

Conclusion

The principal area of discussion of the results will concentrate on how the pupils interacted with the adults, linking this to issues of child development in relation to children with PMLD, and outlining the researcher's view of successful approaches to interaction by the adults that could be thought of as 'good practice'.

The results indicate that although half of the pupils touch the interactive whiteboard more than they use the touchscreen of the desktop computer, for the other half the opposite is true. What appears to be an unclear outcome in trying to decide if interactive whiteboards are 'better' than touchscreens on desktop computers can actually be read as very direct evidence for the place of both technologies within special schools. Examples of how individual pupils work more effectively in one situation compared to the other will be discussed in detail further on, including reference to how the method of touch varies within each pupil as well as between pupils.

The third area of the results that will be explored is that of distraction. This will raise the issue of how interactive whiteboards have potential for improving engagement with the task for pupils with gross motor difficulties as well as key issues that affect how PMLD is defined, leading to open questions for the profession.

The analysis of the results will then move on to discuss the use of video and digital information and how they not only support the dissemination of the work but add the element of investigator triangulation which potentially strengthens the validity and even the reliability of the results.

The final section will open out the implications of this research in terms of what it could mean for general government funding of resources in schools, classroom design, initial and inservice teacher training and the training of support staff, and where assessment and recording goes next in schools, with the potential of DVDs being considered.

Interaction between the pupil and adult

Table 3 shows that while there is little difference overall in terms of the average number of incidents of interaction between pupil and adult at the touchscreen of the iMac or when using the interactive whiteboard (6.5 for the iMac and 6.1 for the whiteboard), there is substantial variation in how often individual pupils interact with the adults. This is summarised as percentages in Table 7. For half of the pupils interaction with the adult is more common when using the iMac, but only three of these pupils actually used the iMac as their first trial. The fact that the technology has minimal influence on the level of interaction between the pupil and the adult is reflected in the work of McCormick and Scrimshaw (2001) who have shown that where interactive whiteboards are used in much the same way as existing blackboards, they do little to develop the interactivity that is fundamental to enhanced learning. Looking further at Table 3 the pupil who is seen to have the lowest number of interactions with adults is the same one, pupil 2, for both the iMac and the whiteboard. Across the two situations he has only four interactions with the adult, yet his level of distraction is the highest in both trials. This is the pupil whose right wrist was in plaster at the time of the observations, and it is important to note that the instances such as at just after two minutes of the trial at the iMac where the pupil looks around in the direction of the adult have been categorised as distraction, since the adult didn't actually engage with the pupil. It could nevertheless be argued that this pupil is displaying behaviour that could initiate an interaction, which in itself is sometimes deliberately taught to pupils with severe and profound learning difficulties.

Clearly, the results cannot be read as 'black and white' examples whereby 'interaction' is good or desirable and 'distraction' is bad and undesirable. A further illustration of this difficulty in reading the results can be seen with the iMac trial for pupil 4. Within the first twenty seconds of the trial the adult working with this pupil talks to him and actively physically prompts him to touch the screen with his left arm. This might be interpreted as reasonable and of value for the pupil, but watching the video footage it is clear that the pupil himself actually reaches to touch the screen two seconds before the adult's somewhat rushed physical prompt, using his right arm. Here then, an incident

that would have been recorded as interaction between the pupil and adult can be seen to capture a moment where the adult is perhaps rushing the pupil, not taking the time to observe what kind of help the pupil might need and where the interaction is certainly adult led, possibly barely justifying the category of being interaction. Sounding a note of caution in this vein, McLinden and McCall (2002) refer to Tobin (1996) who notes that technology can modulate the quality or intensity of the stimuli arriving via a particular channel for a learner with defective sensory channels and that this can thereby enhance the learning environment for that child, if it is used sensitively. McLinden and McCall go on to point out that it is not technology itself which is necessarily helpful, so much as its use to increase social interaction, which they feel should be the major focus for children who have complex multiple impairments. Clearly, if the adult working with the pupil feels obliged to encourage interaction with the 'task' at the expense of reflective interaction with the pupil himself then valuable communicative opportunities can be lost. Ouvry (1987) maintains that one of the main aims for communication work with learners who have PMLD should be to "encourage responsiveness to the presence of others and establish reciprocal interaction patterns". She sees interaction as an essential prerequisite for teaching.

In the literature review it was noted by Nind and Hewett (2000) that teachers can perpetuate low levels of spontaneous behaviour by not responding to pupil-initiated interactions (Beveridge and Hurrell, 1980). The video footage would appear to show this happening for pupil 6 at the iMac, and for pupil 3 at the whiteboard. In the case of the latter at least, the adult had actually misunderstood the researcher's guidance and thought they were not supposed to be involved if it could be avoided. Whilst Beveridge and Hurrell have a valid point to make, the evidence here needs to be treated with caution if being used to support their view.

