This was in contrast to many others (Comber at. al., 2004, p38; Anderson, 2008, p120; Gage, 2002; Knipe and Lee, 2002; Jacobs and Rodgers, 1997; Couzins, 2004) and I would also disagree with Thorpe, since the evidence in this study suggests that a new approach is required, which is quite different from that of the traditional classroom environment. For example, let us consider behaviour management. It is immediately obvious that new approaches are needed, since some of the standard approaches, such as confiscation of items, are not available in a virtual environment. However, the virtual environment does bring with it a number of alternatives not normally available in the traditional classroom environment. The ability to record the session can act as an incentive for children to behave. Similarly, if far-end camera control is available, then there is the ability to monitor the children less intrusively and to mute or disconnect endpoints. The key point to make here is that whilst some behaviour management strategies are not available in the virtual environment, some additional strategies become available as a direct result of the virtual environment. This is a good example of the constraints of video conferencing becoming opportunities if addressed appropriately.

An area that is different when delivering sessions in the virtual environment is planning. If the technology fails when teaching in a classroom teachers are generally very good at spontaneously

generating an alternative plan for the lesson. This is not so simple in the virtual environment since a technical failure may result in a complete loss of communication between the teacher and the children. There were a small number of occasions in this study during which the planning was insufficient, in that the children were off task and I was not able to communicate to them what they should be doing. The use of work booklets was helpful and they were used by some children. However, I believe the planning should include a more specific back-up plan, which tells the learners exactly what they should do in the case of a technical failure. This should be specific to both the session being delivered and the school that the children are from as different schools may have different preferred arrangements in such circumstances.

Another distinct difference between the virtual sessions in this study and more traditional classroom sessions was the use of theme tunes and music to signal key points within the lesson. If I was to use a theme tune to start off every lesson that I delivered in the standard classroom, my experience suggests that this would probably get the learners over-excited and result in poor behaviour. However, this same action appears to have the reverse effect when used in the virtual environment, which echoes the findings of Stover (2009) who reported that music can act as an auditory trigger. In the context of this study, I can only speculate as to why this might be the case as there are many factors involved. I would suggest that video conferencing is not always a fully interactive process, since for a significant proportion of the time the children are watching and listening to those children at the other endpoints and to me. This experience is very similar to watching television and to use a theme tune for an 'interactive television programme' would appear to be more normal than to use a theme tune for a face-to-face lesson. Furthermore, it is not uncommon in children's educational television for theme tunes to be used to signal key parts of the programme (Wright and Huston, 1981). The effect of this is to provide structure to the programme and to keep children on track of what is happening and it is possible that the use of theme tunes in this study has had a similar effect as described in chapter seven.

This idea that not all of a video conference is interactive is not a new idea (e.g. Heath and Holznagel, 2002, pp10-11) and in chapter two there was a description of an experiment researched by Laouenan (1999), which reported that on average only 16 minutes of a 52 minute session was interactive. Generally, it could be argued that video conferenced lessons can be regarded as a more passive experience than standard classroom lessons. This is supported by the evidence in this study, which shows that a significant proportion of the virtual lessons were spent presenting, listening and watching rather than interacting.

To close this chapter-section, I will now return to the table presented at the end of chapter two, which summarised the points of tension in the literature review. A new column has now been added to this table so that the findings of this study can be reflected on in the context of those initial themes.

Point of Tension	Majority View	Minority View	In the context of this
			study
Site facilitators	Site facilitators are an essential requirement to ensure the smooth running of a video conference. They should manage behaviour and learning at the remote endpoints.	When site facilitators have not been available, video conferences have still taken place successfully.	If strategies are put into place for remote behaviour management, monitoring and intervention, then it is feasible to run a successful and effective video conference without using site facilitators.
Training	Training and careful planning are paramount in preparing for participation in a video conference.	Some presenters naturally adapt to using video conferencing technology because they are willing to be flexible.	Willingness and flexibility are important when working with video conferencing technology, particularly when there are technical difficulties. Training is helpful in learning about remote management strategies as discussed above.
Rationale	The justification for using video conferencing should be for pedagogical, and not financial or logistical, reasons. Video conferencing is a potential method of distance teaching and learning across multiple locations.	Video conferencing can be as good as face-to-face teaching (i.e. students have produced similar scores in tests)	The endpoints in this study were geographically close together. It would have been feasible to deliver these sessions face-to-face, but video conferencing was deemed to be more appropriate when balancing the opportunities and constraints of the technology.
Reliability of the technology / technical support	The reliability of the technology is a key factor in ensuring that video conferences are successful.  Technical support is particularly helpful in resolving technical issues as they occur, although they are few. When there are technical issues, they can result in a reduction in learning time.	Remote technical support is sufficient to resolve most problems that occur. For example JVCS have a telephone helpline.	Site facilitators often provide a basic level of technical support and without them, technical problems can be more difficult to resolve.  Many of the connectivity problems in this study were a result of using IP video conferencing rather than ISDN and were worsened through the general lack of technical support available at the endpoints.
Interactivity / virtual presence	Interactive teaching and learning is a key factor in ensuring an effective video conference. This is harder to achieve when there are large groups at the endpoints. A smaller number of participants can increase their virtual presence and improve interactivity.	In situations when there would have been limited face-to-face activity, for example lectures, it is acceptable to use large numbers of participants at the endpoints.	Six children were able to work interactively on mathematical problems through video conferencing. Interaction occurred mostly within endpoints, but also between endpoints.
Pedagogical approaches	Video conferencing supports dialogue and collaboration.	Video conferencing may support instructional or didactic teaching.	Collaboration is an aspect of mathematical problem solving and video conferencing was able to facilitate the children's needs in discussing their solutions with me.

