Teachers' Pedagogic Design of Digital Interactive Whiteboard Materials in the UK Secondary School

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INTRODUCTION

Teachers have always made texts for use in the classroom. The wide spread introduction of Interactive whiteboard (IWB) technology into UK classrooms, and the screen more generally, makes the multimodal resources of color, image, dynamic movement, and sound newly available for pedagogic design in newly connectable ways. These facilities present teachers with new questions about how to design and use teaching materials, new possibilites and constraints. This presentation will examine teachers' design of digital multimodal resources for IWBs and the influence of prevalent policy discourses of interactivity, multimodality and fast pace influence on teacher's digital materials for the IWB.

Why text design matters

Texts displayed on IWBs can be understood as a meeting point of the concerns of educational policy, the commercial sector, pedagogy and technology. Whatever the technology, the question of what is an appropriate text for teaching and learning has been and remains a highly charged one across the curriculum. The texts that are brought into the classroom constitute the cultural, political and social realm for study - the ethical material with which the teacher and the students will need to engage. Larger level policy articulates the social relations of education and work to position teachers and students in respect to the design of texts and in doing so create particular versions of knowledge and student identity. In short, texts are an important element in forming what school knowledge can come to mean. Clearly, in one sense the texts displayed on IWBs are there because teachers have chosen them, either from already existing resources or through their own design. However, teachers are institutionally positioned, so that for example exam constraints steer them towards particular kinds or designs of texts (Sarland, 1991). They are discursively positioned, and it is on the basis of their positioning that teachers' design and make their choices for and of texts. The design process is shaped by the demands of the curriculum; by the teachers' perception of the students' interests and ability; and by the resources of the school and the facilities of the technology. In other words, schools, teachers, students and others are involved in re-inflecting and transforming national policies and text design is a central component in this process.

The design of digital texts

IWBs are an increasingly prevalent digital screen-based technology in the UK classroom (with nearly a half of Maths, Science and English lessons in London schools taught using an IWB) (Moss et al, 2007). The design of IWB materials is integral to how the IWB is used in the classroom, and its impact on teaching and learning. The majority of UK secondary school teachers (78%) design and produce their own materials for the IWB (Moss et al, 2007). Thus how teachers design and use pedagogic texts is crucial to how the full capacity of IWBs is realised.

The IWB can act as a connective, multimodal hub in the classroom to incorporate a range of multimedia and multimodal resources (image, animation, sound, and colour etc) in lessons (Levy, 2002; Graham, 2003; Ball, 2003). An internet-connected IWB can make available new temporal and spatial connections across sites of learning, linking the classroom with museums and other specialised centres (Ball, 2003; Miller, 2003). The use of IWBs in lessons can also open up new possiblities for student interaction (Glover and Miller, 2001; Ball, 2003; Kemeny, 2004; Miller 2003). The potential to save, store, reuse and share IWB materials enables these to be used differently from print materials (Kennewell, 2004). These capabilities of IWBs raise many design challenges: How to choose the most apt mode (e.g. writing, image, animation)? How to combine modes in materials? What reading pathways to design? What kinds of interaction to design into teaching materials and when?

Moss et al's (2007) evaluation of IWB use in London secondary schools suggests that many teacher-made materials for the IWB fail to engage with the capacities and the pedagogic potential of the IWB. One reason for this is that teachers rely on design principles derived from traditional print-based pedagogic forms (i.e. textbooks and worksheets) that are based on the affordances of the printed page, and the transmission-based interaction that this implies. Another is that teachers use the resources and facilities that IWBs make available in unprincipled idiosyncratic ways.

FOCUS AND APPROACH

This paper draws on case study data from the Interactive Whiteboards, Pedagogy and Pupil Performance Evaluation project (which the author directed), a study commissioned by the Department for Education and Skills to evaluate

the introduction of interactive whiteboards to London secondary schools (see Moss et al, 2007 for a full account of the research). The project used a mixed methods research design including in-depth case studies in nine core-subject (Maths, English and Science) Departments in London schools. Case studies consisted of structured observation and video recording of the delivery of a curriculum topic with IWBs, collection of IWB texts, and interviews with the teachers observed.

