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Collaborative research methodology for investigating teaching and learning: the use of interactive whiteboard technology

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This paper discusses the results of a research project which aimed to capture, analyse and communicate the complex interactions between students, teachers and technology that occur in the classroom. Teachers and researchers used an innovative research design developed through the Interactive Education Project (Sutherland *et al.*, 2003). Video case studies were carried out in four classrooms, focusing on the use of interactive whiteboard technology for teaching and learning. The case studies were analysed using StudioCode, an analytic tool which allows researchers to mark and code segments of video data into categories and themes. Teachers developed coding systems drawing on the learning aims and objectives of their particular lessons. The case studies illustrate that the introduction of interactive whiteboards (IWBs) into the classroom involves much more than the physical installation of the board and software. Teachers are the critical agents in mediating the software, the integration of the software into the subject aims of the lesson and appropriate use of the IWB to promote quality interactions and interactivity.

Introduction

This paper is based on a two-year research project funded by the Economic and Social Research Council (ESRC)—'A digital approach to distilling the complexity of teaching and learning'. The overall aim of the project is to capture, analyse and communicate the complex interactions between students, teacher and technology that occur in the classroom. Using an innovative research design developed from the ESRC project, InterActive Education (Sutherland *et al.*, 2003; 2004), we have worked with four teachers to analyse digital recordings of lessons in order to build

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theories of teaching and learning (Armstrong & Curran, 2005). We chose from the outset to focus on the use of the interactive whiteboard in the classroom, as there was very little research on the use of this new digital technology from the perspective of teaching and learning.

The UK Government has recently allocated £50 million for the purchase of IWBs within the primary and secondary sectors, and yet research into these new technologies is very much in its early stages. One of the main reasons given for promoting this technology is its ability to directly support interactive whole class teaching (BECTA, 2004; Department for Education and Skills [DfES], 2004). 1 However, it has been noted that IWBs are not necessarily used interactively and can actually reinforce teacher-centred styles of delivery (Levy, 2002; Kennewell, 2004; Knight *et al.*, 2004). Rather than transforming teacher's pedagogy, the interactive whiteboard can be relatively easily assimilated into existing ways of working. As Glover and Miller (2001, p. 257) note, IWBs are least effective and have limited impact on teaching and learning when teachers 'fail to appreciate that interactivity requires a new approach to pedagogy' and there may be a tendency for IWBs to be used more as an 'interest enhancer than as a new approach to learning' (Glover & Miller, 2001, p. 269).

Teaching, learning and interactive whiteboard technology

The research is situated within a theoretical perspective on teaching and learning which draws mainly from socio-cultural theories of learning (Vygotsky, 1978; Wertsch, 1991). An important aspect of socio-cultural theory is the claim that all human action is mediated by tools. We interpret the idea of a tool to incorporate a wide range of artefacts (for example pen, paper, computer) and semiotic systems (for example language, graphs, diagrams). Within this framework the idea of person-acting-with-mediational-means (Wertsch, 1991) both expands the view of what a person can do and also suggests that a person might be constrained by their situated and mediated action.

Socio-cultural theory foregrounds the cultural aspects of human action. There are several aspects of culture which are important to take into account. Firstly, the teacher and students work within a local classroom culture, which is influenced by local, national and global factors. Within this context the teacher and students bring to the classroom a history of experiences which relate to their previous cultures of learning and tool use. So when faced with a new technology a teacher is likely to make sense of it in terms of previous experiences of older technologies. This suggests, for example, that many teachers are likely to use digital whiteboards as an extension of the non-digital whiteboard. Students also draw on their out-of-school uses of ICT and this impacts on learning in the classroom (Facer *et al.*, 2001; Kent & Facer, 2004).

It is useful here to consider the idea of affordance as a way of exploring the use of a tool (Gibson, 1979; Norman, 1999; McGrenere & Ho, 2000). The original formation of the term affordance evolved through Gibson's (1979) work on his

