Original article

Primary school students' perceptions of interactive whiteboards

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Abstract Students involved in the interactive whiteboard (IWB) evaluation, sponsored by the Centre for British Teachers (CfBT), were interviewed in regard to their perceptions about IWBs. Twelve group interviews (72 students) were conducted between January and Easter 2004 with Year 6 students (between 10 and 11 years of age) in six Local Education Authority (LEA) areas located in the North and South of England. Students were very enthusiastic about particular aspects of IWBs, such as their versatility in the classroom, multimedia capabilities and the fun and enjoyment they brought to learning. Students also highlighted, however, technical problems, teacher and students' information and communication technology skills and students' lack of access to the technology as negative aspects.

Keywords group interviews, ICT, interactive whiteboards, primary schools, students' views

Introduction

There has been massive investment in information and communication technology (ICT) globally over the past few years (Organisation for Economic Cooperation and Development (OECD) 2001, p. 9). The Australian government, for example, estimated that $4.3 billion dollars was spent on ICTs by government organisations on all levels between 1999 and 2000. In the United States, according to the US Department of Education, more than $700 million dollars was set aside for educational technology (US Department of Education, Washington, DC). As major investors in ICTs have found, however, it is not enough to simply invest huge amounts of money and expect the desired outcomes to follow, i.e. improved economic performance or improvements in student attainment. A greater act of will is required in shaping and developing the ICTs infrastructure. On the macro structural level, for instance, there needs to be up to date equipment, training programs and continuing professional development for teaching staff. Technical support too is an important factor (EC 2003).

Bransford *et al*. (2002) argue, however, that it is not necessarily how much money a country invests in ICTs as much as how and if they are adopted and used by teachers in the classroom. It has been shown that ICTs in education impact on the micro level of the classroom demanding changes in classroom organisation, curricula and pedagogical practices (OECD 2001; EC 2003). If ICT is to develop successfully, investment must be accompanied by changes and developments in these areas. Countries that fail to adapt may be disadvantaged economically and socially (OECD 2001, p. 10; EC 2003).

Since 1997, the government of the United Kingdom has invested huge amounts of money in Information and Communications Technologies (ICTs) in the education sector, including interactive whiteboards (IWBs), in the belief that their use in the educative process will raise attainment among British school children. The British Educational Communications and Technology Agency (BECTA 2004) estimated that the overall figure for ICT investment in the United Kingdom between 2001 and 2004 at £1 billion pounds. The Department for Education and Skills

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(DfES 2004b) points out that £50 million pounds has been invested in IWBs alone. While there have been criticisms of ICTs implementation in the past (Lovegrove & Wilshire 1997; Stevenson 1997; EC 2003) there have been improvements in the UK education sector since then. The latest technologies are being introduced, specifically IWBs, teacher training is developing both during initial teacher training and afterwards through continuing professional development programs and technical support is improving.

Much has been claimed about the potential of IWBs including greater interactivity between teachers and students, and increased pupil engagement, motivation and enjoyment, all leading to improvements in pupil attainments (BECTA 2003a; BECTA 2003b; DfES 2004c). While most of this input about IWBs has come from the manufacturers, policy makers, academics, and teachers, there has been very little from students as to what they think about IWB. With the exception of the recent student survey initiated by the Department of Education in the United States (2004), students views have until recently been ignored:

> The opinions of children and adolescents have been neglected in some streams of social research on the grounds that children are not competent to understand and describe their world due to cognitive and linguistic immaturity. (Arksey & Knight 1999, p. 115)

Since the Children Act in the UK and the United Nations Convention on the rights of the child, however, there has been a concerted effort to consider the interests of children and find ways to increase their involvement in decisions that affect them (Aldgate & Statham 1989; DfES 2002; Kirby *et al*. 2003; British Broadcasting Corporation (BBC) 2004). One key area where children are in the majority and yet appear to have no voice is education. Article 12 of the UN Convention states in relation to education:

> In brief, the right to education means the right to experience citizenship. To achieve citizenship and all it entails, children must be perceived not as mere recipients of knowledge, but rather as active players in the learning process. (UNICEF, 2004:http://www.unicef.org/crc/bg009.htm)

It has been claimed however in regard specifically to ICT (Murphy & Beggs 2003, p. 82) that:

> Less emphasis is given to finding out from students how they feel they might best use this facility (ICT) in school.

It would seem to be increasingly important to consider students' views especially with the increasing uptake of ICT (DfES 2004a) (especially IWBs) in schools, since they are key stakeholders in the educative process too. Finding out what switches students on (and off) in regard to ICT in the classroom can inform teachers' practice perhaps leading to the development of a more collaborative educative process. As Scaife and Rogers (1999) argue:

> Kids are aware of aspects of the use of technology that we are not sensitive to and that we need to be told of.

Emerging evidence, however, suggests that ICTs are having positive impacts on students' engagement, motivation and attainment (Harrison *et al*. 2003; Passey *et al*. 2003; Office for Standards in Education 2004a; OfSTED 2004b). This is certainly the case in the United Kingdom the USA (National Center for Education Statistics NCES 2000), Australia (Department of Education, Training and Youth Affairs, DETYA 2001; Department of Education, Science and Training (DEST 2004), Europe (European Commission, EC 2003) and on a global level (Organisation for Economic Cooperation and Development, OECD 2001). If the potential of IWBs is to be realised it is essential that the views of all stakeholders in the educative process are carefully considered and where they may be useful in moving things forward, adopted wherever possible.

This article examines British students' perceptions of IWBs, specifically what they like, do not like and would like more of in their lessons. On a broader level, it is argued that for IWB to be successful the climate within which ICTs generally and IWB specifically are used needs to change, that is, there needs to be greater flexibility in regard to standardized national curricula and standards agendas not only in Great Britain but internationally too. A shift away from traditional teacher and pupil roles in the classroom may also be necessary. Changes in these areas might help to create an educational climate that is conducive to the effective, imaginative and innovative use of IWB. International research, e.g. the USA, Australia and Europe,

seems to suggest that problems encountered in the British experience of ICT implementation are very similar suggesting something of a universal experience where ICTs are concerned. Data are presented from interviews with 72 students in six Local Education Authority (LEA) areas in the North and South of England that took part in an evaluation sponsored by the Centre for British Teachers (CfBT).

What is an IWB?

The British Educational Communications and Technology Agency (BECTA) provides a clear outline of what an IWB is (BECTA 2003b, p. 1):

> An interactive whiteboard is a large, touch-sensitive board which is connected to a digital projector and a computer. The projector displays the image from the computer screen on the board. The computer can then be controlled by touching the board, either directly or with a special pen. Among the potential applications are:
> - using web-based resources in whole-class teaching
> - showing video clips to help explain concepts
> - demonstrating a piece of software
> - presenting students' work to the rest of the class
> - creating digital flipcharts
> - manipulating text and practising handwriting
> - saving notes written on the board for future use
> - quick and seamless revision.

The purpose for using IWBs in the classroom is to enable access to and use of digital resources for the benefit of the whole class while preserving the role of the teacher in guiding and monitoring learning.