Pupil 1 could be said to have generated an interaction with the adult through her behaviour rocking the iMac, four minutes into the trial. The adult has been out of view but can be heard talking to the pupil from behind. Ware (2003) believes that a responsive environment is a positive thing for both the person with PMLD, and for staff and carers working with the person, and that it can

use as strengths the different approaches each individual brings, such as tone of voice. A responsive environment could include furnishings and objects that give sensory feedback and stimulation, but Ware's emphasis is much more on the role of the adult, being ready to respond to the child's actions. As the pupil puts both hands to the computer and rocks it the adult clearly feels the need to intervene and she calmly removes the pupil's hand, moving on to pointing at one of the pictures onscreen and presumably hoping to re-engage the pupil with the task. The pupil actually brings her hands down to the wheelchair she is using, rocking that and arguably rounds off the interaction with the word 'bastard', which is understandably ignored by the adult. In the case of this pupil, there is almost too much active behaviour by her for the adult to be anything but responsive, and the need to become selective emerges.

The complexity of the range of ways in which these ten pupils can be seen to engage with the adults they are seen working with does not in itself prevent analysis of the positive examples of how adults can help the pupil to not only work more effectively at the task but to also use the task as a vehicle for improving other skills. Observation of pupil 9 raises significant questions about the definition of PMLD and his inclusion in this study, which are dealt with further on, but the video clip of him working at the iMac contains a powerful example of the task being used to enhance the development of his spoken language. It is a good demonstration of Vygotsky's theory of the zone of proximal development, with the adult spotting the opportunity to refine the pupil's spoken language in a motivating situation. Just after one minute and twenty-one seconds into the trial the adult points to a kiwi fruit, and having used the simple question "Is that fruit?" and therefore modelled the key word 'fruit', the pupil then repeats the word and is clearly heard to articulate the final consonant of the word. In Loveless and Ellis' book (2001) Loveless, DeVogd and Bohlin (1998) feel that the DfEE standards for the award of Qualified Teacher Status do not change substantially with the integration of ICT; maintaining a purposeful working atmosphere, effective questioning, careful listening and providing pupils with opportunities to consolidate knowledge. The use of an opportunity such as developing a pupil's use of language, where the pupil is working with easily constructed materials that

can be readily tailored to support current educational priorities, depends heavily on the adult knowing enough about the pupil's learning needs and on their skill in knowing when and how to interact with the pupil. This can be seen again in the footage of pupil 10 working at the interactive whiteboard. Not only did the member of staff decide it would be a motivating opportunity for the pupil to use his 'Tilt table' but she noticed that her initial positioning of it hadn't been the best for the pupil and so at one minute and thirty-six seconds into the trial she moves it to improve his ability to use the whiteboard. Since this pupil needs to be in a standing position several times each day her choice to link it to an activity which she thought he would enjoy has the potential to reinforce his acceptance of this physical demand on him. By adjusting the angle of the table during the trial the adult managed to put the pupil in a position where he was able to stretch his arms out and reach every quarter of the whiteboard, which he can be seen to have done when looking back at Table 1. Higgins (2003), on behalf of the National Educational Research Forum, reviewed research during 2003 and concluded that the use of ICT resulted in increased student learning when there was a planned intervention using ICT that targeted a particular area of learning (NERF Bulletin, Summer 2004). The example here of the member of support staff clearly reflecting on the physical learning needs of this pupil contrasts with OfSTED's report on ICT in schools from May 2004, where they say that "Many special schools now have one or more interactive whiteboards. Only a small proportion of these are being used to full effect as often few, if any, staff in the school have had sufficient training to gain confidence in their use or to take any imaginative steps in using the new technology to meet the special needs of their pupils."

Both of the examples above could be argued to touch on what Vygotsky refers to as the 'Zone of proximal development'. Brown, Standen and Cobb (1998) describe this as the gap between the current child's developmental level and the potential level that could be achieved with adult guidance or by working with more capable peers. The adult working with pupil 5 when using the iMac demonstrates this skill of teaching through the task, sensitively assessing what the pupil can do independently and verbally and physically guiding him to

improve on this. At thirty-nine seconds into the trial the adult accepts the pupil sitting back from the task and rather than rushing to physically prompt him to continue she talks to him about the choices that can be seen on screen, allowing him to move back to the task in his own time, ten seconds later. His rather unusual method of touching is discussed further on, but the adult clearly takes a view that she may be able to gently help him to use a more conventional method of touch. She first tries to gently physically intervene at one minute and forty-five seconds, and then with more success at two minutes and twenty-six seconds. She reinforces the physical guidance with the simple verbal phrase "Just one hand". She continues to make judgements throughout the rest of the trial as to when and how best to lead the pupil onto a more normal method of pointing at the screen, balancing a clear view on what she felt would be beneficial for the pupil with allowing him adequate freedom to work with a high level of independence. Describing such an approach in more general terms, BECTa published a report on ICT Supporting Practice (2002) which clearly states in its introduction that "The crucial determinant of success in the classroom is still the teacher and her or his use of ICT to support teaching and learning and raise standards." In going on to describe good practice the report says "Effective teachers model the behaviours they wish to teach." One final statement in the report is that "Lessons with computers maintain pace if teachers know how and when to intervene."