This paper attends to three aspects of the design of IWB materials identified by Moss et al (2007) as central to how IWBs are designed and used in the classroom: curriculum content as a multimodal ensemble, the design of pace, and interactivity. More specifically it asks:

1. *How do teachers design curriculum content as a multimodal ensemble (i.e. image, sound, animation etc) in their materials for IWB and the classroom?*
2. *How do teachers organise, establish and regulate time and pace in their materials for the IWB?*
3. *In what ways do teachers design their IWB materials to support opportunities for student interaction with the board and curriculum content?*

In order to answer these questions it takes a multimodal approach. Multimodality draws on social semiotic approaches to communication (Hodge and Kress, 1988; Kress and van Leeuwen, 2001; van Leeuwen, 2005). It focuses on people's processes of making meaning through the design (selection, adaptation, or transformation) of the representational and communicational modes available at a specific time and place. Modes (e.g. image, gesture, writing) are organized sets of semiotic resources for making meaning (e.g. a visual semiotic resource is the framing of elements in an image as connected or disconnected). Teachers' choice of modes shapes the epistemological design of subject knowledge and the ground for the learners' engagement in the classroom. The IWB material is a necessary resource and central reference point but does not wholly constrain and determine what gets said and done in the classroom. The analytical focus is also on the socially constructed moment when the IWB material is in action, in interaction, and attends to other reference points that are invoked (Moss, 2003). From this standpoint it is the interactions between participants in the classroom that establish and steer what the text will mean (Maybin and Moss, 1993). Alongside this, multimodality provides an analytical resource through which to build the text into teachers' practices (Moss, 2003; Pahl and Rowsell 2006).

There is a common assumption in much of the research and policy literature that we already know what the IWB can best be used for in the secondary school (Moss et al, 2007). This literature converges on the benefits of IWBs as a transformative pedagogic tool with the potential to revolutionize learning and teaching. Three resources are central to the production of this discourse and its' influence on teachers' sense of proper-use and pedagogy with IWBs:

• Multimodality: the IWBs' capacity to harness a wider range of multimodal resources in order to facilitate pupil learning;
• Pace: its capacity to increase the pace and efficiency of classroom delivery and therefore best use of teacher time;
• Interaction: its capacity to enhance interactive whole class teaching.

The following section discusses how this discourse is inflected in teacher-designed texts for IWBs.

IWB text design and use
The purpose is to compare and contrast the different ways that three teachers (that are typical of the range observed) designed and used the resources and potentials of the IWB in order to challenge the emergent convention that good IWB pedagogy is multimodal, interactive, and fast. A brief summary of the three texts designed and used by the teachers is given below.

EXAMPLE 1: This lesson focused on polygon external and internal angles. The teacher created the text displayed on the IWB in real time during the lesson. There was no electronic preparation of the text. The content of the board was primarily hand written formula accompanied by some diagramatic drawings. The teacher worked with a total of seven ActivStudio slides in the lesson. He used three features of IWB technology: the facility to draw straight lines, switch to the next blank screen without erasing, and go back to a previous slide. The teacher taught from the front of the class and the students remained in their seats copying information into their exercise books until the final five minutes of the lesson when a few were invited up to the board to work with some equations.

EXAMPLE 2: This lesson also focused on polygon external and internal angles. The teacher used an IWB text prepared by himself in PowerPoint that consisted of a sequence of 11 slides combined with three slides from Geometers Sketchpad, a software package that has been specifically designed for teaching mathematics. The texts brought to the lesson included flipcharts with hyper-

links, diagrams, graphs and tables. During the lesson the teacher used the IWB's visual and dynamic potential by combining different types of software seamlessly; saving and recovering his work; the use of drag and drop, cover and reveal, annotation tools, features such as the covering blind, and applications such as the calculator. The teacher taught from the front of the class and at several points during the lesson students came to the front for short episodes to interact with the board.