Table 5 – Summary of the points of tension in the context of the present study

# 9.2 Risks, Routines and the Early Structure

In chapter one, there was a brief discussion about the early decisions that were made in the pilot project and at this stage it would be interesting to consider why the early structure (three activities plus a regular weekly activity) remained throughout the main study. This begs the more general question about why teachers teach in the way that they do and in particular why maths teachers teach in the way that they do. Chapter one suggested that these relate to the personal values, the situational demands and the professionalism of teachers and this is supported by Fessler and Christensen (1992, p36), who produced the diagram below to represent the influences on a teacher's career.

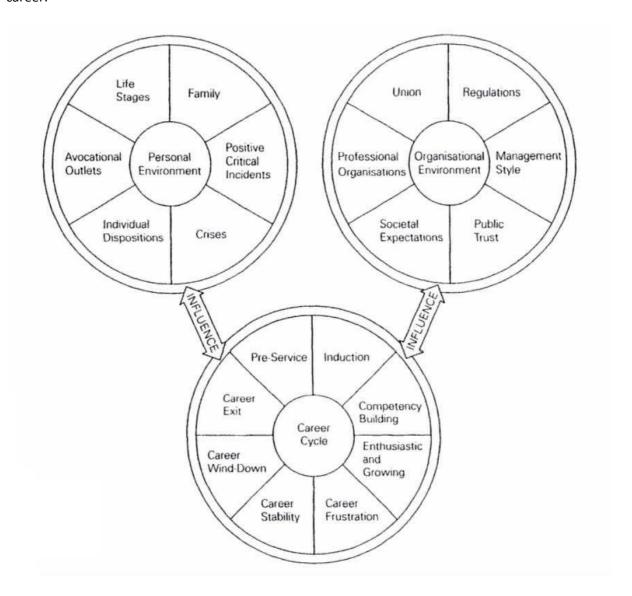


Fig. 38 - Dynamics of the teacher career cycle (reproduced from Fessler and Christensen, 1992, p36)

In thinking about the why the early structure remained it may be useful to think about why teachers adapt their practice over time. Day (1999, p2) states that 'teachers naturally learn over the course of a career', but adds that they can only develop actively and 'cannot develop passively'. The implication here is that for teachers to develop, they must choose the way in which they would like to develop and then proactively seek to make this happen. In the context of this study, this suggests that there are two possible reasons why much of the early structure has remained. The first is that I was unaware at the time of how I should develop both personally and professionally. Any such improvement could have led me to change my practice and hence the early structure. However, the second possibility is that I was aware of how I should develop, but made a conscious decision to keep the early structure the same. Reflecting on this, I would say that techno-stress and the need for control have both played a part in retaining the early structure. Throughout the study, I have been aware that there may be better ways of structuring the sessions and I have even verbalised my ideas to others. However, in the interests of maintaining control and maintaining a reliable structure for the children, I chose to keep changes to a minimum. In the context of delivering video conferences, making additional changes may result in an increase in techno-stress on the part of the teacher. Given that such situations may already be loaded with techno-stress, any changes would need to be carefully considered before being implemented. Looking back at the changes that were made across the study is interesting, since it shows that changes were made to resolve issues rather than to improve practice. For example, the scheduling of the sessions was changed to resolve an issue of timetabling. It could be argued that this is a classic example of me not trying to fix something that is not broken, but I would argue that it is more likely to be about the fear of taking risks in an environment that is already perceived to be uncertain.

The use of technology within the classroom has increased over the past decade and it could be argued that teachers generally believe that technology can improve the quality of the learning experience that children have. This view is supported by the current government, who have

increased investment into education technology from £102million in 1998 to £640million in 2005 (Buckingham, 2007, p8). Indeed, it is thought by some that video conferencing in particular can provide a high quality medium for collaborative learning (Uden, 2006, p204). If educational technology is to be used to enhance learning, then it is not simply a case of using the technology and the learning will automatically get better, since the consequences of using technology are often uncertain (Buckingham, 2007, p177). It is about ensuring that the technology is used effectively, which can be achieved through using well formed routines and strategies to provide an appropriate framework for teaching and learning to occur. This study has focused a lot on the various teaching strategies used in the context of video conferencing, for example behaviour management and assessment, and it has become clear that certain routines have developed.

There are various definitions of 'routines' in the literature, but for the purposes of this study I have chosen to sue Yinger's definition. Yinger (1979, p165) describes routines as 'established procedures whose main function is to control and coordinate specific sequences of behaviour'. This makes the link between the implementation of routines and the desire for control more explicit, and perhaps provides an insight as to why those strategies that evolved in this study were generally those that allowed me to take more control of the virtual environment. Sawyer (2004, p18) makes it clear that teachers need routines to respond to the unique needs of the classroom. Indeed, my experience in this study was that the demands of the virtual classroom can be particularly challenging.

The interpretation of Yinger's definition of routines is important since it incorporates the idea of control. This is not to say that routines are used to control the children or to give control to the children, rather that both the children and I used routines in various ways to maintain control of the often unpredictable virtual environment.