Implications for teacher training and ongoing inservice training for support staff in special schools are clear and relate to the ability to assess a pupil, set clear aims, and respond sensitively and imaginatively in any situation to support those aims. Wragg (1994) found that 57% of primary teachers' questions were concerned with class management, 35% with information recall and only 8% required higher order thinking; and added that Brophy (1981) found teachers to be using infrequent and haphazard praise. Both of these references are now quite dated, and may not reflect positive developments in initial teacher training. The European Agency for Development in Special Needs Education issued a paper following a conference in September 2002, with significant implications for teacher training and INSET with regard to the use of ICT in a classroom. The paper referred to the

importance of “specifically targeted support” and that “teamwork between teachers and other professionals requires support and facilitation”. This certainly doesn’t assume that desirable practice will simply happen. McLinden and McCall (2002) illustrate the kind of caution and sensitivity needed when judging how best to support and interact with the learner who has PMLD, quoting the work of Chen et al (2000) which notes that whilst there are a variety of tactile strategies used with children, there is very little research based evidence that validates their use. Particular strategies can commonly include physical prompting, or more specifically hand-over-hand guidance to assist the child. As just one example of how impossible it is to make wide generalisations, some children dislike having their hands manipulated and react against the assistance, whilst others may passively accept it but could become dependent on the prompting, learning to wait until they feel the touch of the adult’s hand before initiating an action. In this study the researcher was primarily waiting to see the child act independently, but there were several examples where interaction by the adult included some level of physical prompting.

McLinden and McCall go on to describe the work of McInnes and Treffry (1982), where they outline a hierarchy of adult support in three levels. Co-active refers to the adult and child acting as one person and involving a ‘high level of physical prompting’; Co-operative involves ‘sufficient support’ and Reactive refers to the child completing the activity independently. This would be reflected in the school where this study took place as ‘Physical prompting’, ‘Gestural prompting’, ‘Verbal prompting’ and ‘Unaided’. The close overlap here demonstrates that staff working with the pupils in the study at this school will have been working within a relatively consistent national model of methods of supporting learners with SLD/PMLD. Loveless (2001) has found “that teachers do in fact alter their roles and ways of working with IT... varying the nature of the interventions according to the technical experience and cognitive needs of the children.” Whilst this may well be true in the population of teachers within that study, there is at least one example here where the behaviour of the adult actively ignores the ability and cognitive needs of the pupil (pupil 4, at the iMac). It may not be appropriate to optimistically extend Loveless’ conclusions

to the situation of special schools where many support staff may have no formal qualifications and may have undergone little or no induction or training at any given time.

When indicating where this research has encountered examples of positive action by the adults in terms of their interaction with the pupils the researcher has been conscious of the dangers of using the term 'good practice'. In a chapter covering the use of qualitative methods Wragg (1994) warns against the use of terms such as 'good practice' unless they are defined, since there can be no guarantee that what one person believes to be good practice will be shared by everyone else. Instead, it is hoped that by pointing to descriptions of desirable behaviour that can be found with time references in the QuickTime video clips, peer review will allow people to not only decide if they agree that those behaviours are desirable, but may well allow people to find other examples better suited to their own situation. Aird (2001) reflected that Porter et al (1997) found that whilst many staff working in special schools talk about the sensory curriculum for our pupils, there is a worrying lack of good practice in the actual teaching of sensory function in these schools.

Pupil interaction with the display

The large difference in how much each pupil interacted with the displays was very marked (Table 2), such that their general level of actively touching the equipment varied from as few as two touches (pupil 6, iMac) up to forty-five (pupil 5, whiteboard). Individual pupils differed very little between their use of the touchscreen iMac and the interactive whiteboard (see Table 6). The exception to this, as mentioned in the results, was pupil 4. In his case he touched the iMac thirty-one times, but only touched the whiteboard four times. When working at the iMac this pupil was physically guided by the adult to actually touch the screen several times, but more importantly he was physically encouraged to stay in his chair and was returned to it promptly when he left. When the pupil came to work at the whiteboard he was accompanied by a different adult and was given substantially more leeway when he chose to move away from the whiteboard. It is possible that had he been working with the same adult in both situations his results would have been more closely matched.