EXAMPLE 3: The topic of this lesson was algebra and factorisation. This teacher used a prepared ActivStudio flipchart text consisting of four slides. The main slide showed the black outline of a square divided into sections and two sets of shapes: a yellow square and a series of four differently colored shapes (two brown rectangles of the same size, and two different sized and colored squares) which when arranged filled the yellow square and outline. The other slides consisted of a series of algebraic equations written out and to be solved. The teacher taught from the back of the class, and the students used interactive slates throughout the lesson.
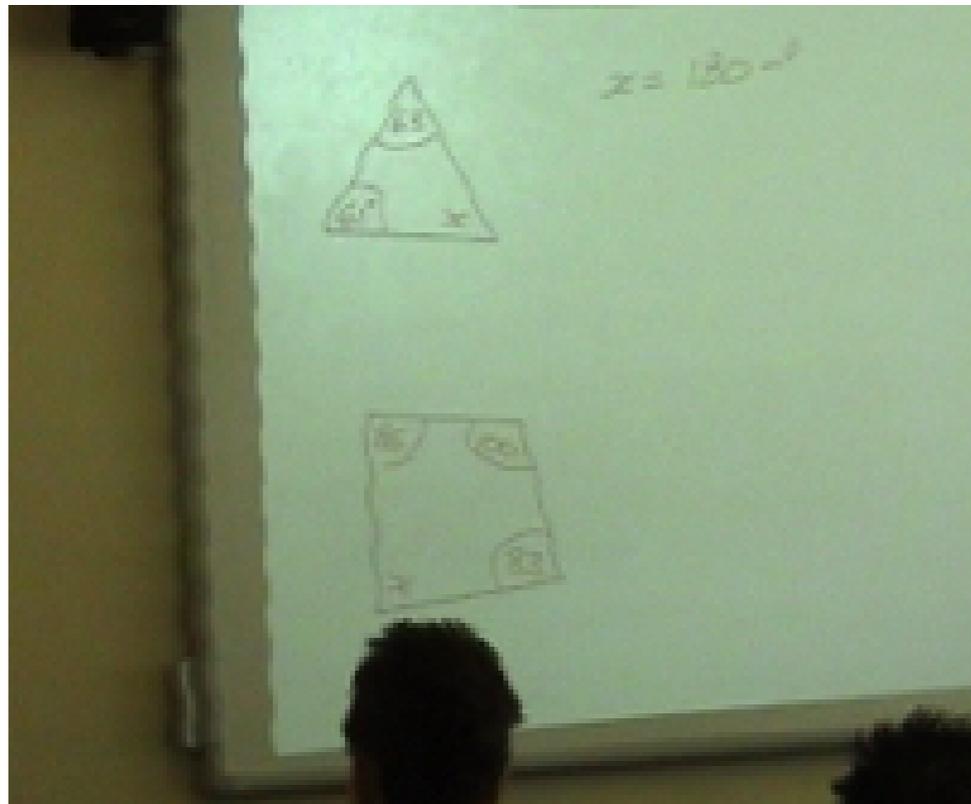

Figure 1.

Observation of lessons with IWBs showed that often teachers do not make use of the full range of multimodal resources and their text design does not change the modes of representation in the classroom in significant ways. This is the case in our first illustrative example. Throughout the lesson the IWB was used in much the same way as a traditional blackboard with the teacher at the front of the classroom. Writing continued to dominate the board text design with some static 2D diagrams. The instructions for each task were spoken by the teacher and were not included in the text displayed on the IWB (figure 1). This served to integrate the texts into the teacher's talk which in turn acted as the main pedagogic vehicle.

These kinds of resources are easiest to make in that they are consistent with teachers' existing pedagogic aims and print-based experience and knowledge.