studies of the physical mechanics of visual perception. At the time, psychologists did not make an explicit link between the physical stimulation of the cones and rods which underlie seeing and the attachment of meaning to the image which the viewer 'sees'. Gibson suggested that each time we see something we also attach a meaning to it. In other words, when we see an object we also see it in terms of what we can do with it—a chair is for sitting (if we are looking to sit) or it can be for standing (if it is strong enough and we wish to reach the ceiling). The same idea holds for technologies for teaching and learning. The IWB potentially affords interaction if the teacher perceives that it can be used in this way, and uses appropriate software that also affords interaction. The IWB may not afford interaction if it is perceived as a presentational tool only. Interaction can, of course, mean many different things. Our use of the term interaction foregrounds the give and take between pupils and teachers, which goes beyond a superficial learning scenario to a stimulating interplay which leads to new formulations and new understanding. We use the term interactivity to focus on the functional aspects that technology and software provide. An IWB can afford interactivity by making use of the different ways of manipulating the applications running on the screen. Pupils or teachers can operate the IWB through a keyboard, or special pen, from different positions in the classrooms. This can change the way pupils and teachers work with the IWB and with each other. This interactivity may lead to the types of interactions described above. As we discuss in a later section of this paper, the affordances of the IWB are inextricably linked to the software used. This perspective suggests that there are no absolute properties of the IWB which enable us to predict the effects which it will have on teaching and learning. So whereas potentially a digital IWB is very different from a non-digital whiteboard there is no guarantee that this potential will be realised in the classroom. In other words what students learn relates to how a technology is used in the classroom, and how a technology is used relates to the teacher's (and students') perceptions of how it can be used, which also relates to their previous experience of similar technologies.

Collaborative methodology: working in partnership

Using two video cameras (one focusing on interactions with the IWB, the other set up to capture the whole class), a sequence of three one-hour lessons for each teacher was video recorded. A researcher, using the editing software Final Cut Pro, then produced a composite image that enabled the image from the whole class camera and IWB camera to be viewed simultaneously. The complete lessons were then made into a Quick Time movie and burned onto a Compact Disc and copies were given to the teachers. An important aspect of our research design was enabling teachers to have access to their data unedited where no prior 'selections' had taken place.

The project researcher was responsible, in the first instance, for viewing all of the video data and selecting interesting clips from across the range of lessons and transcribing the language so that it could be displayed simultaneously while

watching the clips. The teacher practitioners also selected clips from their own lessons that they found of particular interest. These clips were presented in analysis sessions involving researchers and teacher practitioners. To ensure that both researchers' and teachers' voices were represented and to produce the necessary element of 'transparency', we loosely adopted Lesh and Lehrer's (2000) model of iterative video tape analysis conducted in cycles of interpretation. In their model, the video data is viewed by several researchers who then bring their different interpretations to a joint research seminar. Points of difference and similarity can be located across the interpretations of the same clips which then provide the basis for discussion and allows for clarification and alternative interpretations. These interpretations can be tested, refined and extended producing a series of 'interpretation cycles' that help establish a framework for the ongoing analysis. Often when video is used to gather data, the observations made by the participants are not used to provide analytic resources but rather to clarify understanding of incidents, language or technologies (Heath & Hindmarsh, 2002). However within this project teachers' observations are not only used to provide a context for the events observed but their perspectives form an integral part of the analysis process.

In addition to the class sessions, in-depth semi-structured interviews were conducted with the four teachers together with two focus groups of six pupils in each class after the sequence of lessons had been video recorded and transcribed in full. The joint viewing sessions between researchers and teacher practitioners were also video recorded and transcribed and used as part of the analysis.

The analysis process

From our own research questions and those the teachers wanted to investigate, a set of categories were developed which aimed to explore issues of teaching and learning across the range of lessons we had video recorded. During our joint research seminars, we began to develop iterative codings. During subsequent viewings and discussions, these codings were refined while others were discarded depending on whether or not they were deemed useful in helping us investigate the complex teaching and learning interactions within the classroom. It is important to stress that the categories we eventually agreed upon were jointly developed; they arose both from the original research questions around IWB use and issues that the teachers had identified as meaningful and interesting to them. The categories below represent those on which we reached a consensus and were applied to each teacher's data:

i) *Questioning:* questions put by the teacher or pupil.
ii) *Subject Vocabulary:* vocabulary that matched with the learning objectives and were clear examples of students' use and understanding of subject language and subject knowledge.
iii) *Teacher instigated subject-specific vocabulary*
iv) *Pupil instigated subject-specific vocabulary*
v) *Instructional/Directional:* these were statements that related to the manipulation of the software and ICT and were not related to subject language.

vi) *IWB:* who was using the interactive whiteboard and in which parts of the lesson.
vii) *Whole class interactions.*
viii) *Teacher/pupil interactions*
ix) *Pupil/pupil interactions.*
x) *Gaming language:* language specific to the use of computer games.