Ware (2003) comments that speech is the most effective form of communication and suggests that a system of translating communicative attempts by people with PMLD into actual spoken phrases might increase their responsiveness. This could have had implications for the stack used in this study, in which the researcher chose to use a range of music clips as opposed to plain speech. Whether the use of speech would have increased all levels of active touch of the display, maintaining the individual variations, or would have increased the motivation of the less active pupils is a question for further research. Grayst (2002) encourages the use of photos of the pupils, which did give opportunities for the adults to engage in communication with the pupil, and OfSTED (2004) comments "when images are projected on to a large screen, pupils attend well. The use of digital images involving classmates is particularly successful." It was clearly the case for pupil 9, who when working at the iMac not only promptly responded to the adult talking about one of the pupils shown right at the start by touching that quarter, but by fifteen seconds into the trial he was turning towards the researcher at the camcorder, and called his name to draw his attention to the screen as well. The ability of

this pupil to interact with the adults at this level calls into question his placement within the study in terms of the definition of PMLD, and this is discussed further on. A similar impact is evident in pupil 5's work at the iMac. This pupil is non-verbal and can be seen to be very determined about which image he is targeting. At one minute and forty-six seconds he can be seen holding his left index finger with his right hand to aim at the upper left quarter of the screen, and as he misses his aim drops downwards, fortunately not actively touching the screen, since it would have reacted and changed. Instead, the display remains constant and he lines his finger up again and second time around successfully touches the image of his schoolfriend. This pupil's use of holding one pointing hand with the other was unique within the study, and was not based on any physical inability to use either hand independently. Indeed, it was based on her knowledge of the pupil's physical ability that the adult working with this pupil chose to intervene to attempt to encourage a more normal method of pointing and using the touchscreen. When presented with the far larger scale of the whiteboard this pupil (5) still uses the same two-handed method of touching, but does add in single-handed use and even pointing with index fingers of both hands simultaneously. It is difficult to compare the variety of methods of touch used across the whiteboard and the iMac, since the adult appeared to coach him more directly at the iMac. However, this is of interest in itself, since this pupil used the whiteboard first, and the adult clearly changed her way of interacting with him and could be said to have relaxed more into her role as teacher by the second trial, at the iMac.

Whilst focussing on pupil 5, another area of interest is the spatial distribution of touches, shown for all pupils in Table 5. This pupil was noticeably different in how he spread his touches out on the iMac compared to on the whiteboard. For the whiteboard his touches were reasonably well spread out across all four quarters of the screen, whereas on the iMac he didn't touch the lower left quarter at all. The pupil who demonstrated the least variety in which quarters he touched was pupil 3, and this was also on the iMac. Here he concentrated 97% of his touches in the lower left quarter (that being 38 separate touches), with 3% (1 touch) in the upper right quarter. This single different touch

happened at one minute and seven seconds into the trial, and can be clearly seen as physically prompted by the adult. Unlike the example of the adult working with pupil 5 (where sensitive shaping of the pupil's own actions can be seen), this intervention is closer to the manner adopted with pupil 4 at the iMac, where the adult seeks to change the pupil's method of using the touchscreen without first assessing how the pupil is currently using it. Table 5 shows that out of the twenty trials conducted, seventeen demonstrate the pattern whereby the quarter of the screen which receives the highest number of touches is diagonally opposite that which receives the least. This would have also been true of pupil 3 at the iMac, had the touch to the upper right quarter not been physically prompted. This suggests that most pupils have an individual preference for which section of the screen they find it most comfortable to press, and that spreading out from this is what could be thought of as a 'comfort-zone', where the adjacent quarters are a little easier to work with than the furthest removed, which is diagonally opposite. The implications of this for the design of school-produced software for these pupils to work with is that there should be a clear and openly acknowledged balance between the concept and skill the software is being used to support, and the general development of encouraging the pupil to explore all options on the screen irrespective of their individual 'comfort-zone'. Clearly teachers should not automatically assume a child to be failing in a task presented via the touchscreen or whiteboard if the child has not yet developed the fundamental ability to fully explore the display.

BECTA's report on ICT Supporting Practice (2002) states that "Pupils are more motivated to learn if they are given timely and frequent feedback... computers can provide fast and reliable feedback." When looking closely at how pupils actually touched the displays one of the failings in the experimental design was readily seen, as for example with the style of touch used by pupil 3 where he would flick rapidly at the same point on the screen. Glenn and O'Brien (1994) showed that experience of non-contingency produces adverse affects on an infant's subsequent learning, and there was certainly a design weakness in the stack created for the pupils to work with that became evident during the trials. The computer is able to store each touch and operate in response to it as soon

as possible, but for several of the pupils who tended to flick in rapid multiples this meant that for quite some time after they brought their hand back down, the stack continued to cycle through more changes with no further simultaneous action by the pupil. Potentially this could be at the least confusing, but more importantly could undermine their belief in being responsible for the computer responding at all in the first place. Thus, where Glenn and O'Brien go on to list the positive reasons why computers can benefit the learner (precisely because they can respond consistently to the smallest voluntary response of the child), it is also important to be aware that many children with PMLD will not have developed normal patterns of interacting with the computer and physical aids and software will need to be carefully planned for the individual with a knowledge of their typical responses and behaviour.