The teachers' use of the multimodal resources of IWBs in illustrative examples two and three do however begin to facilitate the production of a range of new kinds of texts. The teacher in the second example used dynamic images, colour, numbers and diagrams and moved between applications and screens easily (figure 2).
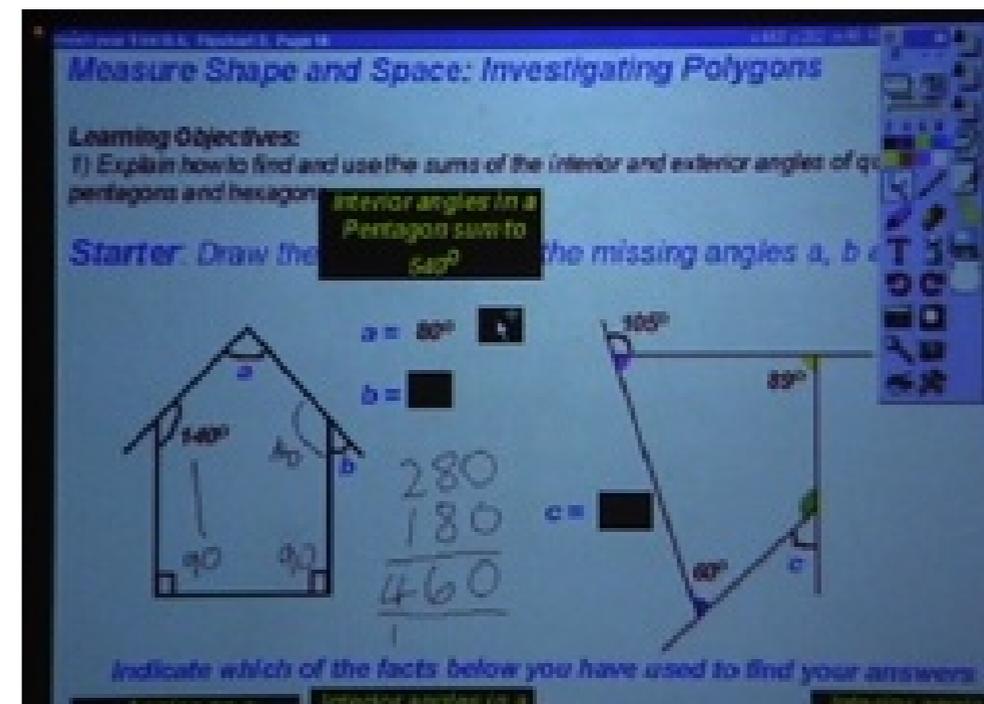

Figure 2.

In the third example the teacher used colour to signify difference and sameness (figure 3). The black-outline of the square displayed on the board provided a guide for the initial arrangement of the shapes, students then suggested and showed alternative arrangements of the four shapes within the square. The students used image, colour, and movement to explore factorisation through their manipulation of the different shapes and visually checking the fit between the series of shapes and the large yellow square. The question of how this approach to design matters for learning is addressed later in this paper.
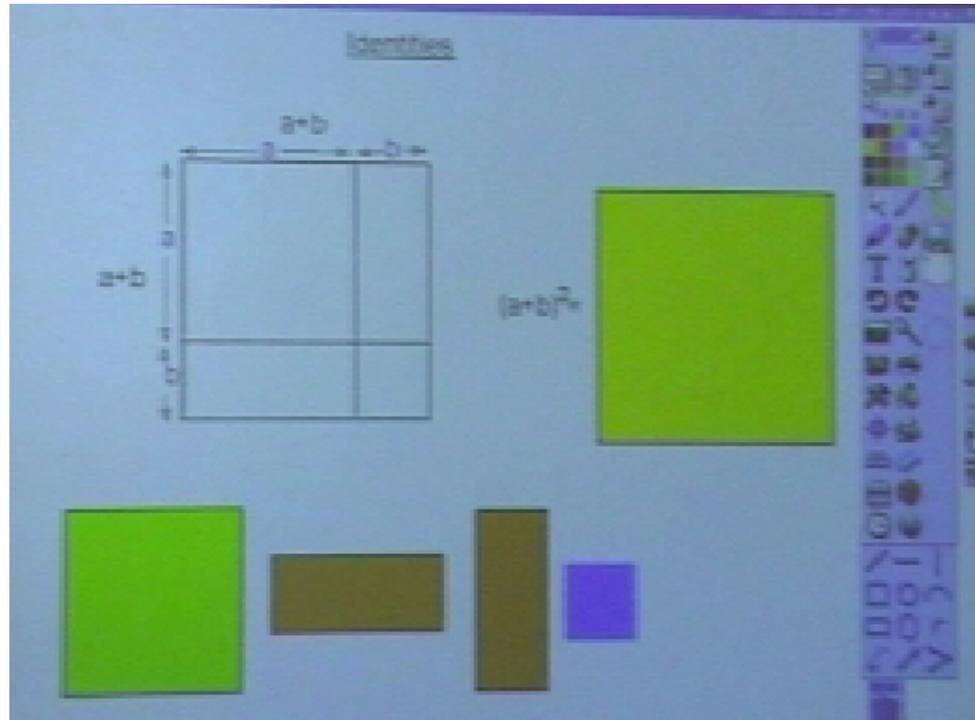

Figure 3.