The point about the early structure remaining unchanged is that this structure provided a routine for both the children and me, which helped me to feel in control. It could be argued that any structure that managed to successfully facilitate such routines would have remained unchanged and perhaps worked just as well. Indeed, in thinking about routines, one could reflect on the face-to-face sessions that took place before the video conferencing sessions began. These were initially introduced during the pilot project as a direct result of practical issues, but the following year I intentionally planned to have these sessions. It is clear to me now that these sessions were crucial in that they modelled the routines that I wanted the children to use when tackling mathematics enrichment tasks, and perhaps it is a weakness of this research that a greater emphasis, in relation to data collection, was not placed on these sessions.

There are many categorisations of routines in the literature. For example, Shumaker (2002, p804) classifies routines into organising routines, understanding routines, recall routines and application routine, amongst others. As well as using Yinger's definition of routines, I have also decided to use part of Yinger's classification of routines. Yinger (1979, p165) divides routines into several categories and the three with most relevance to this research are:

- activity routines (planning and teaching)
- instructional routines (learning)
- management routines (behaviour management and 'rules')

In thinking about what routines were established and used in this study, it is helpful to use this categorisation. Below are some of the routines used in this study divided according to these categories, although it should be noted that sometimes the routines do not fit neatly and exclusively into any one category. Furthermore, some of the routines were established and used by the

children rather than me. The result is that many of the routines below are designed to directly facilitate teaching, but a small number of them are designed to directly facilitate learning.

# **Activity Routines**

- Session structure (three activities plus the weekly activity)
- Instruction, guidance and feedback structure (as shown in chapter five)
- Regular weekly sessions (i.e. same time every week with the same children)
- Use of voice over PowerPoint (as discussed in chapter five)

# **Instructional Routines**

- Delivery of face-to-face sessions during the Autumn term
- The use of the weekly activity (i.e. Countdown and Who Wants to be a Millionaire?)
- Whispering support from off-camera (as discussed in chapter four). This routine was
  developed by the children and it gave them a structure for what to do to support each other
  if they got stuck during their presentations. Perhaps this routine also helped to control the
  children's techno-stress.

# **Management Routines**

- Virtual etiquette for video conferencing (i.e. the use of the mute function, 'buzzing in' when stuck, having a chair for the conference)
- Monitoring progress with an appropriate screen layout (preferably a four quarters split without continuous presence as discussed in chapter seven)
- Regular use of praise and school names (as discussed in chapter eight)
- Using camera presets for flipchart, clock and the whole group
- Frequently changing activities to maintain the high pace of the session

In thinking about the rules of virtual etiquette, this study confirms the view of Leinhardt (1987, p137) that rules may be used to establish routines. The children knew when it was and was not appropriate to speak during the video conferences. For example, it was very rare for the children to interrupt me during the instruction phase, but they regularly 'buzzed in' if they were stuck whilst working away from the camera. This demonstrates awareness from those children at the other endpoints and a respect for the rules of virtual etiquette.

The high pace of the sessions in this study has been discussed several times throughout this thesis and I now believe that the high pace was related to maintaining control. Activities were changed frequently to maintain the high pace and games (i.e. *Countdown* and *Who Wants to be a Millionaire?*) were used to engage the children and keep them on task. This is in keeping with findings of Leinhardt (1987, p170), who stated that if games are used regularly they can maintain both interest and high pace. More recently, a DCSF-commissioned report on learning behaviour concluded that games and quizzes are an essential tool for keeping learners engaged in the classroom (Steer, 2009, p103). Indeed the report names *Who Wants to be a Millionaire?* specifically as being a good starter activity (Steer, 2009, p110).

Yinger (1979, p168) states that routines can be effectively used in the classroom to improve and simplify both planning and actual teaching, and he goes on to argue that routines reduce students' anxiety. In the virtual environment, I would go further than this, since this study has shown that routines can also help to reduce teachers' anxieties, including, perhaps, techno-stress. This research has shown that routines can be helpful in achieving successful and effective video conferences, and this is summarised well below.

"In order to set the stage for effective teaching, a teacher must design a way in which to structure the classroom and conduct a lesson... by teaching and getting skilled performance levels in the execution of routines"

Leinhardt, 1987, p172

The context in this study was mathematics as was the case in Leinhardt's study, in which he claimed that the use of routines is one benchmark of a successful mathematics teacher (Leinhardt, 1987, p135). My study agrees with this, since it showed that routines can also support mathematics teachers in the virtual environment.

Yinger (1979, p164) states that teacher planning is the major tool by which teachers manipulate the environment that will later shape and control their own behaviour. The reader will remember that in chapter seven, the planning of the video conferencing sessions was discussed. Planning for video conferences is different to planning for face-to-face sessions in several ways. For example, the teaching and learning environments are different and care needs to be given to both. Secondly, the classroom environment may be unpredictable, but teaching in the virtual environment could perhaps be even more uncertain due to the additional technical issues that need to be planned for. Interestingly, Floden and Clark (1988, p8) suggest that uncertainty can be reduced through using routines.

Reflecting on the routines and strategies used in this study, it could be argued that they were generally implemented with the aim of preparing and planning for uncertainty. Floden and Clark (1988, p3) discuss the distinction between the uncertainty that teachers perceive and the uncertainty seen by outside observers.