One further aspect of how the pupils physically use the display was touched on in the introduction, namely whether there is evidence of differentiated or undifferentiated behaviour towards the display, as in Piaget's concept of the Sensory-Motor phase of child development. This is harder to gauge purely by the video evidence, and the advantage here of the action researcher actually working in the school means that it is possible to add at least a little more knowledge of the pupil's general behaviour towards other objects to guide taking a view here. One person who demonstrates undifferentiated behaviour towards the displays is pupil 8. He shows some self-stimulating behaviours which have been leading to injury that staff at the school have been very concerned by. These injurious behaviours have emerged more recently, but for a long time he has had the habit of rapidly flicking his fingers, sometimes near to his face, at other times on the table, against his leg and other surfaces. He can be seen using this same type of finger flicking at two minutes and fifteen seconds into the trial with the iMac, and then again seven seconds later in mid-air in front of his face. When being encouraged to face the whiteboard this same pupil begins flicking his fingers in the air near to his face by eight seconds into the trial. The tendency to flick his fingers at objects and just in the air as well, is similar to the behaviour seen by pupil 4, who also seems to display this undifferentiated approach of flicking his fingers at everything rather than

treating each object differently. Pupil 4 is seen flicking at the touchscreen of the iMac, flicking his trouser tie, and at one point doing the same to the camcorder when he goes over to it. Whilst these pupils do appear to demonstrate undifferentiated behaviour towards the displays and objects in general, and most of the others seem to display differentiated behaviours, it would require substantially more information than was gathered within this research to thoroughly investigate all of the pupils on this topic.

Distraction

The three pupils who demonstrate the highest differences in their levels of distraction between working at the touchscreen iMac and the interactive whiteboard open up questions relating to their physical and learning difficulties and the sweeping issue of how PMLD is defined. Pupil 9 demonstrates the largest swing possible, with 100% of the incidents categorised by the researcher as distractions occurring when he was using the whiteboard. It is worth noting that this pupil had the lowest level of distraction across the whole group, with only two incidents being noted, neither of which was at the iMac. Pupils 6 and 10 can then be seen to have differences of 72% and 56% respectively, but this time the pupils both demonstrate more distraction when working at the iMac, and less at the whiteboard. When looking through all of the video clips for the full ten pupils studied, it becomes evident that these three pupils all have mobility difficulties that require major aids such as wheelchairs, leg gaiters and walking frames. The only other pupil seen using a wheelchair, pupil 1, had recently broken her ankle and can normally walk without aids.

It has been mentioned earlier that pupil 9 challenges the definitions of PMLD that have been outlined in this research due to his emerging use of language and this challenge is made stronger by observation of his powerful motivation to engage with the adults around him and to initiate communication.

Returning to the definition used by Ware (2003), she suggests that PMLD describes "a degree of learning difficulty that is so severe that the person is functioning at a developmental level of two years or less (in practice, often well under a year) and also they have one or more other severe impairments, for example being unable to walk, severely visually impaired, or both." This age related link could be thought to clash with the views of McLinden and McCall (2002) who believe that "older (PMLD) children who do not have the means to engage with the world independently are involved in a learning process that is altogether different from that of infants who are following a conventional course of development." Another person urging caution in how labels such as PMLD are applied is Aird (2001), who warns against taking medical diagnoses as the basis for educational provision, citing the example "A common diagnosis

of cerebral palsy in two infants does not mean that both children will have the same characteristics, like, dislikes, preferences, periods of good health - or even the same special educational needs." So whilst certain skills demonstrated by pupil 9 will inevitably raise questions in practitioners' minds about whether he should be categorised as PMLD at all, such as his use of verbal language and his ability to initiate episodes of communication with adults, other descriptors such as his cognitive ability with respect to typical skills such as spatial awareness, sequencing, shape, size and colour coupled with his mobility and personal care needs readily place him within the definition used for this study. Rather than trying to argue that he is genuinely 'PMLD', the researcher feels that pupil 9 successfully highlights the risk that placing too much emphasis on labels of special needs can lead to teachers generalising a wide spread of assumed abilities without focussing on careful individual assessment for the pupil.