Across the project teachers consistently referred to multimodality within discourses of student ability, associating the need for multimodal explanation with low ability. As a result multimodality was often rendered surplus for high ability students. Ability and interactivity were similarly linked and with similar consequences. This positioning of multimodality fails to attend to the potential impact of multimodality on learning. That is how the design of multimodal representations reshapes curriculum knowledge - what it is that is to be learnt and how. Images do not supply a similar version of a concept: they provide a different representation of it. To talk about a concept, to draw it, to animate

it, all draw on different aspects of a concept. Engaging with a variety of modes means engaging with a concept in different ways, each of which fills up the concept in distinct and specific ways. In example three, for instance, the visual and dynamic text, consisting of colored squares to be manipulated, offers the students a different representation that is central to the learning task. It does not reinforce the algebraic representations offered in the lesson. The multimodal representation offers the possibility of making connections between the specialized knowledge of Maths and the everyday knowledge of space and design. This is perhaps reflected in pupils and teacher's comments that image and dynamic representations make concepts, especially complex concepts, easier to see, share, discuss and understand (also found by Wall, Higgens, Smith, 2005).

Designs for pace

Classroom observations showed a variation in pace in lessons where IWBs were used. This raises questions about the relationship between fast pace and effective learning. In the first example, the focus on writing combined with the meticulous rhythm of the teacher's speech created a slow pace lesson. There is little explicit reference to time in the lesson. The teacher rarely asked the students questions, only a few students asked questions but were otherwise quiet as the text unfolded across the boards in real time.

In example three, the pace of the lesson is notably slow and each IWB slide is sparse. The teacher's pedagogic focus is on the processes of co-constructing knowledge and the understanding of these processes rather than demonstrating correct answers. This focus is arguably visually apparent in the sparseness of the text – there is a lot to be constructed. The teacher is open in relation to time. She defined and re-defined the time frame for each activity as students were working. Pupils used the slate to manipulate the shapes on the IWB as they talked aloud explaining what they were doing. The teacher occasionally asked open questions so as to make the process clearer to the rest of the class. In addition to working with the slate students went up to the board to show their workings out or worked with the teacher's laptop.

The potential of IWB technologies to regulate a fast paced lesson was fully realized in the second illustrative example. The teacher used Power Point files to sequence and pace the lesson. This teacher, along with many others in our case studies, commented on how the fast pace enabled by IWBs can make lessons 'flow'. This lesson had a particularly fast pace. The text was a part of a larger sequence of 23 slides on the characteristics of external and internal angles of polygons that the teacher used across three lessons. In this teaching sequence, the teacher used these 11 slides as a linear organizing structure for the lesson including three slides from Geometer Sketchpad. This had the effect

of strongly framing the content, structure and pace of the lesson. The teacher quickened the lesson pace to get through the appropriate number of slides by the end of the lesson. The IWB texts created in advance by this teacher in particular his use of PowerPoint played a major part in structuring the lesson and driving its fast pace. The text design functioned as a time management tool that controls the class rhythm and pace. Such texts increase the pace of whole class teaching in three ways, through 1) the ease of movement between screens; 2) the ability to preload and move between a range of linked materials; and 3) the ability to move easily between applications.

In this lesson the teacher exclusively controlled the flow of materials on the board and in this respect he dominated the lesson. The effectiveness of such fast pace would of course depend upon the teachers' broader purposes, and to some extent the nature of the subject matter they were covering in this way. For instance, fast pace may be appropriate when teaching certain aspects of Maths. It has a less immediate application to substantive areas of English teaching. Indeed the use of such prepared presentational texts may result in a rigid scaffolding and superficial interactivity (Kennewell and Beauchamp, 2007).

Pace is realized differently in classroom texts designed for an individual screen – as information is broken down into smaller sequential elements, which serve to fragment and modularize information. Text design in maths classrooms with a set of blackboards leaves a narrative-like trail through a process to realize a solution. The IWB screen breaks this trail in the way it organizes information over time (rather than space) and this changes the students' access to the narrative thread. Thus the teacher's design decisions in example two break up an information narrative into screen sized (bite sized) chunks. Preparing the screens before the lesson means they can be filled with more information. The IWB text design is similar to that employed on a non-interactive board but that would be built up over the course of a lesson – rather than presented to pupils to read simultaneously (thereby opening up multiple reading paths).