These categories enabled us to draw on a range of semiotic systems such as language, diagrams, graphs and other visual features of IWB supported software to examine how teachers used this range of 'tools' within specific teaching and learning contexts. Each video excerpt (around 10–15 minutes in length) was viewed twice in the group analysis session and then in more detail in the joint analysis carried out between the researcher and teacher practitioner, both of whom had developed a high level of familiarity with the data by that stage of the process.

The case studies

Case study 1: Sarah Curran, Primary Science, Year 6

Of the four project teachers only Sarah Curran and Simon Mills (discussed later) had daily access to IWBs in their classrooms and only Sarah had received any formal training in the use of IWBs. Her school had made significant financial investment in this new technology and training was provided for all staff during school time which was further supplemented by INSET provided by the IWB suppliers. Sarah remarked that taking a whole-school approach to training meant that teachers were more likely to engage with IWBs and would develop the confidence to use it:

> Interviewer: Without training how would you have coped?
> Sarah Curran: Well, I wouldn't and that was that. I think without training, that initiative about it being a whole school issue, you just end up with the key needs or the one or two that find it as being a priority rather than it just being everybody, a whole school thing … otherwise you disengage with it straight away without training and resources.

Sarah was also involved in ongoing training both within her own school and other local schools and was confident in using a wide range of software and media resources.

The sequence of lessons observed at Whitehall Primary was focused on Science and in each lesson pupils were asked to carry out a scientific investigation using IWB supported software. The third lesson focused around the software Virtualfishtank (http://www.virtualfishtank.com/main.html) as illustrated in Figures 1 and 2 below. The aim of the investigation was to design a fish, place it in the virtual fishtank and then time how long it survived before it was eaten by the shark. Pupils were asked to design a number of fish with different characteristics (size of mouth, position in the tank, for example) and then compare how the characteristics of each fish contributed to its ability to survive in this virtual environment.

When we viewed the data, it became apparent that the way in which Sarah and the pupils engaged with this software in the lesson was at odds with Sarah's intended

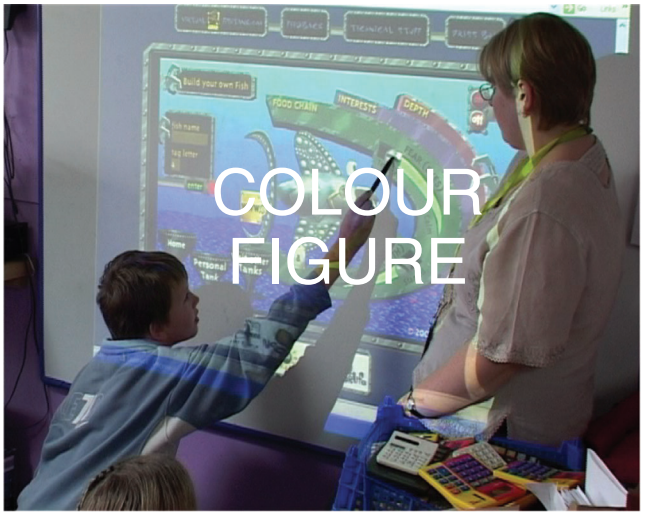

Figure 1. Pupil designing a fish using the interactive sliders

lesson objectives (as discussed more fully in Armstrong & Curran, 2005). Although the pupils had been asked to design a number of fish, record their survival time and compare their different characteristics, this was not possible because most of the fish survived from 20 to 35 minutes making it impossible to carry out the investigation in the way it had been envisaged. Upon subsequent viewings we began to realise that

Figure 2. Pupils using Virtualfish

this was in part due to the inherent affordances of the software. On researching the background to the design of the software, it transpired that it had not been designed as a tool for carrying out the type of comparative investigation conceived by Sarah but had originated from an interactive exhibit mounted at the Museum of Science in Boston that was used to teach about emergent behaviour, group behaviour and modeling.

