Replacement or transformation?
Teacher research into learning processes associated with interactive whiteboard use in primary classrooms

Paper presented at BERA 2006 Annual Conference
Warwick University
6-9 September

Ruth Kershner & Paul Warwick
University of Cambridge Faculty of Education

Introduction

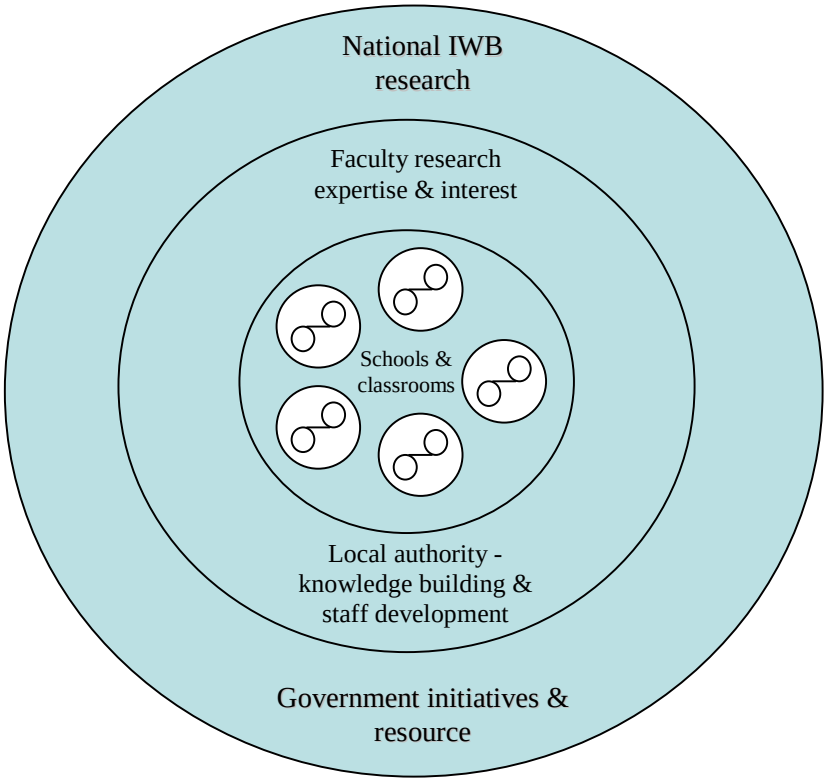
> '…teachers need extended opportunities to think through new ideas and to try out new practices, ideally in a context where they get feedback from a more expert practitioner and continue to refine their practice in collaboration with colleagues. Observation, coaching and talk-analysis feedback may be useful tools for professional development whereby sympathetic discussion by groups of teachers of data... derived from their own classrooms could be an effective starting point for critical reflection. Such an approach could provide supportive interactions with peers through modelling and feedback in order to change traditional patterns of whole class interaction necessary for responsive teaching'
>
> *Smith, Hardman and Higgins (2006)*

This paper relates to an ongoing project which is a joint initiative between the University of Cambridge Faculty of Education and Cambridgeshire Local Authority (LA) ICT Support and Advisory Service. The central aim of the project, consisting of a school-based teacher research group, is to develop primary teachers' understanding of the learning processes associated with interactive whiteboard (IWB) use.

The LA had already been involved in the national Schools Whiteboard Expansion Evaluation Project (SWEEP, http://www.ioe.mmu.ac.uk/sweep/) but they wished to go further in developing their teachers' understandings of pupils' learning during interactions at the IWB. A small-scale research project was set up in partnership with the Faculty of Education. We report here on Phase 1, in which eight (originally ten) teachers in five local primary schools investigated their use of IWBs during teacher-led lesson sections. The teachers' involvement in this school-based research project also gained them accreditation of further professional study at certificate level.

The relationship between different elements of this collaboration might be conceptualised in the following way (after Bronfenbrenner, 1992):

Figure 1: A representation of our research in the context of current local and national initiatives for IWB use in education.



The research questions developed from an initial exploratory interest in the following question: What is happening with the use of IWBs in our classrooms and in what ways is this linked to learning? For the teachers' own classroom-based research, more precise research questions were devised in consultation with the research group. These were:

- What patterns of interaction (cf. Mortimer and Scott 2003) occur in teacher-led sessions when the IWB is being used for... (each teacher's own selected project)?
- In these lesson sections, when does the use of the IWB support interactions known to be associated with learning?

During the course of the project our own research perspective shifted towards the teachers' developing knowledge about children's learning and IWB use. In particular, our interests became focused on the ways in which teachers discussed, and wrote about, their understanding of learning associated with specific uses of the IWB in the classroom. This led to the following research questions, which are the focus of analysis and discussion in this paper:

- Through their analysis of the IWB-related interactions, what do the teachers seem to be saying that they understand and value about pupils' learning?
- How does this connect with their knowledge about the distinctive uses of IWB for learning, in combination with other classroom tools?

IWBs, teaching and learning

The extensive introduction of IWBs in both primary and secondary classrooms in the UK has been encouraged by policy initiatives aimed at embedding ICT use in teaching and learning, part of the continuing 'roll out' of national strategy curriculum initiatives (Primary Schools Whiteboard Expansion, administered by the DfES; National Whiteboard Network @ http://www.nwnet.org.uk/; Higgins, Falzon, Hall, Moseley, Smith, Smith & Wall 2005). Study into the use of IWBs in classrooms has demonstrated how their 'interesting affordances' (Gillen, Kleine Staarman, Littleton, Mercer, Twiner 2006) can be - and have been - harnessed by teachers who have found them to be a substantive teaching resource (Smith 2000; Smith 2001; Becta 2004).

Yet the history of technology-led initiatives in education has demonstrated that such initiatives have often not been accompanied by an understanding of what their take-up might imply for pedagogy (Dawes 2000; Granger & Morbey 2002). A growing research theme in the study of the classroom use of IWBs has thus been the connection of IWB use in the classroom with changes to teaching practices and to pupil learning. The work of the Newcastle team, for example, has focused on impact factors with respect to pupil learning (Higgins et al. 2005; Smith, Hardman and Higgins 2006) and they draw several important conclusions that relate to the focus of this paper. Smith et al. (2006) conclude that the introduction of IWBs has had some impact on 'the discourse moves' used in whole class teaching, but that this is 'not as extensive as that claimed by advocates of IWBs' (p443). They note that there is more switching between whole class and individual work in lessons where the IWB is in use, and that in these lessons 'there were significantly more open questions, repeat questions, probes, evaluation, answers from pupils, and general talk' (p450). Pupil answers were frequent, but briefer than answers given in non-IWB lessons - 'uptake questioning and presentations from pupils had a lower percentage contribution in IWB lessons' (p454). Teacher initiation was more likely to be in the form of an open question within IWB lessons. However apparent indicators of engagement seemed to be at the expense of more protracted pupil answers.

Since IWBs were introduced into schools, concern with the pedagogical implications of their introduction has been an evident strand in the work of some researchers (Glover and Miller 2001, Miller and Glover 2002) and this is a continuing concern for many researchers and teachers. Much of this work examines practice in secondary schools (Hennessy, Deaney & Ruthven 2005; Ruthven, Hennessy and Deaney, SET-IT and T-MEDIA projects), though there is a continuing and increasing concern with the pedagogical impact of the use of IWBs in the primary school (Cogill 2003; Gillen et al. 2006; Lee & Boyle 2003; Smith, Hardman, Mroz & Wall 2004; Smith et al. 2006). Whilst some focus, at least partly, on the teacher's role in mediating the pupils' use of the IWB (Cogill 2003), the notion of the IWB itself as a 'mediating artefact' (Wertch, Tulviste, & Hagstrom 1993) is common to those that take a broadly sociocultural perspective (Gillen et al. 2006). Both of these foci are important in our research.