The technological facility of IWBs (including hyperlinks, layers) supports the breakdown of the curriculum into bite-size portions and this is a frequent feature of teacher's pedagogic designs for IWBs. However, this also relates to the broader pedagogic context being designed for: the demands of a full curriculum, the pressure of examination, behaviour management, and expectations of students. Perhaps it also refracts the discourse of the digitally-literate child of the 21st century – with a limited attention span and a diet of dynamic visual stimulation. The way in which the screen is used to break up, modularize, link, connect and disconnect elements of a lesson is central to the production of pace. It is also central to learning in that it serves to link, classify and frame curriculum knowledge in important ways.

Designs for interaction

Teachers conceive of and design interactivity in different ways. The type of text design in turn shapes the pedagogic possibilities for interactivity. The interactive uses of the technology observed during the project can be categorized in three ways: 1) Technical interactivity – where the focus is on interacting with technological facilities of the board; 2) Physical interactivity – where the focus is on going up to the front and manipulating elements on the board; 3) Conceptual interactivity – where the focus is on interacting with, exploring and constructing curriculum concepts and ideas.

How interactivity is understood and used in relation to the IWB in the classroom is shaped by the pedagogic theories of learning that underpin particular teachers' practice, and that circulate more broadly in a subject department or school. It also varies according to the demands of the subject and topic, the perceived ability of the students, the time available and the peripherals used.

In illustrative example one, the students and teacher remain in a traditional interactive mode. The teacher is at the front and the students seated throughout the lesson copying the content of the board into their exercise books, except for a short flurry of students coming up to the board in the last five minutes of the lesson to solve some equations. Time to think in this example is largely the time children give to solving the equation they are working on on their own. Time at the front is used to exemplify the thinking they have done earlier.

In the second illustrative example the teacher's design of interactivity with the IWB also reinforces whole class teaching from the front, with limited dialogic episodes and student interaction. The teacher's design of texts included the answers to the questions posed during the lesson. The answers were displayed in the lesson through the actions of students (or the teacher) using the cover and reveal or drag and drop facilities of the IWB. Students were asked to choose from a set of optional answers in order to fill in a table displayed on the IWB (to match a polygon with the values of its interior and exterior angles). In each incidence of student interaction with the board the answers could be found (quite literally) on the IWB. Elements of texts could be moved around but not created or transformed. Students were actively engaged in these tasks. Their participation was structured by the teacher's actions and the pre-planned design of the text. During whole class activities, students' verbal participation was guided by sequences of closed questions asked by the teacher. The teacher also guided students' physical interaction with the IWB. Students were asked to go to the front and use the board to demonstrate what they had done in their notebooks. In this case, interactivity was both discussed by the teacher and perhaps tacitly evaluated in terms of technological skills, how often students came up to the board and how often they interacted with

particular features (i.e. drag and drop, cover and reveal). Under such conditions interactivity can come to stand for interacting with the board itself, not necessarily manipulating the concepts the teacher is teaching – a surface interactivity (Hargreaves et al, 2003). This kind of emphasis on interactivity was particularly prevalent in relation to lower ability students and the need for teachers to be *seen* to be interactive.

In the third example, the whole class teaching was designed to enhance and create spaces for interactive work. Discussion and extended dialogue were opened up by the teachers' use of the IWB. The teacher used peripherals (slates) with the IWB. This positioned her at the back of the classroom and enhanced techniques for student participation and control over their own learning. Teaching focused on the process used to find the area of the yellow square in the text displayed on the IWB. Different students controlled the IWB text using a slate passed from one desk to the other to try and find out the area of the square. The contents of the text were used as open-ended prompts and as resources for exploring the processes of factorisation. The teacher intervened with comments, and the students suggested ways of solving the problem. The teacher summarised what they had learnt by asking questions to pupils and indicating the formula behind that process. When summarising the teacher referred to the insights that different pupils had made. The teacher encouraged students' spoken and physical participation and pupils were active in the lessons. The board was used to display students processes of thinking and ideas rather than what they had done or correct answers. Answers were realised through discussion and student participation in the lesson. Teacher and students together created the texts. This lesson was marked by the display of texts for annotation, manipulation and collective discussion and a move away from using IWB features such as drag and drop, hide and reveal. As a result there is less use of the board for direct mapping and transmission of information into student exercise books through copying the contents of the board and more creation of opportunities for talk supported by technology-enabled manipulation of elements on the board. In short the text design is 'left open' for completion by the action of the students.