"A teacher might, for example, think that the proper content of mathematics instruction is a given (i.e. nothing to be uncertain about), whereas a university professor might consider this to be a central problem of mathematics education (i.e. highly uncertain)"

Floden and Clark, 1988, p3

In the context of this study, this brings the dual role of "Adam the teacher" and "Adam the researcher" sharply into focus. Perhaps some of my anxieties during this research were due to the mismatch of uncertainty between teacher and researcher. This might be a natural consequence of a reflective and reflexive research design, but it is worth considering whether or not the effects were heightened in this case due to techno-stress.

One specific aspect of uncertainty that I will look at in more detail at this stage is that of the independent learning of the children in contrast with my desire to remain completely in control. There is a contradiction here, since for the children to become truly independent as learners, which is arguably the point of enrichment, I would need to take a step back and be prepared to lose some control. Floden and Clark summarise this well:

"This tension between preserving autonomy and exercising authority cannot be neatly resolved, though a few superhuman teachers ... Christ and Socrates... seem to be able to transcend these transitions"

Floden and Clark, 1988, p7

In considering uncertainty more generally, Floden and Clark (1988, p14) do make the case that it can add interest and excitement to teaching, although they do acknowledge that stress is a psychological

side effect of uncertainty. Again, in this study, it would appear that the equivalent anxieties were caused by techno-stress.

At this stage, I would like to make clear the distinction and the connection between routines, uncertainty and teaching strategies. The use of routines reduces uncertainty, which in turn allows teachers to choose strategies that will lead more efficiently to their desired outcomes (Floden and Clark, p1988, p9). Routines are designed to provide structure, whilst strategies may facilitate a variety of desired outcomes, e.g. independent learning. These two concepts are not mutually exclusive, but perhaps it could be argued that routines must involve repeated patterns of behaviour whilst strategies may involve more ad-hoc decision making.

# 9.3 Conclusions, Reflection and Individual Development

At this stage, it is worth returning to the main research question as defined in chapter one.

How do teaching strategies evolve when delivering a course of mathematics enrichment sessions using the medium of video conferencing?

To answer this, I will consider each of the sub-questions in turn. I will then consider the strengths and weaknesses of this study and draw some final conclusions.

# What decisions are made in the planning and delivery?

In planning and delivering these video conferences, the key decisions were in relation to the session structure, content, potential technical difficulties, virtual etiquette and virtual presence. The endpoint configuration was crucial in ensuring that the sessions were as effective as possible. The evidence in this study supports the view that having around six of participants at each endpoint can provide adequate virtual presence when required. Although there may be numerous session

structures that might work, the evidence in this study suggests that maintaining a high pace by using three activities and a regular weekly activity can work well in supporting the delivery of an effective video conference. The chosen content for this study were mathematics enrichment tasks, which worked well perhaps because they were open-ended by design and hence differentiated the children by outcome. Other types of task might also have worked, but the evidence in this study suggests that open-ended tasks that encourage independent learning can be naturally facilitated by video conferencing technology. There are numerous technical difficulties that can occur and the most challenging of these is to lose communication with the other endpoints altogether. Any planning should include a back-up plan for those occasions when such severe disruptions occur. Lastly, virtual etiquette is used by most video conferencing suppliers and this study shows that rules are essential to ensure that things run smoothly. This includes basic ideas such as appointing a chairperson and having the microphone on mute when not presenting to the camera. Whilst this does help to remove some potential communication problems, it can also remove some of the spontaneity of the face-to-face environment.

# What strategies are used and how do they evolve?

Many of the teaching strategies used in the virtual environment are the same or similar to those used in the classroom environment. However, there are some areas in which specifically developed strategies need to be used. Behaviour management is one such area, since the lack of physical presence of a teacher at the endpoints could create some challenging situations that need to be resolved. Similarly, non-verbal communication such as eye-contact and body language are of great importance and can be consciously used to improve the effectiveness of a video conference. One strategy that is useful in the virtual environment, but can have the opposite effect in the classroom environment, is the use of theme tunes and music at key points during the sessions. This study 'flew the kite' that there is a link with children's educational television, which is particularly interesting and might be an avenue of further research. In considering how these strategies have evolved, this

study found that changes were often implemented to address problems. This resulted in a set of strategies that worked in providing successful and effective video conferences in this context, but there is no way to be sure that alternative strategies could not have had similarly desirable outcomes.

# What is the experience of the children?

The children enjoyed the experience and they did some new mathematics as a result of taking part in this study. They became more independent as learners since they were physically alone in the classroom and they experienced multiple approaches of addressing the same question. The sessions encouraged the children to work together and to support each other through learning conversations and 'whispering' support from off-camera. Some of the mathematical tasks were too difficult for the children, but the impact of this was not particularly detrimental since the high pace of the sessions moved the children onto new tasks relatively quickly.