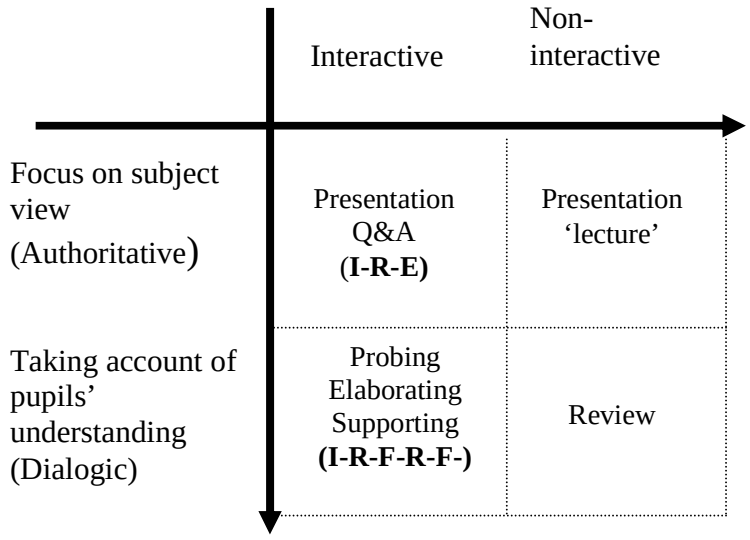
The notion of interpretations of interactivity - particularly by teachers – seems crucial to whether the potential of the IWB affordances really has an influence on pedagogy. In their 'typology of features of interactive teaching', Esarte-Sarries and Paterson (2003:65) indicate 'surface' and 'deep' features of an interactive pedagogy. Though our research does not examine the relationship with this typology systematically, we are certainly concerned with the extent to which the teachers' beliefs and values about learning influence their interpretations of the value of the IWB as a pedagogic tool. In order to research these understandings, an approach that encourages teachers to examine their own dialogue and interactions in the classroom is helpful.

Dialogue, interaction and multimodality

The importance and characteristics of the 'dialogic classroom' have been the focus of much recent international research and study, and of several policy initiatives in the UK (Alexander 2000; DfES 2002; QCA 2003; Rojas-Drummond & Mercer 2004; Scott 1998). The interpretation of the term 'dialogic' is clearly a disputed area (Alexander 2006; Wegerif 2005; Wertsch 1991); yet what seems to be largely undisputed, at least from a sociocultural perspective on the nature of learning in classrooms, is a broad acknowledgement of the centrality of purposeful discourse between pupils and teachers. A central focus on dialogue in this research, therefore, is based on evidence that suggests interactive whole class teaching can promote high-quality dialogue and discussion and that this is seen as the kind of active teaching that is likely to enhance learning (Alexander 2003a & 2003b; Mercer 2003). So in our view, classroom talk is 'central to the meaning making process and thus central to learning' (Mortimer and Scott 2003:3), whilst the teacher's role is to 'engage students in the patterns of talk, almost of argumentation…' (p5) that are associated with engagement in subject and topic learning in the classroom. Thus, we encouraged the teacher-researchers to code and evaluate teacher-pupil talk as one way of focusing the analysis of classroom interactions, using a framework devised by Mortimer and Scott (2003).

Mortimer and Scott argue that, during a lesson, 'as the teacher is engaging ..(in).. linked processes of monitoring and responding, he or she is probing and working on the 'gap' between an individual students' existing understandings and their potential level of unassisted performance' (p21). They make clear, however, that the talk that constitutes this probing may vary according to the teaching intentions for, and learning demand within, various parts of a lesson. Their work uses established methods of coding spoken interactions (I-R-E; Mehan 1979) and developed ones that focus on feedback / elaboration (I-R-F-R-F). Importantly, however, they suggest that such patterns of discourse are linked to broad communicative approaches in the classroom, that are in turn allied to different teaching purposes (Figure 2).

Figure 2: Linking patterns of discourse and communicative approaches in pupil-teacher dialogue (adapted from Mortimer and Scott 2003)



In the model presented in Figure 2 four broad categorizations of communicative approach are presented, which may be summarised as follows (see Mortimer and Scott 2003:39):

- Interactive/dialogic:

the teacher and students explore ideas, generating new meanings, posing genuine questions and offering, listening to and working on different points of view.

- Non-interactive/dialogic:

the teacher considers various points of view, setting out, exploring and working on the different perspectives.

- Interactive/authoritative:

the teacher leads students through a sequence of questions and answers with the aim of reaching one specific point of view.

- Non-interactive/authoritative:

the teacher presents one specific point of view.

The interactive dimension of this categorization is linked to particular patterns of discourse. So, '... there is a clear link between the I-R-E pattern of interaction and the interactive/authoritative communicative approach' and '… there is a link between the I-R-F-R-F- chains of interaction and an interactive/dialogic communicative approach' (Mortimer and Scott 2003:104).

Within the context of our research - in which, amongst other things, teachers were being encouraged to develop common ways of talking about the learning evident in pupil-teacher interactions using the IWB – this framework for analysing discourse presents several useful features. In particular, it indicates clearly that teacher-pupil discourse links to teaching intentions and that therefore there isn't a 'good dialogic' and 'bad authoritative' classroom discourse – rather, talk should be carefully tailored to purpose. Crucially, it intimates the direct connection between such discourse and pupil learning.

However important dialogue is, however, this review has already made clear that other types of interaction and behaviour (Crook 1994) hold an insight into the development of learning processes (Watkins, Carnell, Lodge, Wagner & Whalley 2002). These interactions and behaviours focus both on the various multimodal affordances of the IWB and of other classroom resources. Theories suggesting the ways in which multiple modes depend on one another to create meanings (Kress, Jewitt, Ogborn and Tsatsarelis 2001) are particularly pertinent here, as the 'multiple modalities of representation that new technology increasingly offers' (Williamson 2006:82), combined with the affordances of other classroom tools, seem particularly evident in the use of IWBs in the context of teacher-led lesson sections. Viewed in this way, a focus of this study was therefore on the 'multimodal orchestration of …whole class debate' (Bourne and Jewitt 2003:65) and what this means for pupil learning. It is not the purpose of this paper to tease out in detail the connections between the affordances of the IWB and pupil learning, but we do note that the teachers incorporate their analysis of movement and gesture (Franks and Jewitt 2001) into their coded analyses of classroom data. Further, they specifically look to the visual affordances (Levy, 2002) of the IWB in drawing conclusions about its specific contribution to learning – or lack of it – in their overviews of their classroom research. Again, we make reference to these conclusions in examining what teachers seem to be saying about the connections between learning and the use of the IWB.

It will be clear, we hope, from the above that in we adopt a broadly sociocultural perspective on the nature of classroom learning. The sweep of sociocultural theory is too broad to encompass here, but it is important to note the related theoretical perspectives that inform our work and analysis, and that were introduced to the teacher research group (see below). Central to the research are the multiple understandings associated with the nature of classroom dialogue, multimodality and the mediation of learning. It is also worth noting that this research focuses on

the IWB in the context of the evolving tool systems evident in classroom activity and the associated notions of agency and collaboration.

The research process: conceptualisation and methodology

A guided research group

The research project was initially conceptualised and presented to the teachers as 'collaborative action research', with reference to the following view from Robson (2002:215):

> Action research is primarily distinguishable in terms of its purpose, which is to influence or change some aspect of whatever is the focus of the research.
>
> *Improvement* and *involvement* are central to action research. There is, first, the improvement of a *practice* of some kind; second, the improvement of the *understanding* of a practice by its practitioners; and third, the improvement of the *situation* in which the practice takes place.

From the teachers' perspective, their involvement in action research as it is usually understood focused on the initial reconnaissance and reflection stages of the cycle, and on the relationship of this activity to knowledge-building within the group and more widely. This approach was informed by discussion with the teachers of the implications for building knowledge at different levels of the educational system - pupils (individuals and groups), staff, school, local community, wider educational community - together with the implications for educational change as expressed by Selwood and Twining (2005:2):

> Action research should be informed by the wider body of knowledge, for example within the literature…Action research should also add to the wider body of knowledge, as well as enhancing practice within the action researcher's setting. This distinguishes it from reflective practice, which is primarily concerned with developing personal understandings and practice….
>
> …One piece of action research may only change the situation where the research took place, but if a great deal of action research is undertaken (and shared) education can be transformed.