Pupils 6 and 10 both show substantially more active touching when using the whiteboard than the iMac, and are less distracted as well. Both pupils can be clearly seen to have mobility problems which not only affect their walking and positioning but also affect hand and arm control too. Pupil 6 had sat in front of the iMac for one minute and forty-seven seconds before she even looked at the screen, and it was only with an adult physical prompt that she first touched the screen at one minute and fifty-nine seconds into the trial. Whereas when she used the whiteboard she reached out independently within three seconds of the trial beginning, giggling at the response she got from it. Pupil 10 illustrates some of the difficulties a user can encounter when working with a screen that requires relatively accurate motor control. At forty-two seconds into the trial with the iMac he is seen to lift his right arm up while looking at the screen, but his arm goes past the computer to the right, missing it altogether. Further on in the trial at two minutes and forty-five seconds this happens again, though this time the adult gently nudges his arm back over to contact the screen. His behaviour when working at the whiteboard was noticeably different. Not only did he touch it more frequently and have less distractions (see Table 8), but he became quite excited at several points (for example at three minutes and twenty seconds). For both of these pupils it

would appear that interactive whiteboards can offer them something which a typical desktop computer equipped with a touchscreen cannot. Back-projected models, which would allow staff to help the pupils to get into positions giving full access to all areas of the whiteboard without blocking the projection, would offer even more.

With respect to the kinds of events that may lead to distraction McLinden and McCall (2002) draw attention to the possible sources of distraction the learner may encounter including “the smell of perfume, or the sound made by dangling jewellery.” Even visual stimuli could distract the pupil, whether it be certain colours present within view or worn by the adult, or even broad tones such as shadows or strong light. The presence of the researcher with a camcorder may be a further source of distraction. As Cohen and Manion (2001) say, “it is inadequate simply to describe observation as a non-intrusive, non-interventionist technique”, and reactions of the pupils in this study to the presence of the researcher and the camcorder confirm this. When pupil 4 worked at the whiteboard he turned and walked towards the camcorder at one minute and forty-two seconds into the trial. Although initially not appearing to show any interest in the researcher or camcorder, and just walking into that corner of the room, he then returned at two minutes and thirty seconds, and can be heard tapping onto the camera itself. He clearly demonstrates awareness of its presence. Pupil 7 often behaves in a way that indicates that he has noticed something without ever having been seen to have looked around him. This is particularly true of food and drink. In the trial with the whiteboard this pupil can be seen to gaze at the camcorder at four minutes and thirty-eight seconds, very near the end of the trial, but it doesn't seem to hold his interest and he walks off to the far half of the room. Pupil 9 makes it abundantly clear that he is aware of the researcher and camcorder by calling out the researcher's name whilst looking directly over at him, fifteen seconds into the trial at the iMac. There are several more examples within his work at the iMac and at the whiteboard. Pupil 10 slowly looks round towards the camcorder at one minute and twenty-two seconds into the iMac trial, then away and then back again more directly.

Dissemination of research

The first and most important audience for this research is the school in which the study took place. Wragg (1994) mentions the danger of the 'cosmetic effect' in which a person seeing themselves on video just once may focus on themselves ("Don't I look awful") rather than seeing the wider picture of how they and their pupil(s) are performing and interacting. This is an important consideration in terms of feedback to people involved in this study if it is hoped to encourage reflection and improvement. With this in mind the researcher will be conducting a session reviewing the key points from the research and pointing staff to the website for fuller information should they feel it will be valuable for them. Similarly, parents and carers of the pupils involved in the study will be encouraged to at least review the video footage, and hopefully look into the results and analysis, with a view to helping them to feel more fully informed on their child's development at school. OfSTED's 2004 report on ICT in schools states that "The regular and appropriate use of ICT can greatly raise the expectations of teachers and parents as to the potential of very young pupils and those with severe disabilities".

Another reason why dissemination of this research would be valuable for the researcher is because it may help with questions about the internal validity of the results, which the researcher bases on what he believes to be low-inference descriptors (incidents of touching set quarters of the display, interactions with the adult, and distractions). Feedback from peers may either show that these descriptors were genuinely consistent for different observers, or that different people viewed the raw material differently and would draw different conclusions. It also has the potential to help with establishing the reliability of the results. Cohen and Manion (2001) refer to the views of LeCompte and Preissle (1993) that the requirements for reliability can be unworkable in the case of qualitative research. However, they go on to describe how Denzin and Lincoln (1994) suggest three ways to address reliability in qualitative data, one being inter-rater reliability. This is where another observer would have interpreted the same events in the same way, and the planned dissemination of this research including the raw data of the videos means that this remains a realistic possibility here. This is what Wragg (1994) refers to in classroom

research as “checking the perceptions of more than one person to see if one’s own interpretations have any support”. Denzin (1985) calls this ‘investigator triangulation’. Of course, making the data and results available on a website is not the same as actually reaching an audience, and the researcher will be actively sending the web address to the various internet based forums from which people have generously responded to the questionnaire, as well as to a range of academic researchers interested in either special educational needs or the use of interactive whiteboards (or both), and will also be approaching general and specific educational media to publicise the work.