## Wider Recommendations, Strengths and Weaknesses

Before considering the strengths and weaknesses of this research, it is worth considering what advice I would give to policy makers, teachers and children if they were given the opportunity to be involved with using video conferencing technology in this way. That is, I will now discuss whether or not they should choose to get involved and if they do, what support and training is likely to be required. In the case of policy makers, there can be long-term financial benefits to video conferencing, although significant short-term investment would be required for the initial set up of the hardware and the implementation of such a scheme. Indeed, once schools are familiar with using the technology, it could easily be used to support similar work in other curriculum areas. If policy makers would like to improve students' independent learning in mathematics, then they ought to be looking to implement such schemes in schools, but they should be cautious of the technical issues that can arise, which may cause some teachers to not even consider video

conferencing. In fact, whilst there has been significant growth in the investment of educational technology in recent years, teacher confidence and competence in using the technology has actually declined (Buckingham, 2007, p8). That said, there were lots of teachers across the country who initially claimed that they would never use the interactive whiteboard, yet it is now commonplace in many classrooms. Perhaps a similar outcome could be expected if video conferencing was introduced more widely.

In respect to teaching and learning, there are both opportunities and constraints. Certainly, I would not advocate replacing face-to-face teaching with lessons delivered by video conference. However, this study has shown that using video conferencing technology alongside traditional teaching can create a positive, unique learning environment.

For teachers, there is much to gain from delivering video conferences. In addition to engaging their learners innovatively and facilitating independent learning, there is also an inbuilt opportunity for teachers to reflect on their own practice and for them to record lessons in a very direct, yet unobtrusive way. However, teachers need to be aware of the additional stress, i.e. techno-stress, that they will be putting themselves through. To reduce this, they should ensure that they have appropriate technical support at all of the endpoints as well as sufficient training to ensure they can maximise the potential of the virtual environment. Furthermore, this study can suggest some routines to teachers that may help them to structure their delivery more appropriately (Sawyer, 2004, p18). That said, I should add a note of caution here. All contexts are different and so whilst these routines will serve as a good starting point for teachers, they will almost certainly need to be adapted to the specific situation in which they are being applied. Teachers themselves also need to be flexible, as they would be in the traditional classroom, since the personality of the teacher will be reflected in their choice and application of routines and strategies.

For children, the situation is much clearer. So long as they have the necessary training and technical support, then video conferencing should be an enjoyable and valuable learning experience for them. Not only could it support their academic development, but it may also support the development of their interpersonal skills and their confidence. This study has shown that having six children at each endpoint can be effective for teaching and learning, which supports the wider literature.

The recommendations that have been made here are based on the specific circumstances in relation to this study. However, it should be made clear that in considering whether or not video conferencing will enhance or improve teaching and learning, both the role and use of the technology are key. Throughout this study, it has been argued that there are both opportunities and constraints when using video conferencing in education, but the relevant importance of these will differ between contexts. It is possible that the decision to make use of video conferencing in this study was appropriate due to the social aspect of the required teaching and learning environment, yet in other contexts video conferencing may not be appropriate. Ultimately, I would argue that video conferencing should be used as a teaching and learning tool in much the same way as a computer. That is, it should be used when the opportunities outweigh the constraints in comparison to more traditional face-to-face teaching, and when the user has sufficient knowledge and training to maximise the opportunities and minimise the constraints.

At this stage, it is worth reflecting on the overall strengths and weaknesses of this research. One of the strengths of this study is that is was flexible, which allowed new themes to emerge. This study has also helped to bridge the gap between research and practice since schools are more likely to consider the impact of research that is innovative and timely. This study has been excellent as a tool for obtaining descriptive data about a relatively new application of video conferencing technology within mathematics education. However, the broadness and richness of the data collected has made it difficult to be as analytical as I would have liked. In particular, the volume and richness of

the video data has proved to be problematic and this was compounded by technical difficulties in relation to the recording of the video conferences. If I was conducting this research again then I would ensure there was more technical support for me and I would focus the data collection more carefully. More specifically, I might look at this experience from the point of view of one of the children and have additional filming taking place at that endpoint so that I could include the interactions that took place when the children were not presenting through the video conferencing technology. I would also reconsider being both the researcher and the teacher. In this study, this occurred for practical reasons, but it would have helped me if I could have distanced myself even further.

### Personal Development

I have learnt a lot about myself in undertaking this study and in particular it has brought my own personal values into focus. As a result of this research, I am more likely to get involved in other opportunities involving video conferences and indeed I have already taken up some further opportunities to be more involved with the Motivate project. One of my key learning points in this project is to ensure that back-up plans are in place in case the technical equipment being used to capture data fails. In this case, there were issues over recording the video conferences, which increased my techno-stress notably. I would also say that I felt quite isolated when collecting the data in that I was the only individual within the school organisation interested in researching what was happening. If repeating this study again in the future, I would ensure that I had somebody else there throughout the project to support me.

# **Closing Remarks**

This study has shown that embracing new technology in the classroom can be stressful and challenging for the teacher. However, with perseverance, it is possible to develop new teaching strategies that allow the technology to have a positive impact on the teaching and learning

environment. In chapter two, the gap in the existing literature was made explicit and the contribution to knowledge of this thesis was outlined. In the context of this gap in the literature, the key findings of this study are as follows:

- Site facilitators are not an essential requirement for ensuring the smooth running of a video conference. This study has shown that the participants themselves are able to take on any required responsibilities in this area if the number at each endpoint is relatively small (i.e. between four and eight participants).
- Remote behaviour management and monitoring strategies are an important aspect of the video conferencing tool-kit for teachers. This study has demonstrated the importance of screen layouts in facilitating the use of such strategies.
- 3. The production features associated with children's educational television programmes may be able to inform effective pedagogy for teaching and learning through video conferencing. In particular, this study has highlighted the potential of using theme tunes as auditory anchors to emphasise key points during a video conference.