This understanding of the multi-level connections between research, knowledge-building and educational change matched the development of the overall project and reflected the particular, interwoven, aims of the main constituent groups. The LA wished to develop teachers' deeper understanding of effective IWB-related pedagogy within the County, partly via future dissemination of the work of this teacher group. The Faculty staff were not only concerned with the developing understanding of the teacher group, deriving from a responsibility for the teachers' professional development in the Faculty certificated course, but they were also prompted by a research interest in gathering evidence about IWB-related pedagogy for dissemination to the wider academic community. The teachers as a group were centrally concerned with developing children's learning in their classrooms and schools, and for some the research and accreditation process was a particular attraction for their own further professional development.

This type of research partnership for knowledge-building is common in educational action research, described by Noffke and Somekh (2005:89) as a process which

> …integrates the development of practice with the construction of research knowledge in a cyclical process. Instead of being research *on* a social setting and the people within it, it is research *from inside* that setting carried out either by the participants themselves or researchers working in collaboration with them.

This approach presents a powerful model for educational change that acknowledges the central importance of teachers' individual and collective knowledge about learning and teaching which is developed through involvement in school-based research. However, as Noffke and Somekh point out, the formation of research partnerships requires careful consideration of the balance of power and the working relationships between the practitioner 'insiders' and the 'outsider' facilitators, who may in turn have their own 'second order' research focus (e.g. improving the practice of facilitating teacher researchers) which is not directly connected to 'first order' practice in the school setting.

In our case, the overall research design is not easily classified solely as action research, although this was clearly part of the process. It seems most appropriate to use Robson's (2002) terms for discussing 'real world research' and describe it broadly as a 'flexible' rather than a 'fixed' design. Robson (pp 166-7, citing Cresswell, 1998) describes some of the fundamental characteristics of this approach as: 'an evolving design, the presentation of multiple realities, the researcher as an instrument of data collection (ie. rather than relying on specialist tools and instruments) and a focus on participants' views'. He suggests that whilst a flexible design study is informed by existing traditions of enquiry, features and procedures from different traditions may be employed. Data collection procedures are rigorous, and usually multiple, and data may be analysed in layers from the particular to the general. Regarding aims and purpose, he remarks that:

> The project starts with a single idea or problem that the researcher seeks to understand, not a causal relationship of variables or a comparison of groups (for which a fixed design might be indicated). Relationships might evolve or comparisons might be made, but these emerge later in the study. (p.166).

Robson (p. 167) points out that this approach is only 'soft' (a common criticism) in the sense that 'hard and fast' routines and procedures are not established in advance and followed without adaptation. The process of research involves a great deal of thinking, collaborative effort and willingness to change direction where appropriate. One of the main problems lies in the interpretation of data and the assumed validity of the findings. In traditional, positivist 'fixed design' research, threats to validity are dealt with as far as possible in the initial design process. In flexible designs, validity continues to be an issue as the research proceeds, but it is often understood in terms of credibility, trustworthiness and transferability which are not tied to positivitist assumptions about observable reality and truth. However equally rigorous operationalisation is required by, for example, devoting sufficient time to the study, tackling researcher bias, using triangulation, systematically keeping an 'audit trail' of activities and data, debriefing and checking findings with peers and participants, and seeking 'negative' cases as instances which may disconfirm emerging theories (Robson p.174, citing Padgett, 1998).

Within this 'flexible design' framework, it seems sufficient to describe the teachers in our study as participants in a 'guided research group', engaging in systematic inquiry about their practice and prepared to make their findings public (cf. Stenhouse, 1983). The notion of a guided research group is inclusive enough to incorporate other types of teacher-researcher projects as well as our own approach which combined taught Faculty-based sessions for the whole group with individualised classroom research based on agreed research questions. From our own perspective

the research group itself may be seen as a case study of primary teachers' knowledge and understanding of pupils' learning associated with specific uses of the IWB in the classroom.

Finding out about learning with IWBs

The teacher research group met formally on six occasions during Phase 1 of the overall four-term project, supplemented by tutor visits to each teacher in school. Four Faculty-based sessions took place in the first term, and two at the beginning and end of the second term. In the first term the sessions focused mainly on the topics of learning, classroom dialogue and approaches to classroom observation and school-based research, using a mix of tutor input and relevant reading, group discussion and reflection on classroom activities with the IWB. In the second term the first preparatory session was followed by a period of time in which the teachers gathered data in their own schools, focusing on a curriculum subject or learning process of their choosing (see Figure 3 for the details of their chosen subjects and pupil age groups). In the final session the teachers each made a short presentation to the group about their observations and initial findings, after which they wrote up a folder of their observational evidence and a reflective overview to hand in for the certificate of further professional study accreditation.

Figure 3: The teachers' chosen areas for lesson observation and analysis

Teacher	**Year / subject**	**Lessons videoed**
Dawn	Y5/6 problem solving in maths: mathematical grids	3 lessons: prime squares/multiples; factors and multiples; patterns and relationships
Anne	Y 3 ('lower ability' group) - literacy	3 lessons on plurals; is/are agreement, adjectives
	Y3/4 - literacy	1 lesson on recount texts (science)
Carla	Y 5 – history	3 lessons: understanding and interpreting representations of historical figures
Ingrid	Y 6 – literacy	One lesson: Their/there/they're
	maths	3 lessons: numeracy starters (2 on ratio/proportion; 1 on capacity scales)
Kim	Y4 – literacy	2 lessons: apostrophes; similes in poetry
Meg	Y3/4 – literacy	4 lessons – information writing about the Romans (2 on grammar; 1 on contents page; and editing)
Alex	Y5 ('lower ability' literacy group) - history	2 lessons on non-chronological reports on the Greeks
Rebecca	Y2 maths	4 lessons – numeracy starters: all on ordering numbers

Our research questions about teachers' developing knowledge were prompted in part by the obvious differences emerging in the group in the teachers' thinking about teaching and learning with IWBs and how this connected with their broader pedagogical interests, decisions and contextual constraints. This experience of the research group, together with a theoretical understanding of how teachers mediate classroom learning and the use of tools (both material tools like computers and symbolic tools like language), led us to ask:

Through their analysis of the IWB-related interactions, what do the teachers seem to be

saying that they understand and value about pupils' learning?

How does this connect with their knowledge about the distinctive uses of IWB for learning, in combination with other classroom tools?

To answer these questions we drew on the following sources of data:

- Teacher-researcher group discussions *(informal records of what was said in Faculty-based sessions)*
- Teacher presentations *(informal records of what was said when teachers presented their findings to each other, together with the teachers' various notes, powerpoint slides, etc)*
- Lesson materials *(including written lesson plans, IWB screenshots and children's work)*
- Lesson evaluations *(written voluntarily by some teachers)*
- Coded and analysed lesson section observations *(produced by all teachers – see below)*
- Reflective overviews *(produced by all teachers)*

The most substantial sources of written data about the teachers' understanding of IWB use and learning were the teachers' lesson observation analyses and their final reflective overviews (the latter limited to two sides of A4). The observational analyses were structured in advance (see Figure 4 for an outline record sheet). The teachers were asked to video sections of lessons where the focus of the lesson section was class/group-teacher interaction at the IWB, adding up to a total of not more than 40 minutes.