DISCUSSION: TEACHERS AND TEXT DESIGNS FOR IWBS

As the analysis presented in this paper shows, the policy benefits of multimodality, pace and interactivity frequently associated with IWB pedagogy in the secondary school do not necessarily hold and can even be misleading. It is, this paper argues, more pedagogically useful to think of pace, interactivity and multimodality as resources on a continuum which need to be designed as a holistic trio rather than seen as absolute virtues. For example, if interactivity is high, then pace may need to be slow.

DESIGNING MULTIMODALITY

The potential learning power of multimodality discussed earlier raises questions for the design of IWB texts that move beyond the policy discourse and the assumptions underpinning much research that multimodality is automatically good for learning. Teachers need to be given the time to reflect on what mode is best for what purpose. Text design demands thought about how the links and relationships between modes and screens impact on shapes of knowledge, and particularly the classification of knowledge in the classroom. Teachers also need time to reflect on what new practices of interpretation the multimodal texts they make require from students – to interpret colour and movement, for instance, or to make links across elements. Texts in classrooms are dynamic and activated by the talk, gaze and gestures of teacher and students. This raises another important question for text design, that is, which aspects of pedagogy should be designed into the text and fixed ahead of use and which should be designed around the text in use?

DESIGNING PACE

Redefining pace in terms of time raises other questions. In designing time into IWB texts, it may be useful to address the potential functions of time explicitly. For instance, who and what is to be given time. One potential with prepared texts is to focus on teacher content and in the process this can background a focus on the learner and learning. A difference between the IWB and other forms of technology (including the text book) is that they are on all the time. The ease of movement between applications removes breaks in lesson flow and raises new questions for how teacher time and student time are produced, boundaried and related. The functions of pace and time (e.g. classroom management, motivation, thinking, reflection, and so on) have to be explicitly designed into the text, making connections and disconnections across the time of the lesson. The question of how time is organized in the text is central to the design of the screen, in particular whether time is designed into texts as a linear narrative or as a tentative network stretching out like a web across multiple spaces.

DESIGNING INTERACTIVITY

Designing interactivity into texts in ways that enhance learning means moving beyond seeing students as 'passive recipients of preformed information' (Tanner et al, 2005:3). Design for interactive use of the IWB needs to include the purposeful design of opportunities for exploration and active participation that go beyond physical manipulation. This includes consideration of, for instance, what information to provide as ready-made or for co-construction, what aspects of a concept it is useful to make dynamic and manipulable, as well as decisions over what is an effective balance of time for collective discussion and time to record. The IWB can be used to display, annotate and manipulate students' texts (e.g.

using scanners, visualizers, or sticking student posters on the IWB). Aspects of a text can be designed to be open or closed, fixed or manipulable, each enables different constraints and possibilities for interaction depending on the pedagogic intention.

<div align="center">CONCLUSION</div>

This paper has shown how a focus on IWB text design can contribute to a better understanding of the relationship between forms of representation, technology, literacy and pedagogy in the school classroom. There is a need to move towards pedagogic principles for design and to move away from valuing a technology driven pedagogy that is fast, interactive and multimodal. Examination of teachers' design and use of IWBs in this way has two major benefits. First, it enables a better understanding of the facilities of the IWB, the practices and values associated with the use of IWBs and how teachers' use of the technology helps to shape curriculum knowledge, and the pedagogic relationships of the classroom. This leads to a better sense of the potentials and constraints of the resources teachers are designing with and the contexts they are designing for. Second, a focus on text design highlights the pedagogic design choices teachers are involved in when making texts. This also makes clear how new teacher designs have the potential to realize new pedagogies that bring about change in the classroom. Further exploration of teachers' design of materials is essential to inform the development of teacher training and support on the design of digital materials for the IWB. In particular examination of how curriculum subject demands influence teacher-made IWB materials and the criteria teachers use to evaluate the effectiveness of IWB materials.

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