In considering the opportunities and constraints of video conferencing for teaching and learning, there appears to be a trade-off. On the one hand, video conferencing facilitates independent learning and allows children to access remote expertise and peers in other schools. On the other hand, it is more difficult for teachers to monitor and intervene with support and there is a reduction in learning time compared to face-to-face sessions. This suggests that perhaps there is a tipping point when it becomes more appropriate to learn through video conferencing than to learn in a face-to-face environment.

This study has shown that video conferencing technology, which is traditionally used as a tool for distance learning, can be used successfully and effectively with endpoints that are geographically close together. Whilst video conferencing has clear drawbacks in comparison with face-to-face teaching, this study has shown that there are also some pedagogical benefits in developing the children's independent learning skills if the mathematical content consists of well chosen enrichment tasks and the session structure is appropriately planned and uses well established, but flexible, routines.

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# Appendix 1 Resources Supplied for each Endpoint

# <u>List of Resources per Endpoint</u>

- ♣ 6 scientific calculators
- ♣ 3 packs of coloured pencils
- ♣ 50 x 2p coins
- ♣ Multilink cubes (10 colours x 5)
- 4 12 standard dice
- ♣ 6 exercise books (5mm squares)
- 4 A4 graph paper x 24
- ♣ A4 plain paper (1 ream)
- ♣ Plastic box (to hold resources) x 1
- ♣ 6 pairs of scissors
- ♣ Coloured counters (120 x red, green, blue and yellow)
- ♣ 3 decks of playing cards
- ↓ Laminated boards (3x3 grid, 5x5 grid, 4x6 grid, 8x8 grid, blank clock face) x 6
- ♣ Whiteboard pens (mixed colours) x 6
- ♣ Flipchart pens (mixed colours) x 6
- Flipchart paper (1 ream)
- Dead matchsticks x 60

# Appendix 2 Mathematical Terminology

# **Mathematical Terminology**

Below is a complete list of the mathematical terminology included for the tally conducted in chapter five.

- ♣ Factor
- Prime
- Perimeter
- Quotient
- Conjecture
- Cartesian
- Product
- Rotation
- Reflection
- Congruent
- Multiply
- Divide
- 📥 Area
- ♣ Net
- Triangle
- Square
- Rectangle
- Quadrilateral
- Parallelogram
- Coordinates
- ★ Kite
- **4** Rhombus
- Trapezium
- Pentagon
- 4 Hexagon
- 4 Heptagon
- Octagon
- Probability
- **♣** Odd
- ♣ Even
- Fraction
- Sequence
- Multiplication
- Division
- Calculate
- ♣ Sum
- Consecutive
- Concentric
- ♣ Equation
- Addition
- Subtraction

# Appendix 3 Video Conferencing Session Objectives and Notes

	deo	Objectives	Comments
1	a	Writing probabilities as fractions     Using sample space diagrams     Pattern spotting	In both groups, I remember the children writing down the all the different arrangements of three coins using "H" and "T" notation. However, this was not explicitly referred to as a sample space. The children were able to generalise form three coins to larger numbers of coins and one child commented in her diary about having only three coins to work with.
	b		In my diary, I wrote that the children "spotted the powers of two in the denominators". This suggests that the children were both writing fractions as probabilities and spotting patterns.
	a	<ul> <li>Maximising area with a fixed perimeter</li> <li>Exploring triangles and trapeziums</li> <li>Using basic algebra</li> <li>Linking area and perimeter</li> </ul>	In my diary, I wrote that one child in this group already knew how to find the area of a trapezium, but the others need some guidance. The children worked towards maximising the area with a fixed perimeter although none of them actually solved the problem. In fact, several children commented in their diaries about how difficult they found this task.
2	b	2 Inting a ca and permeter	In my diary, I wrote that the children in this group struggled with area of a trapezium more than the first group. I had to guide them to a solution step by step. I remember both groups coped well when I introduced the equation $x^2 = 4x$ in relation to the area and perimeter of a square. They were not able to solve the equation formally, but they did find the solution $x = 2$ using a trial and error approach and they did understand that the equation linked together the area and the perimeter of the shape.
	а	<ul> <li>Using sequences and series</li> <li>Pattern spotting</li> <li>Developing logical thinking skills</li> </ul>	It is clear from my diary entry that the children did not have enough time to spot patterns or sequences in the <i>cubes within cubes</i> task. They also approached the <i>9 colours</i> problem using a trial and improvement method. The objectives were clearly not met in this session. This is reflected in the children's diaries, with one child writing "I was lost with my ideas" and "I didn't understand what the rest of the group were doing".
3	b		I wrote in my diary about the children at one of the endpoints solving the <i>9 colours</i> task. However, this was with the assistance of a teacher and unfortunately, the children did not spot the patterns involved themselves. The children in this group did cope better with the <i>cubes within cubes</i> task and one child wrote in her diary that this task was the easiest because "it was simple adding up". However, this child had not actually spotted the sequence of numbers and was calculating the number of cubes for each layer from scratch every time.
4	а	<ul> <li>Exploring properties of odd and even numbers</li> <li>Lateral thinking</li> <li>Calculation</li> </ul>	SESSION CANCELLED (SNOW)
	b	• Calculation	SESSION CANCELLED (SNOW)
5	a	Exploring number properties     Using factors of numbers     more broadly	The video data shows the children discussing what a factor is and eventually agreeing on a correct definition. They used this idea of factors in the context of the <i>Block 4</i> task and again the video data shows that they were able to clearly distinguish between a factor and a multiple. In my diary, I wrote about a change in task from <i>Helen's conjecture</i> to <i>abundant numbers</i> and the children had to fully understand the properties of factors to attempt this, which they did successfully.
	b		The video data shows that the children were able to distinguish between a factor and a multiple. This was again demonstrated in the <i>Block 4</i> task. However, the children struggled to find a counter-example in <i>Helen's Conjecture</i> .