The IWB evaluation

The School of Education at Newcastle University was commissioned by the Centre for British Teachers (CfBT) to undertake an evaluation of the impact of IWBs. The evaluation was conducted between 2002 and 2004 and involved a variety of research methods including repeated classroom observations, online surveys and interviews with teacher and students. Its focus was to evaluate:

- the effective use of IWB technology in the primary school;
- the impact of the IWB on classroom interaction;
- the impact of the IWB on pupil attainment;
- the impact of the IWB on teachers' perceptions.

As part of the evaluation, focus group interviews were conducted with a sample of Year 6 (between 10 and 11 years of age) students to draw out their perceptions of IWBs.

Method

Focus groups were selected to gather data from the students involved in the project evaluation since they are considered by many authors on the subject to be ideal for exploring experiences, opinions and concerns (Lewis 1992; Barbour & Kitzinger 1999; Morgan *et al*. 2002a, b; Lewis *et al*. 2004). Focus groups have been used in a variety of settings and for a range of research purposes including health related research and in recent years ICT research (Krueger & Casey 2000; Kinnear 2001; Heary & Hennessy 2002; Morgan *et al*. 2002a, 2000b; Kitzinger 2004). Since the students involved in the evaluation had been working alongside each other in the same classes and with the same teachers since 2002 in what essentially is a social situation, it was felt that more could be gained from interviewing groups of students than individual pupil interviews alone, this especially so in the present given the increasing influence of social learning theories in education, e.g. Vygotsky and Bruner (Smith *et al*. 2004).

Focus groups have a number of advantages over, e.g. individual interviewing. Focus groups are an economical means of gathering data from respondents since the views of many can be gathered simultaneously in a number of sessions; since focus groups have an open format, the data collected are normally in respondents own words; more importantly, focus groups are dynamic and synergistic in nature encouraging respondents to speak and react to comments made by other respondents (Stewart & Shamdasani 1990; Kitzinger 2004). In the present study it was noted how students supported or contradicted the views of their peers regarding aspects of IWB use thus providing, as Robson (2002) argues, a variety of viewpoints rather than the views of an individual. There is an element of social support for respondents offered by the focus group approach, which may prevent them from being overwhelmed in a one to one situation.

Focus groups have been criticised for the lack of generalisability of findings given the somewhat con-

venience nature of focus group recruitment (Stewart & Shamdasani 1990). While it is the case that only 12 focus group interviews were conducted ($n = 72$), it is worth noting, nevertheless, that the views of students across the different LEAs and schools were relatively consistent suggesting a common experience of IWB use. There is also a concern that focus groups might, if not effectively moderated, be dominated by one or two respondents resulting in more individual level data. In order to counter this problem it was necessary, where there were doubts about how many held a particular view, to ask students through a show of hands how many agreed or disagreed with a particular view.

Since the purpose of the interviews was to find out what students thought about IWB it was considered necessary to have something of a trade off between too much control and too little in order that students could find a space to express themselves (Goodison 2002). A semi-structured interview schedule was used which it was felt could provide something of a framework within which students could express their own views and feelings about IWB while also providing answers to the research questions. The questions were refined and arranged in the order they were to be asked during team meetings ultimately ending up with a list of 15 questions agreed upon by those members of the research team who would be conducting the interviews. Some of the questions were adapted from the work of other researchers investigating IWBs (Beeland 2002; Levy 2002). Findings from the interviews were compared during subsequent team meetings, which seemed to confirm the similarity of responses across the different education authorities. The main questions referred to in this article were:

- What advantages does an IWB have over a normal whiteboard or blackboard?
- Do you believe you are able to learn better when an IWB is used in the classroom? If so, in what ways are you able to learn better?
- Have you noticed any problems with IWBs?
- What could your teacher do with the IWB to make your lessons more interesting?

A thematic analysis of the data was undertaken using Nvivo, a qualitative data analysis package. All responses to every question were grouped under that particular question allowing comparisons to be made across the different student groups looking for similarities and differences. In the main there were more similarities than differences in the responses across the various groups, which, it could be argued to a certain extent, strengthens the reliability and validity of the data.

Sample

Groups were composed of six Year 6 students (between 10 and 11 years of age), three boys and three girls. (Arksey & Knight 1999; Barbour & Kitzinger 1999; Greig & Taylor 1999; Morgan *et al*. 2002a, b) Teachers were asked to select students on the basis of ability, i.e. two low ability, two average and two high ability in order that a cross section of views could be gathered (Barbour & Kitzinger 1999). Twelve group interviews ($n = 72$) were conducted between January and Easter 2004. (One focus group in each of the southern LEAs and three focus groups in each of the northern LEAs) (Table 1).

Year 6 students (between 10 and 11 years of age) were selected on the grounds that they had been using IWBs in literacy and numeracy since 2002. It was felt for this reason that they would be experienced users of the technology and would thus be qualified to give their views and perceptions of it. Single sex group interviews were considered which might have been useful in revealing differences between boys and girls, but given that the students learn in mixed gender classes it was thought more appropriate to interview them in mixed gender groups. Interviews were conducted by evaluation staff employed by Newcastle University, one male and two females.

Participants in the interview extracts are identified using the following notation: Int: (interviewer); B (Boy); G (Girl). Where there was difficulty identi-

Table 1. Number of students interviewed by IWB pilot area.

Pilot area	Boys	Girls	Total students	Total groups
LEA 1	3	3	6	1
LEA 2	3	3	6	1
LEA 3	3	3	6	1
LEA 4	9	9	18	3
LEA 5	9	9	18	3
LEA 6	9	9	18	3
Total	36	36	72	12

IWB, interactive whiteboard; LEA, Local Education Authority.

fying the gender of the pupil (especially so in lively and rapid exchanges between students) the letter 'S' has been used to indicate 'Student'. The names of schools have been replaced with numbers, e.g. School 1, School 2, which can be found at the end of each extract. The abbreviation (PW) stands for Plain Whiteboard as distinct from an IWB.

What students like about IWBs

On the basis of pupil comments in this study and findings from earlier research (Smith 1999; Smith 2001; Beeland 2002; Levy 2002; Lee & Boyle 2003) it appears that IWBs are viewed very favourably by both teachers and students. The reason for students favourable views about IWB may be related to a certain extent to their versatility which can be put down to the fact that they are a conglomeration of all previous educational technologies, that is, chalkboard, plain whiteboard, television, video, overhead projector and personal computer but with the added advantage of being able to interact with various elements of these media.