Sarah chose this particular piece of software to support the doing of 'science' but analysis of the video data suggested that pupils were viewing this software as 'gaming' software. Further analysis of the data helped us to understand that this 'gaming' perspective had been reinforced by Sarah when she had first introduced pupils to the fish-tank activity. We began to see that the way in which the teacher and pupils 'read' the software was as a 'game' and we suggest that this relates to both the representational aspects of the software and the particular socio cultural context. We found that the software's visual representation—as resembling gaming software—influenced Sarah's use of language in presenting the task to the class. By referring to the transcript of this clip, we were able to interrogate the language more thoroughly as it related to the software and classroom interactions. We noted that Sarah made no use of any form of scientific discourse or subject specific vocabulary until some 11 minutes into the lesson and there were only 4 brief instances of pupil instigated subject vocabulary in the same period. As Jewitt (2002, p. 177) asserts, 'viewing positions are encoded in an image and this is the resource offered as the basis for the negotiation of meaning'. Consequently, the viewer is 'placed' in a certain position by the maker of the image and viewers make meanings around their interpretation and engagement with the image. The software's interface led one pupil to comment in the lesson that 'it's like a game', which the teacher agreed with. This was replicated by pupils' exclamations while engaged with the software such as 'Don't die! We gotta beat people' and 'We need to beat five minutes!' When one boy announced that his fish had been killed after 21 minutes, his neighbour jumped up exclaiming 'You just got killed? Yes! You got killed!' Consequently, the original lesson objectives had been subverted by both the affordances of the software and its interpretation by the teacher and pupils. Working in partnership with researchers and other teachers had encouraged Sarah to adopt a more analytical and critical approach to IWBs and to pay more attention to how the software could match teaching and learning objectives:

> I look beyond the surface of IWBs now, the way I use them, what types of software and use and why I chose them. It's really encouraged me to pursue this more for my MA dissertation which I have a clear focus for now.

Working in this way encouraged Sarah to examine the relationship between the software and the difficulties she had experienced in achieving her learning objectives:

> I felt I was instructional and did not ask very many questions. Also I allowed the fun and gaming element of the lesson to become the main factor and lost the learning objectives. The science element became secondary. Part of this was due to not fully knowing the software, but also the way the software looked meant I took things at face value….

> Virtual fish has been used again in further lessons, this time with a year 3 class. I was able to give advice on how to frame the lesson and talk through some of the pitfalls of the software such as the fish lasting for 15 minutes.

Initially, Sarah's reading of her data had been very narrowly focused on what she perceived as the positive motivational aspect of the interactive whiteboard, as a useful piece of hardware that pupils enjoyed physically interacting with. However, by participating in this collaborative partnership with researchers and other teacher practitioners she was encouraged to not just reflect on her practice but interrogate and analyse her lessons in a more systematic and sustained way. Clearly, as Sarah's above comment demonstrates, this not only had important repercussions for her own classroom practice but enabled her to give helpful and informed advice to another teacher who was using the same software—understanding the 'gaming' element enabled Sarah and her colleague to continue using the software but with a greater awareness of the types of engagement that were possible thereby framing future learning activities within this context.

Case study 2: Simon Mills, Primary Maths, Year 6

Simon Mills was largely self-taught and, despite having received no formal training, had developed a high degree of confidence and expertise in using the technology enabling him to exploit its full range of potentials:

> Interviewer: And what type of training, if any, have you received?
> Simon Mills: Personally, I haven't received any at all. It's all been built around my own knowledge.
> Interviewer: Are you the only person who's got one in their room?
> Simon Mills: No. We've got five in classrooms and one in the ICT suite.
> Interviewer: And so has anyone had any training?
> Simon Mills: We're all in the same boat. The long-term aim is that I provide the training for those people who have boards now but I don't think there's any plan to have anyone come in and work from outside.

Simon had become particularly interested in understanding how teacher–pupil/pupil–pupil conversations developed in relation to IWB supported software to enable pupils to talk about mathematics, and how it developed their knowledge and ability to initiate and develop these conversations. During the project Simon became increasingly interested in the work of Mercer (1995; 2000), particularly the idea that classroom talk could be viewed as a 'social mode of thinking'. Within classroom numeracy hours he developed this as a basis for designing iterative mathematics lessons using spoken language and collaborative work as the basis for developing shared definitions of terms. Within this approach the IWB, and carefully selected software environments, had become a key tool in facilitating, scaffolding, supporting and recording the outcomes of class conversations. These learning conversations were structured to develop mathematical ideas within the objectives of the National Numeracy Strategy using the IWB as a shared communication space. This model of teaching and learning led Simon to form very specific ideas about what he thought was happening in the teaching and learning spaces created through the use of the

IWB within his classroom. However, the complexity of activity and interaction, which emerged during the shared data analysis process, revealed overlapping conversations between pupils, and pupils and teacher. Therefore, it proved difficult for Simon to clearly identify and study the development of individual conversations which he had hoped to focus on. In addition, when evaluating the place of the IWB in these conversations, talk was not generally focused around the board alone.