Further implications

When the researcher checked a variety of British educational websites for references to research into the use of touchscreens in 2002 there were no links at all on BECTa's site or the National Grid for Learning site, one link on the Virtual Teacher Centre (which was simply a comment from a teacher), and just one link on BECTa's ICT Advice site, which was simple advice with no research links. The researcher's own short questionnaire which generated sixteen full replies indicated that even within this interested group of individuals nobody had actually conducted formal research into the use of touchscreens and/or interactive whiteboards with pupils who have PMLD. Wragg (1994) mentions that Biddle (1989) found that less than one thousandth of the multi-million dollar investment in education in America is spent on research, contrasting that with some pharmaceutical companies who invest as much as 20% of their profits on research. Wragg further points out that of the money that does go into educational research most of it goes towards pupil assessment, and very little gets through to teachers to work in their own classrooms. He goes on to say "Smaller projects, particularly those done by teachers and heads in their own school, can make a valuable impact on local practice". The little actual research that has taken place on the use of interactive whiteboards has ignored their use within the SLD and PMLD population of schoolchildren, and continues the practice of having ignored the impact of the use of touchscreens with these pupils also. It seems clear that one way to address this imbalance would be for the government to heed Wragg's point and seek ways of bringing funding and academic support directly into special schools to encourage relevant research.

The problems which OfSTED's 2004 report on ICT in schools highlighted for the use of interactive whiteboards with pupils who have learning difficulties included pupils blocking the projected image, excessive background light, and the need for a variable height screen. One of the sixteen respondents to the researcher's questionnaire specifically mentioned an additional concern regarding the pupil looking directly towards the very bright projector rather than at the image on the screen (Nevitt, 2003). Others may not have brought negative concerns up due to the phrasing of the question (see Appendix 1).

In the video footage within this research there are several examples of difficulties with blocking projection (pupils 6 and 10), distraction caused by the interactive whiteboard's pens and control buttons (pupils 1 and 2), discomfort with the positioning of the whiteboard on a wall and therefore facing away from the entire room (pupil 8), and looking directly at the projector (pupil 10). Nevitt's concerns and OfSTED's are supported by the results here, and point towards the need for radical rethinking of the design of interactive whiteboards, at least in terms of changes needed to improve their use for people with learning difficulties. Back-projected systems are already emerging and beginning to drop in price, and overlays for plasma and LCD screens may offer further variety to suit different situations. These already offer options without pen trays. Free-standing back-projected models with height adjustable screens may offer some of the modifications needed, though existing examples still do not address the user who may need to face the whiteboard in a wheelchair. Special schools frequently choose Smartboards due to the need to operate it with pure touch rather than via a pen/stylus, and options for special needs users could increase much further if developments in wireless technology were to be combined with the emergence of touch sensitive battery powered displays. There are obvious issues about classroom design as well, in terms of suitable access to power sockets, network sockets and/or wireless networking and speakers, as well as lighting and black-out controls.

Along with concern over physical design of hardware and classrooms the research raises questions about the processes teachers use for planning. McLinden and McCall (2002) point out that the QCA published guidelines in 2001 on the curriculum for pupils with learning difficulties, emphatically encompassing all such children between the ages of five and sixteen 'regardless of factors such as ethnicity, culture... or the extent of their other difficulties'. Mullen et al (1999) undertook a project funded by the Teacher Training Agency which looked in particular at the use of ICT in the teaching of literacy and numeracy. An interesting aspect of its results was that "although the amount of ICT equipment in schools increased during the life of the project, much use of ICT in primary classrooms was planned as an addition to the curriculum

rather than as a key teaching strategy". It would appear that the QCA's worthy advice is still going unheeded. In Nind and Hewitt's (2000) book they question how dynamic and social the learning environments provided in schools tend to be. They consider that many actually tend to be stark and stilted environments. Looking more specifically at the use of ICT within the classroom, it is a valuable question for any occasion when a pupil is working with ICT, as to whether the adult needs to be actively socially interacting with the child alongside any intrinsic response the ICT may be providing. In the case of the learner with PMLD it may be one of the most potent opportunities to develop the learner's enjoyment of adult interaction. Opportunities such as these should not only occur as an additional bonus, but deserve to be planned for as with other learning and teaching.

The issue of developing good practice in the use of ICT by teachers in special schools is touched on by the Inclusion statement that can be found on QCA's National Curriculum website. The now finished New Opportunities Funding (NOF) offered specialist training for teachers working with pupils who have severe learning difficulties, but excluded newly qualified teachers. None of these trainees would have had any specialist SEN input within their initial teacher training ICT content, and the NOF scheme was voluntary, with a generally poor reception amongst those serving teachers who participated. There should be no assumption by schools or government that teachers working with pupils who have SLD or PMLD have come to the job with any relevant ICT training at all.