Versatility

Students were asked what advantages the IWB had over the plain whiteboard. All the pupil groups expressed similar views. Students' comments reveal a sense of variety in what the IWB can offer. Students appreciate the range of resources that can be accessed through the technology (Levy 2002). The following comments highlight these issues:

B: Everything is accurate, like the shapes and every thing. Before you had to get a ruler and draw it and it you can't get it exactly accurate.
G: There's all different games on it, and all of the colours and all of the lines already on it and the grids because you can't get that on a normal whiteboard, you have to do it all yourself. (*School 2*)

It is clear to students that there really is no comparison between the plain whiteboard and the IWB. The latter is more versatile in that it can access and utilise more resources e.g. the Internet, educational software, video clips, games, student assessment tasks (SATs) papers, examples of work done by other students (Smith 1999). A word used regularly by students when talking about the plain whiteboard is 'boring' as the following comment indicates:

G: It's like better than the normal whiteboard because on that whiteboard all you can do is write and draw like boring pictures but on that one (IWB) you can do loads of different kinds of stuff and you can play games on it. *(School 7)*

There is an overwhelming sense of 'more' available and going on with IWB:

B: Because you can do more things on that than that.
B: You can find out more things on that than the blackboard.
G: It's got internet on it (*School 9*)

Multi-media

Students seem to enjoy in particular the multi-media capabilities of the technology, especially the visual aspects (colour and movement), audio (music, voice recordings, sound effects) and being able to touch the IWB. All pupil groups mentioned the multi-media aspects of the IWB as advantageous especially in engaging and holding their attention. It may be these elements that help to increase their engagement, motivation and attention span in lessons. The motivational impact that ICT can have on students if used in particular ways by the teacher has been highlighted in previous research (Bell 1998; Latham 2002; Passey *et al*. 2003; Solvie 2004). There is a sense, from students' comments, of excitement and activity when the IWB is used in lessons, which is contrasted starkly with the somewhat static nature of the plain whiteboard. As one pupil explained:

G: On that (PW) it's really boring, you feel like you're going to go to sleep. But on that one (IWB) you're like still awake and I'm interested. (*School 7*)

Sousa (2001) and Walker-Tileston (2004) point out that children of the 21st century have been part of a multi-media world from birth and as a result they are comfortable with such technologies and this experience can be exploited in the learning environment. Walker-Tileston (2004) argues that children learn best through their dominant senses, seeing, hearing and touching. The IWB can appeal to all three of these

senses simultaneously through a variety of visual representations, sounds and the capacity to touch and interact with the IWB (Harris & Kington 2002; BECTA 2003a). Students in the current study reported that they enjoyed sounds, the visual aspects such as video clips, colour, movement and the tactile elements, that is, being able to touch the board and manipulate objects on it as the following comments indicate:

> You can watch a video clip because you actually pay more attention watching something than just listening. (*School 3*)

> B: It's fun and you can't write on whiteboards like you can on an IWB. You can touch it and it's great to use in maths.
> Int: You like touching the board?
> All: Yeah (enthusiastically). (*School 6*)

> B: There's even like games and it moves about on the screen but that (PW) is just like stationary. When you draw a picture it's like fixed and when you're on that (IWB) it goes all over the place.
> Int: Is it more exciting?
> All: Yeah (loudly and enthusiastically). (*School 7*)

> B: I like it because it helps to get you more involved with the thing you are doing. (*School 8*)

Multi-media effectively creates a classroom without walls, bringing into the classroom concrete examples of real life situations drawn from the students' direct culture, perhaps a key factor in enhancing the child's learning from the Vygotskian perspective (Bransford *et al*. 2002; Gredler, 2004).

Fun and games

All of the pupil groups said that IWB contributes to lessons in terms of making them more enjoyable and fun (Wishart & Blease 1999: Levy 2002; BECTA 2003b; Lee & Boyle 2003).

> B. It's just really good fun and then when we've got 5 min spare time you can play some really good games on it and it's really fun. (*School 4*)

> G: Its got quite good things that make it fun as well as teaching and learning. It makes maths fun, we play maths games. (*School 11*)

> B: We are doing a science topic on plants and what (Teacher) does is she prepares a PowerPoint presentation and you go through it and it's kind of like having fun and learning at the same time. It's really exciting and it's just brilliant. (*School 4*)

There seems to be, however, a preoccupation among students regarding the use of games in numeracy and literacy lessons. Games certainly add an element of excitement and fun for students and there is evidence to suggest that they can in certain circumstances have beneficial effects (Subrahmanyam *et al*. 2000, 2001). Nevertheless, a balance must be struck between structured and meaningful uses and unstructured uses purely for the purposes of gratification, i.e. games. There is a concern that with a growing interest in linking home and school ICT use students may carry with them from the home environment the strong association they have formed between ICT and games and enjoyment (Moseley *et al*. 2001).

What students don't like about IWBs

Something that students do not like is technical problems (DfES/National Grid for Learning, NGfL 2002) which from their perspective cause disruption, delay and frustration. If IWB is to be an effective educational technology from the students' point of view, it should be in working order. Teachers' and pupils' skills or lack of them with IWB were also identified by students as problematic.

Technical problems

Students were asked, 'Have you noticed any problems with IWBs?' Students came up with a myriad of problems, many of them very similar across the pupil groups, some minor and some major that may, nevertheless, conspire to have a negative impact on lessons. Problems can be categorized as directly related to faults or failings in the technology itself or associated software to something external impacting on the technology. The former include, for example, the IWB 'freezing' or 'crashing'. The latter include sunlight shining on the board preventing students from seeing it properly. Many students also highlighted the need to reorient/recalibrate the IWB as problematic. Students' comments regarding some of these problems are provided below. Seven of the pupil groups re-

ported a problem commonly encountered when using a personal computer i.e. freezing:

G: When it crashes you have to reload everything up.
B: You have to switch it off, leave it for a bit and switch it back on. It takes ages and you have to make sure that you've saved everything.
G: And sometimes like if it freezes and you're trying to do some work on it and you're trying to find a new page, you can't you just have to wait. The teacher just writes it on the plain whiteboard. (*School 2*)

Nine of the pupil groups identified the need to re-orient/recalibrate the IWB as problematic. This involves pressing a sequence of red crosses on the board so that objects and text are readable and also movable. If the board has not been oriented text appears fuzzy and unreadable while objects can't be moved to different locations on the board. This is apparently a major source of irritation for students as the following comments suggest:

B: I don't like it because you have to orientate it and if you don't get it exactly right and then if you write something on it, say you wrote it here (indicates on IWB), normally it comes somewhere down there and you can't underline things to look like something else.
G: it's really hard if you want to get something and orientate it properly, it can be a bit of a nuisance because you're trying to do it and then you have to go back and orientate it, and we just give in and concentrate on the plain whiteboard. (*School 5*)

B: And when it doesn't get oriented when you write on it, it goes over there. (indicates opposite of where it should be)
G: Once (teacher) orientates it sometimes the board just goes further down and when you're clicking on the board, it'll be there (instead of where it should be). (*School 10*)

Seeing the IWB

Another common problem identified by eight of the pupil groups was not being able to see what was on the IWB. This might be due to the fact that the IWB display is not bright enough or when light shines in through the windows onto the screen (Smith 2001). In some of the evaluation schools the IWB was not placed in the front centre of the classroom due to the practical necessity of finding convenient power outlets. This resulted in difficulties for some students in these schools seeing the board given its somewhat asymmetric positioning. Students provided the following comments:

S: Sometimes we can't see it because the light from the window shines on it. Sometimes you have to turn the lights off because it is too bright.
S: Those blinds are not big enough to totally block out the light so you've got all these beams of light coming down so when (Teacher) writes something in the light, you can't see it whatsoever. (*School 3*)
B: Make it lighter than it is now because it is dull.
Int: I've noticed it isn't too bright is it?
All: Yeah.
B: But it is bright with the lights off. If you put the lights off you can see it and if you put the blinds down as well. (*School 7*)
S: If it was centred everyone would really see the board better. There are forty in our maths group and eight of them can't see the board very well.
S: The sun shines through the window and when the sun shines on it you can't see a thing. (*School 8*)

Many schools involved in the present evaluation purchased blinds which appear to attenuate the problem of sunlight shining onto the IWB. However, even where there were blinds students still complained about the effects of sunlight on the IWB.