6	а	Developing communication of mathematical strategies     Making logical decisions	The children's diaries show that they enjoyed trying to find winning strategies, but that they also found it difficult. The video data shows that once the children have got a partial strategy they are able to explain it clearly. However, they children have not always come to discover their strategies by following a logical approach. For example, one child stated that his strategy was good because he had never lost a
	b		game but he did not take into consideration the fact that he played the same opponent every time, who happened to be weaker than him.  In my diary, I wrote that the children communicated their ideas and strategies using counters blu-tacked to a mini-whiteboard. This was very clear to follow and is definite evidence that the first of these two objectives has been met. However, it is difficult to be sure about whether or not the decisions made in reaching these strategies were
	a	Reframing problems     Interpreting tricky problems	logical since they generally occurred away from the camera.  In my diary, I wrote that the children were not able to solve the 4x6 milk crate problem without me helping them to reframe it (i.e. telling them to consider where the spaces would be rather than considering where the bottles would be). The children's diaries show that they found the 8 queens task difficult as some of them had not played chess before and did not know much about how a queen moves on a chessboard. However they were able to interpret the problem and eventually find a correct solution.
7	b		In my diary, I wrote about the children's discussions over whether a rotation of a correct solution qualified as another unique solution. The video data also shows the children having similar difficulties to the first group in solving the 4x6 milk crate problem. There is evidence in my diary to suggest that some of the children did not like the idea of reframing, since when they found a correct solution, they maintained that they had solved the problem using their original trial and error approach and had not used the reframing hint that they had been given. A teacher from one of these schools contacted me after the session to say that the children had been working on the knight's move problem all afternoon and had come up with a correct solution. They recorded their solution by using a laminated grid and numbering the squares from 1 to 64 in the order that the knight landed on them. I felt this was a very and dedicated impressive performance from the children
8	а	<ul> <li>Exploring properties of shapes</li> <li>Communicating mathematical ideas in a logical order</li> </ul>	The video data shows the children struggling to come to grips with the idea shapes that are mathematically similar. However, they used a ratio test on some of the rectangles and squares in their booklet and were beginning to make sense of it. My diary states that the children approached the <i>squares on a chessboard</i> task in a logical way by considering 1x1 squares, then 2x2 squares, etc.
	b		The video data shows the children using numbers on their diagrams to help with communicating their mathematical ideas. In my diary, I have recorded the fact that one group of children decided to use a real laminated chessboard to help in solving the <i>squares on a chessboard</i> task.
9	а	Exploring properties of number     Calculation	SESSION CANCELLED (INTERNET FAILURE)
	b		SESSION CANCELLED (INTERNET FAILURE)

	I		The state data shares the shift down sets at the state of
10	а	<ul> <li>Using coordinates</li> <li>Properties of shapes</li> </ul>	The video data shows the children using the coordinates to write down the clues for the location of the buried treasure in the <i>Treasure Island</i> task and my diary states that they did this "without too much trouble". The video data shows the children wasting a lot of time drawing out inaccurate girds. This may well be my fault since I did not give them any pre-prepared sets of axes. The result was that only a limited amount of time could be spent considered the rotational and reflectional properties of the shapes they were drawing.
10	b		In my diary, I wrote that the children were able to use the coordinates given in the question to find the location of the buried treasure "without very much guidance". Indeed, one child wrote in her diary about the <i>Treasure Island</i> task stating "I find co-ordinates quite fun". As with the previous group, the children wasted a great deal of time drawing the axes rather than concentrating on the properties of the shapes themselves. The children did consider some of the rotational and reflectional properties of the shapes, but only for a limited time.
11	а	Exploring properties of binary numbers, square numbers and prime numbers	The video data shows me explaining that the <i>guesswork</i> task involves using powers of two and I do mention binary numbers. However, the children are not given the opportunity to explore binary numbers further. My diary states that during the <i>Never Prime</i> task, the children did investigate the number properties of certain calculations and discovered that the answers were always multiples of three. After some prompting, they were able to be more specific and say that the answers were all multiples of nine. Some of the children might have realised at this stage that the multiples of nine are a sub-set of the multiples of three, but nothing was explicitly vocalised about this. During the last task, <i>Number Rules OK!</i> , the children made good progress on solving the problems. I was pleased that one of the children asked about the meaning of word "quotient" as this helped to improve the children's mathematical vocabulary.
	b		I wrote in my diary that the children at Angelford Primary School and Daleway Primary School were able to perform the magic trick described in the <i>guesswork</i> task, but the children at Eastport Primary School struggled with this and did not have very much to say. During the <i>Never Prime</i> task, the video data shows the children quickly discovering that all of the answers are a multiple of nine. However, the video data also shows that there is a teacher in the room with these children who appears to be providing them with a lot of help. As such, it is difficult to be sure whether or not explored the properties of their numerical answers themselves or if they were told the answer. Square numbers were not mentioned at all in either of the two conferences (11a or 11b) since they were part of the final task, <i>ten hidden squares</i> , which was not completed due to time constraints.
12	a	<ul> <li>Developing logical thinking skills</li> <li>Exploring nets of shapes</li> <li>Using trial and improvement</li> </ul>	The video data shows the children thinking logically and coming up with good solutions for two of the tasks in this conference, namely <i>five quick problems</i> and <i>sweetshop</i> . In the latter of these two activities, I had initially thought that the children might use a trial and improvement approach, but they were actually much more systematic. I wrote in my diary that "the children did well on this activity". As the children were doing so well, I used a task call <i>chocoholics</i> , which is not listed on the original lesson plan. This task also required the children to uses systematic and logical thinking and again my diary states that "the chocolate bar question was also enjoyed by the children". The video data shows the children tackling the <i>cut nets</i> task without too much difficulty and this is supported by my diary, which states that the children completed the task with "relative ease".