The dialogue and non-verbal interactions were coded using a system agreed within the group, based initially on Mortimer and Scott (2003) and adjusted to include codes for child-child interactions and for non-verbal interactions. Further analysis focused on the strings of dialogue that could be construed as comprising 'learning episodes', based on the group's previous discussion about the observable behaviours (including dialogue) that are likely to be associated with these learning processes:

- Constructing new knowledge and understanding (CON)
- Collaborating with others to develop understanding (COL)
- Using tools to support the development of understanding (TOOL)
- Demonstrating autonomy and purpose. (AUT)

Adapted from Watkins et al, 2002 Effective Learning

Figure 4: The original format for the teachers' lesson observations and analysis

School: **Class:**	**Teacher:**	
Context and learning intentions: Subject/topic of the lesson. Central learning intentions of the lesson. Purpose of the analysed section of the lesson.		
Dialogue and 'staging'	**Coding**	**Evidence of learning?**
A transcript of the interactions (spoken and non-verbal) and any other relevant 'staging' information (e.g. TA encourages child to provide answer).	For <u>pupil/teacher interaction</u> use the following: **I** – teacher initiates **I(c)** – child initiates **R** – child responds **F** – teacher feeds back **E** – teacher evaluates (i.e. moving the child towards better subject understanding *Remember, there are likely to be two basic patterns of discourse:* *I-R-E (authoritative)* *I-R-F-R-F-R-F- (dialogic)* For <u>pupil/pupil interaction</u> *(likely to be rare but possible during teacher-led episode; patterns of such discourse probably same as above)*: **i** **r** **e** (may use home or school knowledge) **f** **NV1** – non-verbal interaction that indicates use of knowledge using the IWB**NV2** - non-verbal interaction that indicates involvement or use of knowledge away from the IWB	Can any parts of the recorded lesson section be said to be a 'learning episode', providing evidence of learning? This is the place for personal reflection on your evidence, but you should look particularly for interactions that provide evidence of any of the following learning processes: - Constructing new knowledge and understanding (con) - Collaborating with others to develop understanding (col) - Using tools to support the development of understanding (tool) - Demonstrating autonomy and purpose (aut)

Research and knowledge-building – developing the discourse

The teachers involved in this project were all experienced and had extensive practical understanding of 'what works' in the classroom and why, including the use of IWBs to support teaching and learning. At an early stage the teachers listed potential advantages of IWB use. When their ideas were later grouped into five headings (see Figure 5) it was clear that much was being said about learning processes as well as the more familiar motivational aspects. The teachers' knowledge of learning, evident in this and other early activities, provided the foundation for the more systematic lesson analyses carried out later.

Figure 5: An initial list of IWB advantages produced collectively by the teacher group, later grouped by Faculty researchers under five headings

Attention and motivation

- 'makes it fresh'
- immediacy
- gets attention…then everything follows…no fidgeting
- focus – screen covered (with media pictures, video…) …more likely they'll engage
- pupil interest in quality of presentation
- whole class activity and involvement
- problems of entertainment…is this related to learning?

Access to information in multimodal forms

- use of media on smart notebooks – videos, films
- adaptability of IWB to access media in various guises
- 'going back in time' – easy accessibility to previous screens

Personalising learning

- good for visual learners, those poor at writing
- good as self-assessment tool - AfL
- special needs – enhancement of understanding

Task structure and completion

- break down into small tasks
- couldn't have done the task without the IWB

Learning processes and outcomes

- editing as part of process
- making connections with previous learning – can 'literally go back in time'
- making connections between lessons and ideas
- provision of real contexts for learning
- access to different ways of representing what you know
- improving and developing pupil collaboration
- ownership of the work – collaborative nature of learning with the teacher
- novel outcomes
- language development and use in relation to personal media
- personal development of media presentation
- physical interaction still important

The opportunity to work with the teacher group in the four Faculty-based sessions before they embarked on data collection in their own classrooms allowed us to consider certain concepts

together, in the light of each person's experience, and gain a common vocabulary for talking about learning and teaching. Specific ideas and examples could therefore be linked to each other and possibly extended by reference to the accounts of pedagogical principles and approaches commonly found in the academic literature.

The key conceptual frameworks and associated readings introduced to the teachers were:

- Classroom activity and interactions 'with', 'around', 'through' and 'in relation to' computers (cf. Crook, 1994)
- Social constructivist learning theories and processes (cf. Watkins et al. 2002)
- Communicative approaches and patterns of discourse (cf. Mortimer and Scott 2003)
- Research principles, processes and techniques (Robson, 2002; Selwood and Twining 2005)

This provided the group with a common vocabulary which included the following **key terms and phrases**:

About learning as a **social** process and a **metacognitive** process:

- **constructing** new knowledge and understanding
- **collaborating** with others to develop understanding
- using **tools** to support the development of understanding
- demonstrating **autonomy** and purpose
- **reflecting** on learning

About teacher-pupil interaction, learning and teaching:

- **communicative approach**
- **patterns of discourse** (including **I-R-F-etc…..coding**)
- **interactive/authoritative/dialogic** teaching

About research processes:

- research questions **– exploratory, descriptive, explanatory, emancipatory**
- **ethical issues** (BERA 2004)

Examples from the discourse: meaning what you say and saying what you mean?

Most of the above 'key terms' appeared quite quickly in the teachers' conversation and writing. For instance, in the first of Alex's lesson analyses, he writes about 'evidence of learning' as follows:

> The evidence collected has demonstrated that the children have used **collaborating** with others to help develop their understanding (mostly collaborating with the teacher and the TAs).
>
> The **discourse** had a tendency to the **I-R-F pattern** with some moving to **I-R-F-R-F** for short periods of time. This is most likely due to the task (children sharing their ideas with each other and the teacher and TAs to create one piece of work). The children's ideas were discussed and used to create the final page of work.
>
> The IWB was used to work through the teaching activity and the children had the opportunity to decide the size and position of the text on the final page. This was done both orally and physically by the children so it could also be said that the children were using **tools** to support the development of understanding of how a non-chronological report can be set out.

Meg writes similarly in the first of her lesson analyses:

> …Others agree that it doesn't make sense. Children **constructing** new knowledge that sentences can be restructured…
>
> ….Unplanned **collaboration** between Tom and Bryony in order to clarify their own thinking….
>
> ….Peter demonstrating **autonomy** here – moving the focus away from ordering the sentence to punctuating it….

Anne also makes extensive use of some 'key terms':

> Goes into a **'dialogic / non-interactive'** stage, where teacher is continuing to consolidate children's ideas...
>
> …The session takes form of **interactive dialogue**, with children having chance to decide for themselves.
>
> …The teacher has been able to share and mark their (the pupils') key ideas during **dialogue**. Therefore this has been a phase of **constructing** new ideas….

The appearance of these words in writing and conversation provides some evidence about the routes of knowledge-building for certain teachers in the group. However, this cannot be assumed to be the only or even the main sign of their understanding. Neither can it be assumed that when the teachers used the key terms they meant the same things. For example, not all the teachers used the exact terms yet it was clear from what they wrote and said about their lessons that they were reflecting in similarly analytical ways. As Carla writes:

> …children do not simply take the information they receive, they subject it to their own cognitive processes; they don't simply look at it passively or repeat it but actively add to it or change it.

Carla wrote eloquently about learning in several ways – sometimes with the 'key terms' (or their abbreviations) and sometimes not. The lesson observation sheet acts as a mediating tool for knowledge-building by the group but the teachers' written notes on 'evidence of learning' are unlike ordinary writing or conversation, and at this stage they are only really meaningful to the group involved. The development comes when this structured thinking and the associated vocabulary is incorporated into the personal and professional discourse used outside this research group – thereby serving the two purposes of anchoring the new theoretical concepts in the teachers' own wider knowledge base and practice, and bringing the knowledge gained from participating in the research group to further discussion and planning with colleagues. One example of this potential development comes from Alex:

> The IWB was used to work through the teaching activity and the children's notes were copied on to one page at the end of the flip chart. This process helped to demonstrate to the children how they could take and collect notes all together so it could also be said that the children were using tools to support the development of their understanding.