It is difficult to determine from pupil interviews alone how often IWBs and their associated hardware and software fail but what is more important is that they do fail and regardless of whether the problem is a minor or major one, one is left wondering what impact this has on students. It is important, therefore, that technical support should be readily available (OECD 2001) especially given the increasing acceptance and use of IWB in schools. A recent article in the London *Times Educational Supplement* (Lee 2004) highlighted the increasing uptake of IWB in schools and the decline of plain whiteboards and chalkboards/blackboards. There is a risk that 'putting all of ones eggs in one basket' may lead to difficulties especially if the IWB fails or there is a power cut.

The positive impact that good technical support can have on the uptake of ICT in schools has been highlighted in other research (Ronnkvist 2000; OECD 2001). A recent OfSTED report (2004a, p. 17) highlights the diversity of technical support systems in British schools and notes that such support is insufficient in primary schools. The report also highlights the negative impact that poor technical support

can have on the on the use of ICT resources in teaching and learning. If technical problems cannot be rectified quickly by the teacher or by a qualified technician then it may be the case that teachers and students will lose confidence in the technology resulting in lack of use.

Teacher and pupil IWB skills

Students are keenly aware of their teachers' shortcomings in relation to the technical and pedagogical uses of IWB (OECD 2001; Smith *et al*. 2004). Various articles and reports have highlighted the impact of low teacher confidence with ICT and a corresponding greater knowledge of ICT among students and the effects this can have on power and status within the classroom (OECD 2001; Goodison 2002; Smith *et al*. 2004). Only three pupil groups, however, highlighted problems with their teachers' IWB skills, which makes it difficult to determine whether this is a local or more general problem. The extent of this problem may be revealed by later research since it is still early days in the introduction of IWB. Comments from students in regard to this issue are presented below:

> B: Everyone's really quite used to the whiteboard but we've got this teacher and well she's kind of new to the whiteboards cos (sic: because) she's a new teacher and I think she's still catching on to using the whiteboards and so are two other teachers. (*School 1*)
> G: It can get a bit annoying when she can't remember how to work it. (the IWB).
> B: Because sometimes it's a bit dodgy (sic: uncertain). It doesn't work sometimes and she has to calibrate it.
> G: And sometimes the pen doesn't work on it and she (teacher) starts banging it against the wall and saying work and stuff.
> G: And she's stamping it on the floor to make a big bang.
> B: It wastes lessons. (*School 2*)

Realising the potential of IWBs means that teachers should be confident and in a position to use them effectively both in technical terms, i.e. how to turn it on, where to find files and software and pedagogically, i.e. integrating it effectively, purposively and meaningfully into lessons. If teachers do not have the confidence to use IWB effectively this may result in poor and limited use of the technology (OfSTED 2004a, b). This suggests that it may be a case of more time and experience using the technology in conjunction with more training to bring teachers up to speed both technically and pedagogically leading hopefully to increased teacher confidence with the technology. While teachers' confidence levels with ICT have risen over the past few years (DfES 2003, 2004a) there are still concerns about ICT skill levels and training opportunities for teachers (OfSTED 2004a, p. 22). The Impact2 study (Harrison *et al*. 2003, p. 8) highlighted the importance of technical support and ICT training and recommended that:

> Schools and teachers need continuing support, including more funding for equipment which can be used flexibly, access to at least one technician on the premises, and more training for teachers in how to integrate ICT with subject learning. This will ensure that they are able to achieve the necessary changes in school culture and teaching practices to reap the benefits of the Government's investment.

Training in the technical and pedagogical aspects of IWB should be viewed as a continuous process rather than a discrete one, requiring regular training sessions so that teachers can maintain and develop their ICT skills. And yet there appears to be little forward planning and budgeting for teachers' continuing professional development (OfSTED 2004a, p. 25, Venezky 2004, p. 4). OfSTED (2004a, pp. 38–39) points out in regard to training that:

> The use of whiteboards in ICT lessons to demonstrate activities such as accessing the intern*et al*so supports pupils' learning well. However, in only a small proportion of schools are whiteboards being used to full effect. In many schools, too few staff 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.

In regard to training, it is perhaps worth mentioning that three student groups highlighted a potential problem with supply teachers (substitute teachers who come into schools to replace teachers who are off sick) and their abilities or rather lack of them, with the IWB.

Students mentioned receiving training from whiteboard consultants when the IWBs had been installed. Students, nevertheless, like teachers, may need to develop and maintain their skills, knowledge and confidence with the technology through regular use

over time. Independent, self-directed learning will require that students are confident and knowledgeable users of the technology. Seven of the pupil groups said that it was relatively easy to learn how to use the IWB as the following comments suggest:

B: It's just like using a normal computer but I sort of like the things where you can press it and it automatically does it.
G: No, I don't think it is easy to learn, once you've got the hang of it, you get the hang of it, it's alright, but at the beginning it can be a bit fiddly and that.
Int: But you gradually pick it up.
G: It takes a week or so to get used to it. (*School 5*)
Int: What about . . . how's long it take to learn how to use the whiteboard?
All: About a week, about a day.
S: Depends on whether you have a computer at home and how much you know.
Int: So if you have a computer at home you find it easier to use the whiteboard.
S: If you have a computer and you don't use it, then it's hard but if you know . . . if you've got a friend and you've got the internet and it's dead up to date and that and you don't have a computer yourself and you go on theirs then it's alright, it depends on your background of computers and knowledge and stuff. (*School 8*)

Students did, nevertheless, highlight some minor difficulties they encountered while using the technology. These included casting their shadow over what they were writing and moving objects on the board. Some students reported that objects would not always go where they wanted them to go as the following comments reveal:

S: When you try to write on it, sometimes you can't see what you're doing because you have to stand back as well to stop your shadow getting onto the board otherwise you can't see what you're doing. (*School 3*)
B: If you put your arm on it like that (shows position of arm on board) while you write, it'll just go all over. You'll have lines under your arm. (*School 4*)
G: Another thing is when you turn and move stuff it sometimes, you want to try and make a new box, sometimes that can be a bit hard and you've got to try and think about it and . . .. If it's really easy and you want to just move it straightaway, you have to group it and that, sometimes because like it will take a long time, you think it's all grouped and then you move it, and only parts of it move. (*School 5*)

While children in the 21st century have grown up surrounded by a variety of technologies (OECD 2001; Kozma 2003) and are perhaps more au fait with most if not all of them compared with some of their teachers, they too require sufficient levels of training that will enable them to use the technology both at their teachers' request and independently. One pupil highlighted this point when he said:

B: If she (teacher) doesn't let certain people use it (the IWB) as much and then she chooses them one day, they'd be really scared to go up to it cos they wouldn't know how to touch it or how you write with the pens. (*School 12*)

What students would like more of

The perception of students is that they do get access to the IWB and that this access involves a range of activities including, e.g. moving text around to form sentences in literacy lessons and moving angles through various degrees in numeracy lessons. This is not the entire universe of their activities however. The following comments highlight some of their activities and experiences:

S: When we're like doing rotation, we had a rotation lesson today, you can like press a button and it rotates it and then you've got to guess how many degrees it's like rotated, and whether its clockwise or anticlockwise.
Int: Why does that help you with angles?
S: Because we get to see which way its turning instead of just seeing one picture like before and one picture after, we get to see it in the process so you know how to do it. (*School 11*)

Int: What about literacy then? In what ways does the IWB help you to learn in literacy?
B: You can do the sentences. It's got parts of sentences and you can put them together. On that board (PW) you have to rub them out and put them back on again.
Int: Right, right. (*School 7*)

The following comments indicate that students feel they do indeed get access to the IWB but there is a suggestion that it is teacher directed access rather than independent and autonomous:

Int: Does (teacher) let you go onto the Internet a lot?
G: (Teacher) starts it up (logs on) and lets us browse around it. (*School 6*)

P: (Teacher) let's the blue table (student classroom grouping) do everything. We stop working because blue table are getting all the goes (sic: opportunities to use) on the IWB. (*School 8*)

Int: Do you (all) get a chance to go up and touch the board very often?
All: Yeah.
B: Sometimes.
Int: Has everyone had a go at touching the board?
All: Yeah.
G: Me and (boy) had a go yesterday because we were doing a science investigation. (*School 10*)

Int: Does she let you use it (The IWB)?
B: Yes she lets us like come up and do a sum or work out a problem or something.
All: Yes.
G: And in English if we have to work out a question or something then she will ask us to come out and write it on the board. (*School 2*)

Students' comments certainly suggest positive experiences and a certain level of interactivity and access with the IWB. Nevertheless, access seems to be on the basis of what the teacher intends to show the whole class and the students' use of the IWB seems to fulfil this purpose. A study conducted by Furlong *et al*. (2000) which investigated students' perceptions of ICT use at school and home suggested that students felt the use of ICTs in school was prescriptive and access was limited. As has been shown by research in other countries (DETYA 2001; EC 2003; DEST 2004) independent access and self-directed learning play key roles in improving the quality of students' experiences and learning. This suggests that realising the benefits of ICTs requires more flexible curricula and changes in teacher and student roles (EC 2003; Lewin 2004). The issue seems to be about equitable access to IWB within the classroom, i.e. how much access do students get to IWB and whether all students get meaningful and purposeful access. These questions may be especially important where student to teacher ratios are high (Venezky 2004). It is not possible to answer all of these questions from focus group data alone. Although judging by students' comments this is an area that needs to be researched further. Students were asked, however, what their teachers could do with IWB to make their lessons more interesting. Most students groups (7/12) felt that they should be allowed to use the IWB more. There is a sense of inequity among some of the students' comments with suggestions that not everyone gets an opportunity to touch or use the IWB in every lesson (OECD 2001, pp. 93–94). The following comments from different schools highlight these particular issues.

B: I reckon, (teachers) do let us use it quite a lot, but I reckon she still could ... because we are quite reliable with it actually and you might think we would break it, but we are actually alright and I think at playtimes she could let us go on it and draw on it.
G: Yes, like if it was wet play and stuff. (*School 2*)

B: Let us use it more often.
G: We can use it and things because we know how to use it now from (teacher) using it and I think we should be allowed to go on it like with adult supervision.
Int: But what way do you want to use it more in lessons?
G: Like if she's asking us a question, if someone gets it wrong so that she asks other people and so that someone comes up more often and so that she asks us more often to go up to the board.
G: She normally asks the same person over and over again.
B: Let us play on it a bit more during wet play times. (*School 3*)
B: Let more people have a go.
G: Everyone could have a go on the whiteboard more often.
G: We have enough already.
B: We've all had a go but it's just like not like every day we all get a go.
B: None of us get a go. It's like once every month. (sad depressed tone). (*School 10*)

Access to ICT generally is viewed as important for students (Kennewell 2001; OECD 2001) although this may be limited by the pupil–computer ratio (Venezky 2004, p. 13), or in this particular study, the pupil–IWB ratio. Lessons with a duration of 45–60 min may make access to the IWB for all students difficult if not impossible and yet regular access and use of ICT has been shown to produce positive impacts for students as a recent OfSTED report highlights in regard to the Internet (OfSTED 2004a, p. 37):

> Where students in all kinds of school have regular access to the internet, they often develop surprisingly high levels of skill and of insight into its use.

Students' comments suggest that access to the IWB is controlled through teacher selection and that not all students get the opportunity to use the IWB during a

lesson. This certainly seems to be a limitation from the students' perspective. Earlier studies highlight the same issue (Beeland 2002; Solvie 2004) with students expressing a keen desire to touch and use the technology independently but apparently being prevented from doing so by the teacher. One of the conclusions from the Impact2 study (Harrison *et al*. 2003, p. 8) in relation to students and ICT use was that:

> Since students are likely to acquire ICT skills quickly and easily through using them for self-directed tasks, more time should be spent on exploratory learning in curriculum subjects and less time on teaching skills in discrete ICT lessons.

Clearly there is a need to provide students with access to the technology and yet the introduction and use of IWB in the classroom seems to have highlighted some tensions between the structure of the British education system and traditional pedagogical practices which place the teacher at the centre of the educational universe, while ICT and IWB require a more decentred role for the teacher as facilitator and knowledgeable guide (OECD 2001; Bransford *et al*. 2002; Kozma 2003).

One of the advantages of IWBs, it has been argued, is the way that they allow teachers to teach from the front of the class (Smith 2001; Levy 2002). It may be the case, however, that this simply maintains the traditional lecturing role while ICTs generally and IWB specifically appear to 'demand' a more flexible and collaborative approach between teachers and students (OECD 2001; Kozma 2003; Kozma & McGhee 2003). The 'typical' use of the IWB, from one observer's point of view (Kenny 2004), seems to suggest that this flexible and collaborative approach is somewhat lacking and that teachers' traditional blackboard/plain whiteboard practices if used with IWBs may unwittingly maintain the status quo in the classroom. A number of authors (Kennewell 2001; Smeets & Mooij 2001; Goodison 2002; Kerrawalla & Crook 2002; Cox *et al*. 2003a) show in their research that the environment in schools for ICTs use is controlled by the teacher. It may be this control that prevents students from engaging with ICTs and IWB more freely and autonomously. A recent study seems to suggest that students' autonomous uses of ICTs may be limited to wet play times or lunch breaks (Somekh *et al*. 2002). Research into differences between children's use of ICT at home and in schools (Topping 1997; Donnelly 1998; Harris 1999; Subrahmanyam *et al*. 2000; Moseley *et al*. 2001; Kerrawalla & Crook 2002; Konstantinos & Tsitouridou 2002; Dunsmuir & Clifford 2003; Lewin *et al*. 2003; Murphy & Beggs 2003; Sutherland-Smith *et al*. 2003) seems to suggest that as a result of greater autonomy at home children use ICT longer and for a variety of purposes. It may be that allowing greater pupil autonomy in the classroom could benefit students. Home use appears, however, to be unstructured and unplanned but involving greater autonomy, while school use is structured, planned and with a particular learning goal in mind but with less pupil autonomy.