	b		During the <i>five quick problems</i> task, the children came up with some good ideas. However, my diary states that the children struggled with the <i>sweetshop</i> task, but they did manage to solve the problem after some guidance from me. The video data shows that the children were okay with the <i>cut nets</i> task and this is supported by my diary, which states that "the children worked well on this". This is in contrast to one of the children's diaries in which it states "I disliked cut nets the most because it was really confusing". The same child wrote "It was quite a challenging session". However, another child in the same sessions write in their diary that <i>cut nets</i> was "fun and easy".
13	a	Developing logical decision making for mathematical games	The children did think carefully about their decisions when playing make 15 during this session. My diary states that some of the children came up with the idea of a blocking strategy, which I was pleased about, but equally some of the children claimed to be getting a draw at the end of every game, which is very unlikely. The video data shows that once these issues with the understanding of the rules of the game had been ironed out, the children were able to make some logical decisions.
	b		My diary states that the children had lots of good ideas about possible winning strategies for the <i>make 15</i> task and that they were able to put them into practice by playing against me over the video conferencing link. Similarly, I wrote in my diary that the children developed some good ideas for the <i>got it</i> task.

Appendix 4
Glossary of
Abbreviations
and Terms

# **Glossary of Abbreviations and Terms**

ADSL Asymmetric Digital Subscriber Line

AOL America Online Inc.

ARPANET Advanced Research Projects Agency Network

AT&T American Telegraph and Telegraph

Bandwidth The larger the bandwidth of an internet connection, the greater the amount of

information that can be transmitted and received per second

Becta British Educational Communications and Technology Agency

BERA British Educational Research Association

Broadband This refers to an internet connection with a large bandwidth

CPD Continuing Professional Development

DCSF The DCSF (Department for Children, Families and Schools) is a Government

department

DfES Department for Education and Skills

DVC Desktop Video Conferencing

DVD Digital Video Disc

Elluminate Remote tuition platform

Endpoint This is the stand-alone unit located in the room with the participants of a video

conference. The unit often has a camera built in with connections for televisions, projectors, speakers and microphones. It is usually operated by a remote control

similar to what one might expect for a DVD player or television

GCSE General Certificate of Secondary Education

Global Leap is a not for profit organisation funded by subscription from UK schools

to provide help, support, develop and extend content for video conferencing in the classroom. It also gives support to content providers and identifies appropriate

contacts and support internationally.

H.239 A video conferencing protocol that allows multiple signals to be transmitted

simultaneously

H.323 This is a type of IP-based video conferencing designed for multimedia

communication

HP Hewlett Packard

IBM International Business Machines Corporation

ICT Information and Communications Technology

ISDN Integrated Services Digital Network

JVCS Janet Video Conferencing Service

Key Stage The education system in England is divided into five key stages; key stage 1 (5 to 7

years old), key stage 2 (7 to 11 years old), key stage 3 (11 to 14 years old), key stage

4 (14 to 16 years old), key stage 5 (16 to 18 years old)

LA The LA (Local Authority) is the part of the local DCSF Government structure

Magic DVD Ripper Computer software that allows DVDs to be converted to an editable format

MDVC Multipoint Desktop Video Conferencing

MMP Millennium Mathematics Project

Motivate is a real-time video conferencing project for schools, providing maths,

science and cross-curricular video conferences and linked projects for students aged

5 to 19 internationally

MSN Microsoft Network

NAGTY National Academy for Gifted and Talented Youth

Nrich A branch of the MMP dedicated to problem solving

NVivo Computer software to assist with coding qualitative data in textual format

OfSTED Office for Standards in Education

PC Personal Computer

PicTel PictureTel (acquired by Polycom in 2001)

Pinnacle Computer software used for editing video data

PLNs (Primary Learning Networks) are groups of schools working together towards

strengthening pupil learning and implementing effective CPD programmes. Funding

is provided centrally through the DCSF.

QCA Qualification and Curriculum Authority

SATs (Standard Attainment Tests) are Government benchmark examinations. At key

stage 2, the highest score that can be achieved is level 5

SSAT The SSAT (Specialist Schools and Academies Trust) is an independent organisation

responsible for Academies and schools specialist college status in England

THES Times Higher Education Supplement

TLA Teaching and Learning Academy

TTA Teacher Training Agency

US United States

VGA Video Graphics Array