Here we see Alex bringing social constructivist terminology into his writing about learning. His final comments on tool-use appear to stretch the concept from his teaching to the children's learning. This seems like speculation on Alex's part, but it prepares the ground for his reflecting on future lessons in which the children take more control of the IWB facilities. It may also be possible to connect Alex's thinking about tool-use with the developing knowledge of the whole group. In the teachers' lesson observations and analyses the varied conceptions of 'tool use' (for learning and teaching) ranged from the teacher's use of the IWB functions such as note-taking and shape-moving to provide the children with models and demonstrations, to the children's involvement in general 'interaction' with IWB (ie. taking their turn at the board) or in their learning to use the IWB 'tools' like the highlighter pen and using these tools to demonstrate their understanding. Given these different interpretations, tools may be understood best as a distributed classroom resource, bridging teaching and learning rather than serving one or the other.

Understanding teachers' use of the IWB to support teaching and learning

Two case examples

Below we present two illustrative case studies from the group. These examples have been chosen because both focus on aspects of literacy with Year 3/4 children – one with the whole class and one with a pupil group identified with distinctive learning needs. In both cases the lessons are linked, providing the opportunity to place the teachers' observational 'snapshots' in a wider context. After the brief case examples we will discuss them in the light of evidence from the whole teacher group, with reference to our two central research questions about what the teachers understand and value about learning and how this connects with distinctive uses of the IWB.

Case Example 1: Meg

Meg selected extracts from four linked lessons with her Year 3/4 class, all part of a unit of work about 'information writing' which involved the children in writing booklets about the Roman army. In Lesson 1 she wanted the the children to focus on how sentences can be reordered to keep the meaning the same or to change the meaning. In Lesson 2, the children were identifying verbs in sentences and recognising that some sentences contain more than one verb. In Lesson 3 the

focus was on how to write a contents page. Lesson 4 was a review and consolidation lesson, designed to focus on aspects the children had found difficult so far, and then moving on to model the writing of full sentences and examine how these can be combined into a paragraph.

Some distinctive uses of the IWB are seen in each lesson and, unsurprisingly perhaps, these relate strongly to the written lesson objectives. In all four lessons the big screen visibility of the IWB is signficant in focusing the joint attention of the teacher and the pupils, including those not directly involved in working at the board, and providing a reference point for whole class conversation. This includes, for instance, allowing children to see an emerging pattern for verb endings in lesson 2. In Lessons 1 and 2, the IWB is used for moving words around and highlighting verbs on the screen, with most of the dialogue focused on grammar. In Lessons 3 and 4 this type of specific IWB function appears to be less central to the lessons as a whole and parts of the conversation range more widely about the Romans in general. However, some distinctive uses of IWB affordances are also evident in these last two lessons. These uses include the presentation of scanned text in large screen format, the reordering of whole sentences on screen, the typing of children's suggestions onto the IWB and, importantly, the facilitating of access to previous activities and learning (cf. a piece of scanned work available for editing in accordance with lesson success criteria).

Interestingly, the last two lessons also show more explicit connections between the IWB focused talk and other classroom activities and resources. In Lesson 3 this involves the use of a book to make a point that cannot be evident from its scanned contents page on the IWB screen. In Lesson 4 the teacher explicitly refers to her reading of the children's booklets as the basis for planning the lesson, and the IWB screen is used to remind the children of the written success criteria and of a paragraph they had written on the previous day.

Case Example 2: Anne

Anne selected extracts from four literacy lessons. Three lessons involved a Year 3 group described by Anne as having ‘poor literacy skills’ and the fourth involved her full Year 3/4 class. Three of these lessons related to the science topic of seeds and plants, and the fourth to the use of adjectives in a variety of factual writing. For the purposes of this case example, we will concentrate on the first two group lessons on literacy and science writing. In lesson one she wanted the children to examine the use of plurals and ‘is/are’ verb agreement in writing, set in the context of the seed planting that they had carried out on the previous day. In lesson two this work was extended to develop a science writing frame (cf. Warwick et al 2003) using plurals and ‘is/are’ agreement**.**

As with Meg, distinctive uses of the IWB can be seen in each lesson, relating strongly to the written lesson objectives. In both lessons Anne notes that for this ‘poor literacy skills’ group, the ability to read aloud from the big screen is significant for them in focusing attention and allowing them ‘process at their own pace’. A teacher can adapt the size, nature and orientation of the text and other on-screen components to suit the audience and for this group of children Anne chose to insert deliberate mistakes which could be identified easily using the highlighter tool. The public nature of the IWB screen enables the whole group to examine and discuss the text, making changes as appropriate. The drag facility allows the pupils to experiment with alternatives without the commitment (and associated anxiety?) of similar activities carried out on paper or a conventional whiteboard/blackboard.

It is important to note that the activity of seed planting and the associated writing is the broader context for the grammatical work described above. Both Meg and Anne used the IWB in different ways to embed contextualised 'images of writing' (e.g. scanned pupil text, teacher-prepared writing frames) to be worked on directly by the children – either in response to previous work or as a precursor to later classroom activity. The use of these 'objects' on the IWB screen may be subtly different from the ways in which writing is often used on conventional whiteboards/blackboards. On the IWB there is the opportunity to work directly and easily with ideas fundamental to the lesson objectives, through manipulating and playing with the text and images in a way that seems to give pupils time and space to develop their thinking (although, as will be clear from the discussion below, this depends on the management of time and resources in the classroom and, crucially, on what teachers understand and value about pupil learning).

So, how do children learn? The teachers' perspectives

It was clear from the start of the research group meetings that the teachers had a broad consensus about what is important for pupils' learning. As shown in Figure 5 above, they collectively saw the advantages of the IWB as lying in several areas: enhancing pupils' attention and motivation, providing access to information in multimodal forms, personalising learning to individuals, facilitating the task structure and completion, and supporting the processes and outcomes of learning. The comments on learning processes are interesting in the way that the teachers' views match certain principles that are commonly found in the psychological literature (e.g. Whitebread 2000) – including the need to make connections with previous learning and the associated relevance of 'real contexts' for learning, the benefits of representing knowledge in different ways, the value of collaborating, gaining some 'ownership' of classroom learning and reflecting on work through the process of editing, and the importance for learning of language development and physical activity. When this list is compared to the social constructivist framework introduced to the research group, which identifies key elements of learning in terms of construction, collaboration, tool-use and autonomy (cf. Watkins et al. 2002), all the elements are present in some form in the teachers' first list, and some continue to appear as important in the teachers' thinking as the project goes on – especially the importance of pupils' active involvement in constructing knowledge and their collaboration in the classroom. Pupil autonomy and purpose are less evident in the teachers' data, and there is a hint throughout that 'tool-use' tends to be presented as a process which is at least as much to do with teaching as it is to do with pupils' learning. This is likely to reflect the nature of lessons observed, all of which were focused on teacher-pupil dialogue with groups or the whole class, with the teacher directing activity at the IWB. It may also reflect the group's different perceptions and understandings of 'tool use', as described above.