A recent Australian study (Lee & Boyle 2003) indicates that when teachers begin to use IWB their traditional teaching practices do give way to new ones as a result of the greater flexibility that IWB gives them in the classroom. Whether this same flexibility will lead to changes in UK teachers' practices is uncertain since the demands of the National Curriculum and the standards agenda on teachers may effectively prevent such innovation.

There is clearly an issue here about power, status and control in the classroom for both teachers and students. ICTs do effect changes in the roles of teachers and students with the teacher moving towards the role of a facilitator, a knowledgeable guide, and away from the traditional lecturing role (Kozma & Anderson 2002; EC 2003; Kozma 2003; Kozma & McGhee 2003). This seems to result in more independent and self-directed learning among students. The role of the teacher may need to change from one of controlling every aspect of a lesson to a more protective and facilitative one, providing a safe environment within which students can explore the concrete world through ICTs. The developing role is not simply that of a gatekeeper, however, protecting students from potentially harmful content on the Internet but also as a guide developing within them a critical awareness of what actually constitutes accurate and reliable content (Venezky & Davis 2002). The presence of a teacher is still a vital one but simply needs to adapt to the demands that new technologies bring into the classroom. (Cox *et al*. 2003b; Deaney *et al*. 2003; Gredler 2004). A recent letter in the London *Times Educational Supplement*, however, reveals a teacher's feelings of 'obsolescence' in regard

to students' independent use of ICTs (Turner-Bissett 2004).

Conclusions

Research into the impact of IWBs conducted between 2000 and 2003 highlights a number of common themes from the students' perspective including technical problems, teachers and students' ICT skills, and access to the technology. (Smith 1999; Smith 2001; Beeland 2002; Lee & Boyle 2003). These are confirmed in the present study. None of the problems identified by students in the current study is, however, insurmountable.

Problems with IWBs identified by students in the current study may be short-term in nature i.e. 'teething troubles', rather than long-term difficulties. It may be that later studies show this to be the case. The current situation appears, however, to suggest a state of imbalance, a sense of a work still in progress rather than nearing completion. Statistics reveal, for instance, that teachers' ICT confidence levels are high (DfES 2004a) (whether this includes competence with ICTs is not known) and training for those teachers just starting out and for those already in established posts appears to be improving although doubts remain in some quarters (OECD 2001; Venezky & Davis 2002; OfSTED 2004a, b). Technical support has been shown to be a vital component in any ICT infrastructure (Ronnkvist 2000; OECD 2001) and yet it appears to be in a state of underdevelopment at the present time (OfSTED 2004a). There needs to be a greater orchestration of these diverse but interrelated elements if ICT is to be successfully established in UK schools.

Returning to the issue of pupil participation in the educative process. It seems that while surveying students through questionnaires, individual interviews and/or group interviews may help to find out what 'works' for them in relation to ICTs and IWB, the potential impact of their views in terms of increasing their participation may be limited by the current educational climate in Great Britain with its emphasis on standards and raising attainment. There is some evidence to suggest that students' views are elicited and then ignored by teachers since they are under pressure to fulfill other more pressing agendas. (Demetriadis *et al*. 2003; Tearle & Dillon 2003; Wood 2003). This does not seem to be the case in the United States where students' views are, apparently, welcomed and valued (US Department of Education 2004). However, comments in the British media hint at a certain level of resistance among teachers to the notion of more pupil participation in the educative process (Cunningham 2004, p.16; BBC 2003). Recent articles in the London *Times Educational Supplement* (Kenny 2001) and *The London Times* (Blair 2004) highlight some of the possibilities of increasing pupil participation but also hint at some of the perils.

Is it possible to have genuine pupil interaction in the classroom if the demands of an inflexible national curriculum and standards agenda result in a classroom situation where teachers are compelled to rigidly control lessons and limit pupil participation and access to the IWB? A recent study in Europe (EC 2003) suggests that where teachers have greater autonomy in the classroom there is greater innovation with ICTs. If, as students' comments seem to suggest, the extent of students' involvement in lessons where IWB is used is limited to fulfilling the teachers' objectives for the lesson isn't this a rather limited form of interaction? This may be, as Aldrich *et al*. (1998) argue, a form of interactivity at its most basic level. Won't this seriously restrict what has come to be seen as an important and effective use of ICTs and in this case IWB? That is, the capacity for students to learn through self-directed use of the technology (EC 2003; Blackmore *et al*. 2003; DEST 2004)? Surely pupil participation in its broadest sense should include room for autonomous or semi-autonomous activity where they can learn from their own mistakes, choices and decisions but with the help and support of a knowledgeable guide and facilitator, the teacher? Information and Communication Technologies demand a greater level of openness and collaboration between teachers and students and yet could it be that pressure on schools and teachers to meet targets imposed on them by the demands of a standardized and nationally applied curriculum and other standards related initiatives might be conspiring to prevent this from happening (Lewin 2004)? It should also be mentioned in passing that the concept of 'interactivity' has not been accurately and perhaps more importantly operationally defined, which in it self must be problematic for teachers (English 2002; Hargreaves *et al*. 2003; Burns & Myhill 2004).

The findings presented here have been taken from a small qualitative study and it would be premature to make any hard and fast judgements about IWB in schools since IWB implementation is still in its infancy. More research into pupils' classroom access to ICTs needs to be undertaken. Students, nevertheless, provide some useful insights into the uses of IWB, which it would be foolish to ignore. While the technology is clearly engaging from the students' perspective there is a concern that any gains in this direction may be lost if the technology is not reliable, if teachers are not adequately trained to use it, and perhaps more importantly, if the educational climate militates against increased pupil access to the technology. It would be a pity if the benefits that could be gained through the more open, collaborative and imaginative uses of ICT and IWB were thrown away simply for failing to adapt to the demands of new technology.

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References

Aldgate J. & Statham J. (1989) *The Children Act Now: Messages from Research*. The Stationery Office, London, England.

Aldrich F., Rogers Y. & Scaife M. (1998) Getting to grips with 'interactivity': helping teachers assess the educational value of CD-ROMS. *British Journal of Educational Technology* **29**, 321–332.

Arksey H. & Knight P. (1999) *Interviewing for Social Scientists*. Sage Publications, London.

Barbour R.S. & Kitzinger J.), (eds) (1999) *Developing Focus Group Research: Politics, Theory and Practice*. Sage Publications, London.

BBC (2003) School 'democracy' plans criticised. Available at: http://news.bbc.co.uk/go/pr/fr/-/1/hi/education/3226986.stm. Last accessed 11 December 2004.

BBC (2004) Lib Dems unveil 'pupil guarantee'. Available at: http://news.bbc.co.uk/1/hi/uk_politics/3875283.stm. Last accessed 9 July 2004.

BECTA (2003a) *What the research says about ICT and motivation*. The British Educational Communications and Technology Agency, Coventry, England.

BECTA (2003b) *What the research says about interactive whiteboards*. The British Educational Communications and Technology Agency, Coventry, England.

BECTA (2004) Background to the NGfL. Available at: http://www.ngfl.gov.uk/about_ngfl/background.jsp. Last accessed 5 November 2004.

Beeland W.D. (2002) Student engagement, visual learning and technology: Can interactive whiteboards help? Available at: http://plato75.ncl.ac.uk/beeland.pdf. Last accessed 15 December 2004.