The National Curriculum website states that all teachers have a responsibility to develop a more inclusive curriculum through three key principles:

- Setting suitable learning challenges
- Responding to pupils' diverse learning needs
- Overcoming potential barriers to learning and assessment for individuals and groups of pupils.

One point emphasised in fleshing these principles out is that "Teachers should aim to give every pupil the opportunity to experience success in learning." Even on something so apparently simple as using a touchscreen or an interactive whiteboard this research has shown that there is a pressing need for careful

assessment of the pupil with regard to whether are yet capable of exploring the full display spatially. If new and existing teachers in special schools are not aware of the possibility of a pupil being in the stage where they work with a 'comfort-zone' then the pupil may be presented with work that is too far advanced for them, leading to unsuitable learning challenges, ignoring their diverse learning needs, and failing to overcome barriers to learning for the individual.

OfSTED's report on ICT in Schools (2002) noted that for special schools "few are yet able to plan for the effective use of equipment to enrich the curriculum", and also that "teaching assistants are often key players in their school's use of ICT". The reference to teaching assistants (TAs) is very important in an average special school, where many of the adults the pupil will work with are TAs with no national framework for training, especially with regards to the use of ICT and working with pupils who have PMLD. Many special schools have developed their own training programmes for TAs, and combine this with national qualifications such as NVQ; it would be highly desirable to see the government encouraging this with funding and specialist support for those schools choosing to pursue this route.

Aird (2001) refers to the document issued by SCAA in 1996 which urged SLD schools to consider how teaching time could be most profitably used to ensure a productive learning environment rather than become anxious about allotted hours for individual subjects. At this time now when the Key Stage 3 Strategy is urging discrete provision for ICT in schools it is timely for special schools to be reminded of SCAA's advice.

BECTa's ImpaCT2 report (Somekh et al, 2002) noted that home use of ICT is increasing rapidly and that the nature of use in the home is more diverse and wide ranging than is typically the case in schools. However it also noted that pupils without access to ICT at home are significantly disadvantaged. Pupils with learning difficulties who need access to ICT facilities via touch will incur significantly greater costs than their mainstream peers. For those pupils with PMLD who appear to use an interactive whiteboard more successfully than a touchscreen there are even greater cost implications for the family over and above the costs of standard ICT equipment.

The explicit use of video as a tool for data collection within this research is combined with its value for making dissemination of the results more accessible than a purely textual report. One key advantage Wragg (1994) lists for recording an event with video is the removal of pressure to make instant decisions with respect to the data recorded. It also allows the observer to review the tape again to then analyse for further different events that it would not have been feasible for one person to record alongside the intended main point of observation. In the disadvantages Wragg includes loss of information such as room smells and events out of camera shot, though of course some features such as these might still not have been recorded through other systems unless they were expected to be important. Wragg goes on to compare the positive use of video for surgeons learning from their colleagues, with the situation in schools, saying "It is a great pity that (it) is not imitated more frequently in teaching." Dissemination of research such as that conducted here using video clips over a website makes a small move in this direction. In discussing positive examples of the use of video within initial teacher training Wragg particularly emphasises the advantages of interactive videodisc, with options such as freeze frame. This is equally true of QuickTime video clips, including the option for looping, playing just selected portions of the video and even searching by added text references.

McLinden and McCall (2002) state that "video is now widely used by teachers as a means of recording progress in children with multiple disabilities". As such practice by teachers continues it is clear that schools need to develop efficient systems for gathering and storing such data. Digital information has to be managed according to the laws governing Data Protection (1998) and the Freedom of Information Act (2000). The value of video data far outweighs the bureaucracy involved in meeting the requirements of the legislation, and schools should be actively encouraged by government to equip themselves with the resources needed to make good use of such data. The most user-friendly options for storing video data at the current time involve copying digital video clips onto DVD. A school might choose to file clips relating to individual pupils, clips featuring subject areas, or topics such as class management and many others.

Whatever storage systems emerge in the future it is clear that schools need to have the resources and trained staff to be able to gather the data they judge to be valuable, store that digital data in readily accessible media, and use it to inform their teaching and to assess the learning of the pupils.

A further use to which video records can be put within schools is for self-assessment within the school. The report on ICT in schools by OfSTED (2004) states that "less than a third of co-ordinators undertake any formal monitoring of teachers' use of ICT". Video offers one option for addressing this, and can provide the teacher with valuable opportunities to reflect on their work, while allowing the co-ordinator to assess progress across the school in circumstances that would rarely allow enough time to actually visit all of the classrooms in person.