For some teachers the attention to learning processes is constantly intervowen with reflection on what their observations of classroom interaction also show them about learning outcomes (ie what the pupils know and understand), and the essential connections between them. For instance, a series of comments about 'evidence of learning' from Dawn's first lesson analysis goes as follows:

Figure 6: An extract from Dawn's transcript of Lesson 1

Dialogue and 'staging'	**Coding**	**Evidence of learning?**
T: …..What would you multiply by itself to make 6?	I	
Jenna: 3	R	
T: 3 by 3 is….	F	
Jenna: Oh, 9 (child puts hand to mouth)	R	Child realises her mistake
T: 3 + 3 is 6. Have a think	F	
(other children put hands up)	NV2	Evidence of other children concentrating
Jenna: 9	R	
T: 9, what number can multiply by itself to make 9?	F	
Jenna: 3	R	Child understands 3 x 3 = 9
T: 3, Good girl well done, so actually for this one we could have 9 in there as well couldn't we…..	E	

In lesson two another string of Dawn's comments goes:

Figure 7: An extract from Dawn's transcript of Lesson 2

Dialogue and 'staging'	**Coding**	**Evidence of learning?**
….		
T : Ok so 1 8 is 8, 4 8's are?	F	
Child off camera: 34		Evidence of the child thinking through the question although the response is incorrect
(all children looking at board as Sam speaks)		
Sam: 32	R	
T: So 1 8 is 8, 4 8's would be 32. So is she right?	F	
(hands shoot up to disagree)	NV2	Evidence of others listening and reasoning
Bryony?		
Bryony: No because the triangles got to be 6 and you can only do it that way.	R	

T: So you want to put the 6 in here? (some children disagree. Hands go up) Bryony: Oh …..	F I(c)	Response shows child listening and able to spot the error of another child

In both cases we have a narrative account of what learning looks like to Dawn in these lesson sections when she analyses her transcript of the dialogue and interaction. It is interesting to see that her beliefs about what the children know feed into her interpretations of what they think and do next and her own subsequent engagement with individual children or the class as a whole – a process which may represent her 'in-flight' thinking when she leads the teacher-pupil dialogue during the lesson. This is a perspective on learning outcomes which is not just to do with summative assessment of learning at the end of a programme of study, but an incorporation of what the children appear to know into decision-making about how to move the classroom dialogue forward.

What do teachers value about pupil learning?

The above examples demonstrate that the research group focus on teacher-led episodes provides a particular type of lesson context for the teachers to express what they understand and value about pupils' learning. A further illustration of this contextual effect is seen when we look at what the teachers seem to value about learning. This is linked to the specific goals for the pupils involved, as becomes clear in the different emphases seen in Anne's analysis of her whole-class and group lessons. In the whole-class lesson she focuses mainly on dialogic strategies for bringing the children to a shared understanding of what a 'recount' text is. In contrast, for her group lessons with children with 'poor literacy skills', at several points of her lesson analyses Anne remarks on the value of the pupils' seeing themselves as 'experts' and helping each other. For example, she makes notes at one point on a section in which Dean is at the IWB, taking his turn to write the plural form of 'dinosaur' while the other children are whispering letters in the background:

> Pupil-pupil interaction – note how Dean has a chance to change his mind and modify his answer. Is this because the children are whispering answer, and they are acting as (less threatening?) experts? Is it because the time he has taken to write has given him thinking time? Is it because he can see previous answers still on the board? collaborative stage?
>
> (later in the same lesson)…."no, no, no!!" Children have noticed that child at board has made a mistake. Because they are able to see what D. is writing, it is they – rather than the teacher – who acts as the one to convince him to modify his work.

Anne's sees one of her main roles as to engage the children with each other: 'turn to class and explain….', and to direct the discussion by emphasising key ideas, reinforced by the visibility of correct answers on the IWB.

So the specific evidence about what the teachers know and value about learning emerges from the activity in which it based, and it is not immediately obvious from either transcribed dialogue sections or summary comments. It is the connections between the two, together with any additional reflections, which are crucial. This reflective process can itself lead the teacher to articulate and change what she knows and values about the pupils' learning. For instance, the patterns of discourse evident in Meg's transcriptions show several traditional examples of teacher-pupil dialogue in I-R-F-R-E… type strings, supported by non-verbal interactions (NV1) when children come to the IWB to move images or write. This suggests that Meg regularly leads the conversation with a question to the whole class. She then identifies a pupil to respond and follows up this response with a further comment which extends the discussion or refocuses the topic. This is a typical pattern which confirms Meg's central role in the chosen whole-class lessons. Yet Meg also includes some notable examples of 'i' and 'e' – interpreting these interventions by the pupils as evidence of their engagement in the learning process. For example, see the extract in Figure 8.

Figure 8: An extract from Meg's transcript of Lesson 2

Dialogue and 'staging'	**Coding**	**Evidence of learning?**
T – Good girl. Do you want to come and underline it?	E	
Lynn comes to underline it	NV1	
Tom – Isn't there two more?	i	Demonstrating autonomy by questioning whether there are more than 2 verbs in the sentence.
T- Tom which others do you think are verbs?	I	
Tom – Expanded and territory	R	

This does not just serve as an example of Meg's understanding of the pupil's learning at that part of the lesson, apparently informed by the previous research group discussions of the key elements of social constructivism. It is also one of a number of moments of child-initiation which stand out from the general run of the lesson, and Meg herself reflected on this afterwards. For example, in evaluating lesson 1 she writes:

> What I would change: IWB had sentences on it which could be manipulated to rearrange the sentence. Certain words were linked together as I anticipated how the children would re-order the sentences. Next time I would write all the words in the sentence separately because the children had their own ideas about how they should be re-ordered which led to interesting discussions....
>
> Children's response: ....I was interested by the number of child initiated questions there were - two boys particularly stand out.

Meg strongly values pupils' active involvement in the process of knowledge building around the lesson focus, and it is this which may have influenced the way in which she allowed the systematic observation and coding itself to affect her understanding of her children's classroom behaviour and engagement in learning. In presenting her work to the teacher-research group Meg

said that she had always felt that one child's 'interruptions' were largely unconstructive and disruptive to the flow of learning in the classroom. However she had re-classified this behaviour as focused 'initiation', always directly pertinent to - and often developing - the lesson discussion.

In some cases there were hints of the potentially powerful effects of sharing what is known and valued about learning with the pupils. For instance, Ingrid explicitly links her actions at the IWB and her comments about what she was doing with the children's thinking:

Figure 9: An extract from Ingrid's transcript of Lesson 1

Dialogue and 'staging'	**Coding**	**Evidence of learning?**
T : Okay. So to use something like this is actually a good idea, a Smart Board or a visual model, a picture or even a drawing. To help you solve a problem. Excellent. *(Drags and enlarges next question on same SB page – hands start to rise before question is asked)*	F E	Pupils were anticipating the next question which illustrated to me that the IWB was encouraging them to predict what was going to be asked and they were already on their way to finding an answer.

This type of 'thinking aloud' in class seems important in connecting the work at the IWB with the children's involvement in learning and the demonstration of what they have learned, expressed in the dialogue and activity that forms the lesson itself.

Connecting the teachers' knowledge about learning with their knowledge of the uses of the IWB in the classroom

As seen in the previous section, the teachers' detailed lesson observations and further reflections provide useful insight into what they know and value about how children learn in the context of the particular types of teacher-led lessons which were the focus of this investigation. Some of these ideas were articulated in the teachers' final reflective overviews. These included some broad conclusions, such as:

- I think that the IWB is an integral part of the modern day classroom and used properly and imaginatively is an asset to both teaching and learning.
- It has to be said that the more resources that are available to teachers to impact children's learning the better. The IWB is definitely an addition to the growing number of tools accessible. However they shouldn't be used in isolation. Using the IWB can have a positive effect on children's talk associated with learning but so can any additional resource. The true influence surely must be how the resource is used.

There were also many examples of the teachers' understandings of the actual connections between IWB and learning, including the activities and dialogic processes which mediate:

- The type of interaction *(I-R-F-R-F)* … appears to be connected to the type of activity rather than the use of the board itself.
- Having reflected on the outcomes of my research, I find that – although there are some interesting interactions associated with the IWB – it would be inaccurate to claim that

these same interactions could not have been generated in a classroom without an IWB. When we shared research findings as a group, I could not help but notice that many of the positive features of IWB use were related to *teaching* benefits, which is subtly different from the *learning* benefits, which are our specific focus.