Bell M.A. (1998) Teachers' perceptions regarding the use of the Interactive electronic whiteboard in instruction. Available at: www.smarterkids.org/research/paper6.asp. Last accessed 27 November 2004.

Blackmore J., Hardcastle L., Bamblett E. & Owens J. (2003) *Effective Use of Information and Communication Technology (ICT) to Enhance Learning for Disadvantaged School Students*. Deakin Centre for Education and Change, Institute of Disability Studies, Deakin University and Institute of Koorie Education, Deakin University, Australia.

Blair A. (2004) Could do better ... children give their teachers marks. *The Times*, London, p. 4, Monday 13.12.2004.

Bransford J.D., Brown A.L. & Cocking R.R.), (eds) (2002) *How People Learn: Brain, Mind, Experience and School*. National Academy Press, Washington, DC.

Burns C. & Myhill D. (2004) Interactive or inactive? A consideration of the nature of interaction in whole class teaching. *Cambridge Journal of Education* **34**, 35–49.

Cox M., Abbott C., Webb M., Blakeley B., Beauchamp T. & Rhodes V. (2003a) *ICT and Attainment: a Review of the Research Literature*. DfES Publications, Annesley, Nottinghamshire, England.

Cox M., Webb M., Abbott C., Blakeley B., Beauchamp T. & Rhodes V. (2003b) *ICT and Pedagogy: a Review of the Research Literature*. DfES Publications, Annesley, Nottinghamshire, England.

Cunningham A. (2004) Teachers are now bricks in the wall. *Daily Express*, London, p. 16, 06.12.2004.

Deaney R., Ruthven K. & Hennessey S. (2003) Pupil perspectives on the contribution of information and communication technology to teaching and learning in the secondary school. *Research Papers in Education* **18**, 141–165.

Demetriadis S., Barbas A., Molohides A., Palaigeorgiou G., Psillos D., Vlahavas I., Tsoukalas I. & Pombortsis A. (2003) Culture in negotiation: teachers' acceptance/

resistance attitudes considering the infusion of technology into schools. *Computers & Education* **41**, 19–37.

DEST (2004) *Australia's Future Using Education Technology*. Department of Education, Science and Training, Australia, ISBN 0 642 77465 X.

DETYA (2001) *Information and Communication Technology for Teaching and Learning*. Department of Education, Training and Youth Affairs, Australia.

DfES (2002) *The Children Act, Department for Education and Skills*. Annesley, Nottinghamshire, England.

DfES (2003) *Survey of Information and Communications Technology in Schools*. Department for Education and Skills, London.

DfES (2004a) *Information and Communications Technology in Schools in England*. Department for Education and Skills, London.

DfES (2004b) Interactive whiteboards. Available at: http://www.teachernet.gov.uk/educationoverview/briefing/currentstrategy/interactivewhiteboards/. Last accessed 24 December 2004.

DfES (2004c) Interactive whiteboards: question and answer. Available at: http://www.dfes.gov.uk/ictinschools/ict_active/factfile.cfm?articleid=511. Last accessed 24 December 2004.

DfES/NGfL (2002) *Young People and ICT: Findings from a Survey Conducted Autumn 2001*. Department for Education and Skills, London.

Donnelly J. (1998) Bringing ICT home. *Managing Schools Today* **8**, 27–29.

Dunsmuir S. & Clifford V. (2003) Children's writing and the use of information and communications technology. *Educational Psychology in Practice* **19**, 171–187.

English E. (2002) Pedagogical dilemmas in the National Literacy Strategy: primary teachers' perceptions, reflections and classroom behaviour. *Cambridge Journal of Education* **32**, 10–26.

European Commission (2003) *Elearning: Better Elearning for Europe*. Location: European Commission, Directorate-General for Education and Culture, Luxembourg.

Furlong J., Furlong R. & Sutherland R. (2000) *Screen-play: an exploratory study of children in 'techno-popular' culture*. Economic and Social Research Council, Award Reference Number: R000237298, Regard, University of Bristol, Bristol, England.

Goodison T.A. (2002) Learning with ICT at primary level: students' perceptions. *Journal of Computer Assisted Learning* **18**, 282–295.

Gredler M.E. (2004) *Learning and Instruction: Theory into Practice*. Pearson Merrill Prentice-Hall, Englewood Cliffs, NJ.

Greig A. & Taylor J. (1999) *Doing Research with Children*. Sage Publications, London.

Hargreaves L., Moyles J., Merry R., Patterson F., Pell A. & Esarte-Sarries V. (2003) How do primary school teachers define and implement 'interactive teaching' in the National Literacy Strategy in England. *Research Papers in Education* **18**, 217–236.

Harris S. (1999) Secondary school students' use of computers at home. *British Journal of Educational Psychology* **30**, 331–339.

Harris S. & Kington A. (2002) *Innovative classroom practices using ICT in England*. The National Foundation for Educational Research, Slough, Berkshire, England.

Harrison C., Comber C., Fisher T., Haw K., Lewin C., Lunzer E., McFarlane A., Mavers D., Scrimshaw P., Somekh B. & Watling R. (2003) *ImpaCT2 The Impact of information and communication technologies on pupil learning and attainment*. Department for Education and Skills, Annesley, Nottinghamshire, England.

Heary C.M. & Hennessy E. (2002) The use of focus group interviews in pediatric health care research. *Journal of Pediatric Psychology* **27**, 47–57.

Kennewell S. (2001) Interactive whiteboards – yet another solution looking for a problem to solve. *Information Technology in Teacher Education* **39** (2001), 3–6.

Kenny C. (2001) Students pick their new head. Available at: http://www.tes.co.uk/search/story/?story_id=349673. Last accessed 17 December 2004.

Kenny J. (2004) Project and serve. Available at: http://www.tes.co.uk/search/story/?story_id=2047328. Last accessed 15 December 2004.

Kerrawalla L. & Crook C. (2002) Children's computer use at home and at school: context and continuity. *British Educational Research Journal* **28**, 751–771.

Kinnear H. (2001) In British Educational Research Association Annual Conference, Leeds University, 13–15 September 2001.

Kirby P., Lanyon C., Cronin K. & Sinclair R. (2003) *Building a culture of participation involving children and young people in policy, service planning, delivery and evaluation*. Department for Education and Skills, Annesley, Nottinghamshire, England.

Kitzinger J. (2004) The methodology of focus groups: the importance of interaction between research participants. In *Social Research Methods: A Reader* (ed. C. Seale). Routledge, London.

Konstantinos V. & Tsitouridou M. (2002) The home computer in children's everyday life: the case of Greece. *Journal of Educational Media* **27**, 9–17.

Kozma R.B.), (Ed.) (2003) *Technology, Innovation and Educational Change: A Global Perspective*. ISTE, Eugene, OR.

Kozma R.B. & Anderson R.E. (2002) Qualitative case studies of innovative pedagogical practices using ICT. *Journal of Computer Assisted Learning* **18**, 387–394.

Kozma R.B. & McGhee R. (2003) ICT and Innovative Classroom Practices. In *Technology, Innovation and Educational Change: A Global Perspective* (ed. R.B. Kozma), pp. 43–80. ISTE, Eugene, OR.

Krueger R.A. & Casey M.A. (2000) *Focus Groups: A Practical Guide for Applied Research*. Sage Publications, Thousand Oaks.