As he began to look at his lessons in more detail, Simon was able to observe that, although lessons and activities were initiated and scaffolded through use of the software environments, the choice of software to match learning objectives and outcomes enabled students and teacher to engage in multiple discourses around the subject matter. This occurred while Simon was using the IWB as a shared semiotic text, drawing on the dynamic elements of the software to consolidate and support the learning of the students in relation to the designed intentions of the session. Despite the apparent limited physical interaction with the IWB during these lessons by the teacher and students from the video observation it was possible to observe a whole range of other semiotic indicators (Figure 3). Simon was able to show that the IWB was far from peripheral to the progression of lessons, and the learning conversations which evolved.

This case study demonstrates the importance of teachers having long-term, sustained engagement with new technologies. Being an experienced IWB user—having had daily access to one for several years—Simon was able to fully integrate this technology into his classroom practices, using it to support and enhance students' learning conversations about mathematics.

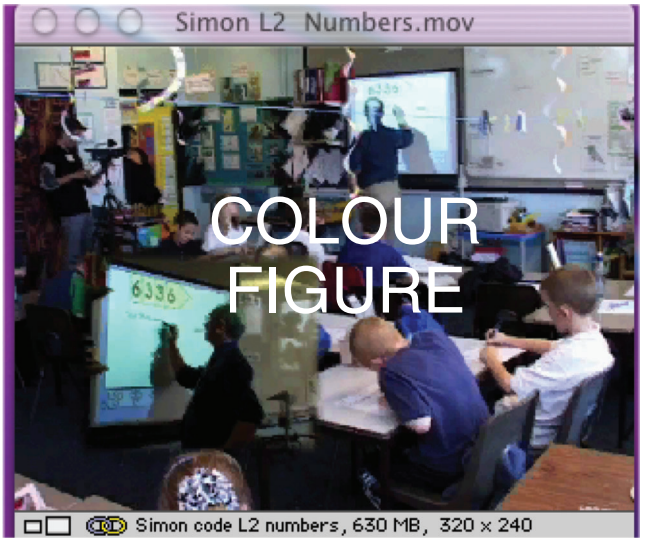

Figure 3. A video screen shot of the teacher physically engaged with the IWB and the children engaged with the shared space. This is evident within the video, through observation of gestural and whole or part body movement, pupils' verbal engagement with each other and the teacher, and their responses using other tools to the activities they observe around them.

Case study 3: Ian Thompson, Secondary English, Year 8

Only Sarah and Simon had daily access to IWBs in their classrooms which was an important factor in developing confidence and expertise in using the IWBs' full range of potentials. At the time the research was carried out, Ian Thompson was very much a 'novice' user and had found little opportunity to explore specific software packages for his subject English due to his restricted access to an IWB:

> I have limited access to IWBs because I don't have one in my teaching room … I happen to only teach this group once a week, somebody else teaches them the rest of the time so it hasn't been particularly difficult for me to get one lesson for quite long periods, but generally speaking that would be impossible and so ither I devise a series of stand-alone lessons which are useful for IWBs or if it's an introduction but to do any work that incorporated it in any way, you know, well I couldn't rely on it, put it that way. I would need to know that I can use my own classroom where I was teaching most of the time.

Although Ian, like the other teachers involved in the project, was a motivated ICT user, he had received no formal training and expressed a lack of confidence in using IWBs:

> Ian Thompson: I've been in that room before [where the IWB is located] but I've never used that board before.
> Interviewer: Why is that?
> Ian Thompson: Basically because of lack of confidence I suppose.

For his sequence of lessons, Ian chose to use Smart Notebook, a feature of SMART Boards that allows the text to be moved around using the drag and drop facility. He stated that he felt he had chosen a 'safe' piece of software because of his very limited previous use of IWBs but felt he was able to manipulate this software to fit his purpose. Although this process was successful in that the pupils were clearly engaged, his lack of experience of using other types of IWB supported software meant that he had no idea whether this was the most appropriate piece of software for the task, which related to the construction of 'dual narrative.'

From Ian's perspective, his participation in this project provided the impetus for using the IWB and enabled him to begin to see how IWBs could be useful in his lessons. Prior to this he had been very sceptical about how they could enhance teaching and learning stating that having a laptop and data projector were sufficient. However, having looked at his lesson videos and having become more familiar with IWBs, he recognised that the 'interactive' possibilities of the board enabled him to model textual editing and encouraged him to allow pupils to come up to the board and move text around, a way of working that had been quite alien to him before:

> I learned a lot about pupil involvement in lessons as well as my own use of space in the computer room. Certain pupils were more actively engaged in the learning process because they could make use of the IWB to manipulate text. This was particularly instructive for one pupil who not only produced a much longer and better-crafted piece of writing after using the IWB but was also able to articulate what he had learned and how this had happened. As a teacher I noticed that I was happier to move away from my traditional teacher position of centre stage and allow the pupils to occupy the focal point of the lesson. It was also useful for me to hear the thoughts of researchers who were

> watching a video of my lesson in a non-judgmental way. Most observations of lessons are done by observers in positions of authority (who are looking for affirmation of preconceived notions of what a 'good' lesson looks like. Watching the recorded lesson with the researchers who had also witnessed the lesson was a very different process that allowed me to question my own assumptions and to be receptive to the views of others.