- The analysis of my lessons, which were all very similar, shows very similar patterns of behaviour and interactions, mainly I-R-F-R-F. This has shown me a lot about my style of teaching in this type of lesson but it's not necessarily proof of the influence of the IWB in the children's learning. The subject area, lesson content, activities, presentation and teacher delivery must all be factors in how children learn and it's quite difficult to separate out which is having the most influence. I know which one I hope is!!
- It is my belief that the IWB encourages and supports the teacher in asking 'good questions'…It is impossible to state whether the same interactions would have occurred without the use of the IWB. It is an excellent tool, but without the open-ended questions very little dialogue would have taken place.
- The children are focusing on the board and not me. I have more freedom to move around the class and gauge children's reactions to what is being said. I have also noticed that many of the children 'help' each other by creating shadows on the board pointing to the correct answer to be changed or highlighted.
- Learning is reinforced through representation by imagery and perceptual organisation. The physical act of pointing and activating the screen helps to consolidate what is being learned. The techniques created to reveal information - drag and drop, rub out to reveal, annotating over other software and screenshots, spotlight and reveal tools – motivate the children to become more involved and to use thinking time more effectively.

This research process allowed us to draw quite precise and contextualised conclusions about each teacher's understandings of IWB affordances in the teacher-led lessons they chose as their focus. However this is not entirely an individual process, and we did find some overall trends and agreement in the research group:

What the group agreed:

- Generally positive views about the contribution of the IWB to teaching and learning.

- Making connections across lessons using saved screens or fast access to resources is a particularly valuable facility to support learning.

- The multimodal nature of the expression and development of ideas (especially in shared writing), is another particularly valuable contribution to learning

- The public nature of the IWB facilitates collaborative learning between pupils. Pupil confidence seems to be enhanced through the sharing of ideas, mutual support and communication (including non-verbal communication).

- Combining whiteboard visual imagery with the use of other classroom tools (artefacts, documents etc.) can be valuable, or even essential.

- The understanding of the activity purpose, the pupil group, teaching approaches and the contextual constraints (including assessment of outcomes) are central to effective IWB use.

Yet the broader context of teaching also has a significant influence on the teachers'

perceptions of IWB use to support the children's learning. This is most noticeable in the lessons driven strongly by specific learning objectives, commonly now made explicit to the children in English primary classrooms. For example, Anne remarks in Lesson 1 that '…having correct answers on board constantly reinforces learning…'. In certain circumstances a preoccupation with achieving lesson objectives will influence perceptions of what the IWB is seen to afford in relation to the goals for that lesson time. As with Meg above, a teacher may value 'initiations' by the children, but only when they come to be seen as contributing positively to the lesson. The distinctive advantage of the IWB in this respect may be that the detailed thought put into planning the material in advance may focus and facilitate the type of adaptations that would support this type of learning in the future. A sufficiently flexible tool, used thoughtfully by the teacher, can mediate learning as a scaffold rather than a straitjacket (Warwick and Maloch 2003).

Some general findings and discussion points

- **Teacher knowledge**

  Incorporating theoretical knowledge about learning (e.g. from the introductory group sessions) can help some teachers to draw more precise and contextualised conclusions about IWB affordances, but the teachers showed individual differences in their responses (e.g in their use of the 'key terms'). *When does contact with theoretical ideas and terminology 'help or hinder'?*

  The inevitably contextualised uses of the IWB which provided the focus for detailed observation and analysis influences teachers' apparent perceptions of the value of the IWB to learning, particularly in relation to the specific goals for the pupil group in question. *Does focusing research on a process of learning (e.g. shared writing) rather than on subject knowledge or assessment of learning facilitate teachers' attention to the IWB affordances which support learning?*

  The process of coding discourse and interaction helps some teachers in understanding learning in their classrooms. *In involving teachers in a 'fine-grained' analysis of learning (e.g. coding patterns of interaction around IWBs) to what extent does grain size matter for individual teachers in their own classroom contexts, and what are the implications for maintaining teachers' active involvement in research and knowledge construction.*

- **Teaching and learning**

  'Learning is reinforced through representation by imagery and perceptual organisation. The physical act of pointing and activating the screen helps to consolidate what is being learned. The techniques created to reveal information - drag and drop, rub out to reveal, annotating over other software and screenshots, spotlight and reveal tools – motivate the children to become more involved and to use thinking time more effectively.' (an extract from Carla's final reflective overview)

  Attention to the forms of representation of information and knowledge is important, but there are issues concerning translation when using classroom tools that mirror what is on the IWB screen (notably orientation and scale, ie. horizontal/small to vertical/big). Talk is

important in making tool systems work. Until we can identify the perceptual processes which underlie the 'magic' of the electronic IWB images compared to conventional presentations we remain tied to an analysis that requires a detailed interpretation of what are often extremely subtle effects.

- **Knowledge, values and tool use in the constraints of the classroom setting**

  The use of the IWB supports interactions known to be associated with learning when the teacher recognises that the pupils' active engagement is important for learning and she can manage the digressions confidently and effectively. This indicates that the main impact of the IWB over time is not to impose new ways of teaching but to facilitate the type of interaction which the teacher values and is able to identify as associated with the children's learning. The implication is that training about IWB use must be accompanied by consideration of teachers' beliefs and values about learning and teaching.

Replacement or transformation? It depends on the teacher…

> '…teachers need extended opportunities to think through new ideas and to try out new practices, ideally in a context where they get feedback from a more expert practitioner and continue to refine their practice in collaboration with colleagues. Observation, coaching and talk-analysis feedback may be useful tools for professional development whereby sympathetic discussion by groups of teachers of data... derived from their own classrooms could be an effective starting point for critical reflection. Such an approach could provide supportive interactions with peers through modelling and feedback in order to change traditional patterns of whole class interaction necessary for responsive teaching'
> *Smith, F., Hardman, F. and Higgins, S. (2006)*

In current primary classroom contexts the IWB has often replaced other resources which have multiple everyday uses (e.g. flipcharts, whiteboards, etc.) and certain aspects of teaching have been facilitated (e.g. preparation of materials) and possibly transformed (e.g. the pace and flow of lessons). Certain features are important, like the large screen visibility that acts to facilitate initiation and evaluation by pupils not directly involved in answering the teacher's question or working at the board. However, this will only happen in practice if the teacher positively allows it as part of the conversational routine and she explicitly incorporates some of the children's contributions. This indicates that the IWB is not having a direct impact on teacher-pupil interaction, but that it may facilitate the type of interaction which the teacher values and is able to identify as associated with the children's learning. It may also be that when an IWB has become embedded in the classroom and the teacher is confident in her technical skills, the thought that has gone into the original planning of material to be presented in each lesson allows easy adjustment in the light of the children's responses. The decisions that are made about what will or could be changed on the IWB in themselves shed light on the teacher's principles of learning and teaching. The teacher mediates IWB use and instances of uses of the IWB in particular lessons have to be placed in the context of what happens before and afterwards. It is both the observation of what's happening in the moment and the additional information about the teacher's thinking which may allow us to understand the actual and potential impact of IWB use on pupils' learning.

References

Alexander, R. (2000) *Culture and Pedagogy: International Comparisons in Primary Education*. Malden, MA: Blackwell Publishers

Alexander, R.J. (2003a) Talk in teaching and learning: international perspectives, *New Perspectives on Spoken English in the Classroom.* London: Qualifications and Curriculum Authority

Alexander, R.J. (2003b) Oracy, literacy and pedagogy: international perspectives, in Bearne, E., Dombey, H., Grainger, T. (eds) *Interactions in Language and Literacy in the Classroom*. Milton Keynes: Open University Press. pp 23-35

Alexander, R.J. (2006) *Towards Dialogic Teaching: rethinking classroom talk*. Thirsk: Dialogos.

Becta (British Educational Communications and Technology Agency) (2004) *Getting the most from your interactive whiteboard: A guide for primary schools.* Coventry: Becta

Bourne, J. & Jewitt, C. (2003). Orchestrating debate: A multimodal analysis of classroom interaction. *Reading, Literacy and Language,* 37(3), 64-72

Bronfenbrenner, U. (1992) Ecological Systems Theory, in R. Vasta (ed.) *Six Theories of Child Development: Revised formulations and current issues.* London: Jessica Kingsley Publishers, pp. 187-249.