Latham P. (2002) Teaching and learning primary mathematics: the impact of interactive whiteboards. Available at: http://www.beam.co.uk/pdfs/RES03.pdf., last accessed 30 November 2004.

Lee J. (2004) A whiteboard smokescreen? Available at: http://www.tes.co.uk/search/story/?story_id=2055677. Last accessed 15 December 2004.

Lee M. & Boyle M. (2003) The educational effects and implications of the interactive whiteboard strategy of Richardson primary school: a brief review, Available at: http://www.richardsonps.act.edu.au/RichardsonReview_Grey.pdf. Last accessed 27 November 2004.

Levy P. (2002) *Interactive whiteboards in learning and teaching in two Sheffield schools: a developmental study*. Department of Information Studies, University of Sheffield, Sheffield, England.

Lewin C. (2004) Access and use of technologies in the home in the UK: implications for the curriculum. *The Curriculum Journal* **15**, 139–154.

Lewin C., Mavers D. & Somekh B. (2003) Broadening access to the curriculum through using technology to link home and school: a critical analysis of reforms intended to improve students' educational attainment. *The Curriculum Journal* **14**, 23–53.

Lewis A. (1992) Group child interviews as a research tool. *British Educational Research Journal* **18**, 413–423.

Lewis V., Kellett M., Robinson C., Fraser S. & Ding S. (2004) *The Reality of Research with Children and Young People*. Sage Publications, London.

Lovegrove N. & Wilshire M. (1997) *The Future of Information technology in UK Schools*. McKinsey & Company, London, England.

Morgan M., Gibbs S., Maxwell K. & Britten N. (2002a) Hearing children's voices: methodological issues in conducting focus groups with children aged 7–11 years. *Qualitative Research* **2**, 5–20.

Morgan M., Gibbs S., Maxwell K. & Britten N. (2002b) Conducting focus groups with children. *Paediatric Nursing* **14**, 1–2.

Moseley D., Mearns N. & Tse H. (2001) Using computers at home and in the primary school: where is the value added? *Educational & Child Psychology* **18**, 31–46.

Murphy C. & Beggs J. (2003) Primary students' and teachers' use of computers at home and school. *British Journal of Educational Technology* **34**, 79–83.

NCES (2000) *Teachers' tools for the 21st century: a report on teachers use of technology*. National Center for Education Statistics, US Department of Education, Washington, DC.

OECD (2001) *Schooling for Tomorrow: Learning to Change: ICT in Schools*. Centre for Educational Research and Innovation, OECD, Paris, France.

OfSTED (2004a) ICT in schools: the impact of government initiatives five years on. Available at: http://www.ofsted.gov.uk/publications/index.cfm?fuseaction=pubs.displayfile&id=3652&type=pdf. Last accessed 29 December 2004.

OfSTED (2004b) 2004 Report: ICT in schools – the impact of government initiatives: primary schools. Available at: http://www.ofsted.gov.uk/publications/index.cfm?fuseaction=pubs.displayfile&id=3653&type=pdf. Last accessed 29 December 2004.

Passey D., Rogers C., Machell J., McHugh G. & Allaway D. (2003) *The Motivational Effect of ICT on Students*. DfES Publications, Annesley, Nottinghamshire, England.

Robson S. (2002) Group Discussions. In *The International Handbook of Market Research Techniques* (ed. R.J. Birn), pp. 296–316. Kogan-Page, London.

Ronnkvist A.M. (2000) *Technology support: it's depth, breadth and impact in America's schools*. Center for Research on Information Technology and Organizations, Minnesota University, Minnesota.

Scaife M. & Rogers Y. (1999) Kids as informants: telling us what we didn't know or confirming what we knew already? In *The Design of Children's Technology* (ed.Druin A. pp. 27–50. Morgan Kaufmann, San Francisco.

Smeets E. & Mooij T. (2001) Pupil-centred learning, ICT, and teacher behaviour: observations in educational practice. *British Journal of Educational Technology* **32**, 403–417.

Smith A. (1999) Interactive whiteboard evaluation. Available at: http://www.mirandanet.ac.uk/pubs/smartboard.htm. Last accessed 18 November 2004.

Smith H. (2001) Smartboard evaluation: final report. Available at: http://www.kented.org.uk/ngfl/ict/IWB/whiteboards/index.html. Last accessed 27 November 2004.

Smith P.K., Cowie H. & Blades M. (2004) *Understanding Children's Development*. Blackwell Publishing, Oxford, UK.

Solvie P.A. (2004) The digital whiteboard: a tool in early literacy instruction. *Reading Teacher* **57**, 484–7.

Somekh B., Lewin C., Mavers D., Fisher T., Harrison C., Haw K., Lunzer E., McFarlane A. & Scrimshaw P.

(2002) *ImpaCT2: Students' and Teachers' Perceptions of ICT in the Home, School and Community*. DfES/BECTA, London.

Sousa D.A. (2001) *How the Brain Learns*. Corwin Press, Thousand Oaks, CA.

Stevenson D. (1997) *Information and Communications Technology in UK Schools*. The Independent ICT in Schools Commission, London, England.

Stewart D. & Shamdasani P.N. (1990) *Focus Groups: Theory and Practice*. Sage Publications, London.

Subrahmanyam K., Greenfield P., Kraut R. & Gross E. (2001) The impact of computer use on children's and adolescents' development. *Applied Developmental Psychology* **22**, 7–30.

Subrahmanyam K., Kraut R.E., Greenfield P.M. & Gross E.F. (2000) The impact of home computer use on children's activities and development. *The Future of Children* **10**, 123–144.

Sutherland-Smith W., Snyder I. & Angus L. (2003) The digital divide: differences in computer use between home and school in low socio-economic households. *Educational Studies in Language and Literature* **3**, 5–19.

Tearle P. & Dillon P. (2003) *Evaluation of the Intel Teach to the Future Programme*. University of Exeter, England, Exeter.

Topping K.J. (1997) Family electronic literacy: part 2 – home-school links: through computers. *Reading* **31**, 12–21.

Turner-Bissett R. (2004) Move over, the machines are here. *The Times Educational Supplement Online*, London.

UNICEF (2004) Convention on the rights of the child. Available at: http://www.unicef.org/crc/fulltext.htm. Last accessed 9 August 2004.

US Department of Education (2004) *Toward a new golden age in American education: how the Internet, the law and today's students are revolutionizing expectations*. National Education Technology Plan, US Department of Education, Washington, DC.

Venezky R.L. & Davis C. (2002) *Quo Vademus? the transformation of schooling in a networked world*. Centre for Educational Research and Innovation, OECD, Paris, France.

Venezky R.L. (2004) Technology in the classroom: steps toward a new vision. *Education, Communication and Information* **4**, 3–21.

Walker-Tileston D. (2004) *What Every teacher Should Know About Media and Technology*. Corwin Press, Thousand Oaks, CA.

Wishart J. & Blease D. (1999) Theories underlying perceived changes in teaching and learning after installing a computer network in a secondary school. *British Journal of Educational Technology* **30**, 25–41.

Wood E. (2003) The power of pupil perspectives in evidence-based practice: the case of gender and underachievement. *Research Papers in Education* **18**, 365–383.