Throughout Ian's sequence of lessons, the teacher's focus was on developing pupils' understanding of 'Dual Narrative'. Using a PowerPoint presentation that he had prepared he modelled a story that made use of this narrative device. Pupils, working in pairs, then began writing their own stories at the computer, each taking different voices which were then combined and edited on screen. During the latter part of the lesson sequence observed, Ian decided to make this a whole class activity by combining six of his own sentences with those of a pupil, using the SMART Notebook. Ian chose a student, who he described as quite a challenging male pupil, to come up and physically manipulate the text while Ian and the rest of the class, through joint discussion and questioning, edited the text to produce a coherent narrative. Ian stated that this was quite a departure from his normal mode of teaching. He reported being normally reluctant to let pupils come up to the board but he stated that with the IWB 'it seemed like the natural thing to do and that helped to break down those barriers between pupils and normal teacher space'. Ian thought this was particularly beneficial for the whole group and this particular boy:

> It helps them because they like the look of it [IWB]. Visually it's useful. It's useful for kids like that boy [the pupil who had manipulated the text] who did very well this morning, whose behaviour is much better today doing that … at least he's started to think about text and when he went back to doing his own editing he was using some of those techniques. He was doing cut and paste in a way that I was surprised to see.

Throughout this clip, the pupil responded to his classmates' editing decisions and he could be observed standing back and reading the text after he had moved sentences around. The ease with which text could be moved meant that there was fluidity about the text which pupils seemed particularly responsive to. Ian's analysis of the data led him to observe that the IWB was a useful tool for introducing complex text types, although lack of time had meant that only one pupil had the opportunity to manipulate text in the construction of a dual narrative. This led Ian to consider how pupils' use of the IWB could be developed further to enable pupils to explore textual editing both in whole class and small group scenarios. Ian's case study demonstrates that even with very simple software, by manipulating texts in this way, the IWB becomes an extremely effective teaching tool not only for whole class discussion. Furthermore, it suggests that the ability to physically interact with text and language in this way can also be very powerful for the learner.

Some concluding remarks

The experiences of these teachers echo the findings of other researchers (BECTA, 2004) who have also commented on the importance of in-service support and training. Without this, it is unlikely that teachers will either be aware of or are able to exploit the potential affordances of IWBs. It is significant that Simon and Sarah,

both of whom had regular access to an IWB, used an enormous range of subject specific software and multimedia resources such as Flash, DVDs, video-conferencing and the Internet compared to that used by Ian, for example, who mainly used PowerPoint and Smart Notebook (the latter allowing text to be manipulated on screen).

Furthermore, these case studies illustrate that the introduction of IWBs into the classroom involves much more than the installation of the board and software. Teachers are critical agents in mediating the software; the integration of the software into the subject aims of the lesson and the appropriate use of the IWB to promote quality interactions and interactivity. Training and ongoing support is required for teachers to appropriately use IWBs and to support their selection of appropriate software. The potential affordances of the IWB are often not realised for a wide range of reasons. In Sarah's case study the software potentially allowed for an exploration of the variables and invariants which are part of the ecological system of a fish tank; however, the teacher and pupils viewed the software as a game in which the aim was to win by designing a long-living fish. The focus on winning detracted from a possible scientific investigation.

Teachers bring a much-needed critical perspective to the research process. From a methodological perspective, we are aware that there are hurdles to overcome in this type of research collaboration. The time commitment required by researchers and teachers is indeed substantial and there are the logistical problems of getting all research partners together at the same time—a problem we have certainly encountered within this project. However, the benefits of involving teachers in these research partnerships provides one of the best ways of bridging the gap between academic research and classroom practice and digital video and associated analysis software have been powerful tools in facilitating this type of work. Through engaging in this research process, teachers have deepened and enhanced their own reflections on their changing pedagogic practices of working with interactive whiteboard technology, which brings a much needed real-life perspective to understanding and unpacking the complexities of the classroom.

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