Burns, C., & Myhill, D. (2004). Interactive or inactive? A consideration of the nature of interaction in whole class teaching. *Cambridge Journal of Education*, 34(1), 35-49.

Cogill, J. (2003) *How is the interactive whiteboard being used in the primary school and how does this affect teachers and teaching*. Available at http://www.virtuallearning.org.uk/whiteboards/IFS_Interactive_whiteboards_in_the_primary_school.pdf . Accessed 20 March 2006

Cresswell, J.W. (1998) *Qualitative Inquiry and Research Design: Choosing among Five Traditions.* Thousand Oaks, CA: SAGE

Crook, C. (1994) *Computers and the Collaborative Experience of Learning*. London: Routledge

Dawes, L. (2000) First connections: Teachers and the National Grid for Learning, *Computers and Education,* 33(4), 235 – 252.

DfES (2002). *Key Stage 3 National Strategy: Training Materials for the Foundation Subjects.* London: Department for Education and Skills. http://www.standards.dfes.gov.uk/keystage3/respub/fs_trmat. Accessed 10 April 2006

Esarte-Sarries, V. & Paterson, F. (2003) Scratching the Surface: A typology of Interactive Teaching, in J. Moyles, L. Hargreaves, R. Merry, F. Paterson, & V. Esarte-Sarries, *Interactive Teaching in the Primary School: digger deeper into meanings.* Maidenhead: Open University Press

Franks, A. & Jewitt, C. (2001) The Meaning of Action in the Science Classroom, *British Educational Research Journal*, 27 (2) pp201-218

Gillen, J., Kleine Staarman, J., Karen Littleton, K., Mercer, N. & Twiner, A. (2006) *A learning revolution? Investigating the pedagogic practice around Interactive Whiteboards in British primary classrooms.* Paper presented at the American Educational Research Association Conference San Francisco, April 9, 2006

Glover, D. and Miller, D. (2001) Running with technology: the pedagogic impact of the large scale introduction of interactive whiteboards in one secondary school, *Journal of Information Technology for Teacher Education*, 10(3), 257-276

Granger, C. A., & Morbey M. L. (2002) Factors Contributing to Teachers' Successful Implementation of IT, *Journal of Computer Assisted Learning*, 18, 480-488

Hennessy, S., Deaney, R. & Ruthven, K. (2005) Emerging teacher strategies for mediating pupils' interactions with technology, *The Curriculum Journal*, 16 (3)

Higgins, S., Falzon, C., Hall, I., Moseley, D., Smith, F., Smith H. & Wall, K. (2005) *Embedding ICT in the Literacy and Numeracy Strategies: Final Report.* Newcastle University for the Department for Education and Skills. Available at http://partners.becta.org.uk/index.php?section=rh&rid=11275 . Accessed 12 May 2006.

Lee, M. and Boyle, M. (2003) *The Educational Effects and Implications of the Interactive Whiteboard Strategy of Richardson Primary School*. Richardson Primary School, ACT, Australia. Available at http://www.richardsonps.act.edu.au/RichardsonReview_Grey.pdf#search=%22Lee%20Boyle%20Richardson%2BPrimary%2BSchool%22 . Accessed 14 May 2006

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

Mehan, H. (1979) *Learning Lessons: Social Organisation in the Classroom.* Cambridge, MA: Harvard University Press

Mercer, N. (2003) The educational value of 'dialogic talk' in 'whole class dialogue', *New perspectives on spoken English in the classroom: discussion papers.* London: Qualifications and Curriculum Authority

Miller, D. and D. Glover (2002) The Interactive Whiteboard as a Force for pedagogic Change: The experience of five elementary schools in an English authority, *Information Technology in Childhood Education Annual*. Available at www.aace.org/DL/index.cfm/fuseaction/view/paperid/9117 Accessed 2 March 2006

Mortimer, E. and Scott, P. (2003) *Meaning Making in Secondary Science Classrooms*. Maidenhead: Open University Press

Noffke, S. and Somekh, B. (2005) Action research, in B. Somekh and C. Lewin (eds) *Research Methods in the Social Sciences.* London: SAGE

Padgett, D.K. (1998) *Qualitative Methods in Social Work Research: Challenges and Rewards.* Thousand Oaks, CA: SAGE

Qualifications and Curriculum Authority (QCA) (2003) *New Perspectives on Spoken English in the Classroom: Discussion Papers*. London: Qualifications and Curriculum Authority

Rojas-Drummond, S. & Mercer, N. (2004) Scaffolding the development of effective collaboration and learning. *International Journal of Educational Research*, 39(1-2), 99-111

Robson, C. (2002) *Real World Research: 2nd. Edition*. Oxford: Blackwell

Ruthven, K. Hennessy, S. and Deaney, R. (2004-2007) SET-IT and T-MEDIA projects @ http://www.educ.cam.ac.uk/istl/pub.html#t-media Accessed 7 July 2006

Scott, P. (1998) Teacher talk and meaning making in science class reference: a Vygotskian analysis and review, in *Studies in Science Education*, 32, 45-80

Selwood, I. and Twining, P. (2005) *Action Research*,

http://www.becta.org.uk/research/research.cfm?section=6&id=4910 Accessed 18 August 2006

Smith, A. (2000). *Interactive Whiteboard Evaluation.* http://www.mirandanet.ac.uk/pubs/smartboard.htm Accessed 25 April 2005

Smith, H. (2001). *Smartboard Evaluation: Final Report.* http://www.kented.org.uk/ngfl/ict/IWB/whiteboards/report.html#6 .Accessed 5 February 2006

Smith, F., Hardman, F., Mroz, M. and Wall, K. (2004) Interactive whole class teaching in the national literacy and numeracy strategies, *British Educational Research Journal*, 30(3), 395-411

Smith, F., Hardman, F. and Higgins, S. (2006) The impact of interactive whiteboards on teacher-pupil interaction in the National Literacy and Numeracy Strategies, *British Educational Research Journal*, 32 (3), 443-457

Stenhouse, L. (1983) Research as a basis for teaching, An inaugural lecture in the University of East Anglia February 1979, reprinted in *Authority, Education and Emancipation,* pp. 1770195. London: Heinemann Educational Books

Warwick, P. & Maloch, B. (2003) Scaffolding Speech and Writing in the Primary Classroom: a consideration of work with literature and science pupil groups in the USA and UK, *Reading, Literacy and Language*, 37 (2), 54-63

Warwick, P., Stephenson, P., Webster, J. & Bourne, J. (2003) Developing pupils' written expression of procedural understanding through the use of writing frames in science: findings from a case study approach, *International Journal of Science Education,* 25 (2) 173-192

Watkins, C., Carnell, E., Lodge, C., Wagner, P. & Whalley, C. (2002) *Research Matters No 17: Effective Learning, Revised Edition*. London: University of London Institute of Education National School Improvement Network. Available at http://k1.ioe.ac.uk/lcll/chriswatkinspubs/Watkins02b.pdf . Accessed 9 September 2005

Wegerif, R. (2005) *Dialogic or dialectic? The significance of ontological assumptions in research on educational debate.* Paper presented at Education Seminar Series, Faculty of Education University of Cambridge, 15 December 2005

Wertsch, J. (1991) *Voices of the Mind: A Sociocultural Approach to Mediated Action*. Cambridge, MA: Harvard University Press.

Wertsch, J.V., Tulviste, P., & Hagstrom, F. (1993) A sociocultural approach to agency, in E.A. Forman, N. Minick & C.A. Stone (eds) *Contexts for Learning: Sociocultural Dynamics in Children's Development.* New York: Oxford University Press. pp 336-356

Whitebread, D. (ed.) (2000) *The Psychology of Teaching and Learning in the Primary School*, London: RoutledgeFalmer

Williamson, B. (2006) Elephants can't jump: creativity, new technology and concept exploration in primary science, in P. Warwick, E. Wilson & M. Winterbottom (eds) (2006) *ICT and Primary Science.* Buckingham: Open University Press/McGraw Hill, pp70-92