

Transition in pedagogical orchestration using the interactive whiteboard

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Abstract This paper revisits the analysis of how the interactive whiteboard (IWB) can contribute to effective pedagogy. It builds on previous work concerning the relationship between the features of IWBs and associated technologies and some key components of pedagogy, including the stage of IWB use, the role of ICT, the type of interactivity, and the overarching aspect of orchestration for learning. Two example lessons are constructed to illustrate the relationships associated with a basic stage of IWB use as a blackboard substitute and the most sophisticated, synergistic stage of IWB use. The analysis of these lessons is used to show that in the synergistic lesson, the IWB functions as a hub for classroom activity. The key difference is that both the teacher and pupils use the affordances of IWB for orchestration of activity rather than merely using a set of unrelated tools predominantly used by the teacher. Implications are drawn concerning the need to develop skills in orchestration for learning alongside technical skills in IWB use through initial teacher education and subsequent professional learning.

Keywords Interactive whiteboard · Transition · Orchestration · Affordance · Teacher's role · Teacher education

1 Introduction

There is now a substantial body of literature concerning the interactive whiteboard (IWB) and its use in teaching and learning from around the world including Hungary (Lavicza and Papp-Varga 2010), South Africa (Slay et al. 2008), Taiwan (Jang and Tsai 2012), USA (López 2010) Germany, (Cutrim Schmid 2010), Israel, (Blau 2011), Brazil (Freire et al. 2010), and particularly Australia (Bennett and Lockyer 2008; Holmes 2009; Winzenried et al. 2010; Serow and Callingham 2011) and most

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recently Turkey (Somyürek et al. 2009; Turel 2011; Türel and Johnson 2012; Nihat Şads and Ozhan 2012). These studies have noted IWB's popularity with teachers, their effects on learner attention in lessons, and their support for more dialogic interaction in the classroom noted within studies from the UK (Mercer et al. 2010).

There are, however, some aspects of the effect of IWBs which do not seem to have been adequately discussed. Previous analysis of the affordances of IWBs for a raft of pedagogical actions (e.g. Kennewell and Beauchamp 2007) does not seem to tell the whole story of how the IWB aids teaching and learning. Some of the teachers who were observed in the course of two funded studies in which we were involved (see Kennewell et al. 2007; Tanner et al. 2009) did not merely replicate traditional pedagogical actions or devise new ones which exploited the affordances of IWB; they additionally used the IWB to help them combine actions more effectively, including switching modalities, shifting activity in time and space, revisiting improvable objects and handing lesson control to pupils (Jewitt et al. 2007; Mercer et al. 2010; Twiner et al. 2010). This orchestration—rather than mere sequencing—of all the resources available reflects an awareness of the continual availability of multiple resources that the board represents. Indeed, the board is not merely one of the resources to be orchestrated, it has features that afford the act of orchestration itself.

The purpose of this paper, based on evidence from the studies above, is to extend our analysis and understanding of the cumulative effect of integrating multiple resources and tasks on the teacher's ability to orchestrate features of the classroom setting in order to improve learning. As we will show, teachers develop their own, and pupils', use of the IWB as their technical and pedagogic skills and beliefs are influenced by their perceptions of its affordances and constraints. This paper will also exemplify two stages of this development to demonstrate the potential of the early stage of 'blackboard substitute' and a more sophisticated, 'synergistic' stage of IWB use.

1.1 The 'board' as hub for pedagogical actions

It is common for the term IWB to be used to represent a variety of what have been described as 'whole-class interactive technologies' (Hennessy and Warwick 2010) which are channelled through the IWB. Many of the phenomena attributed to the IWB, however, concern only the large projected image, and could just as well be achieved using a computer and digital projector, together with a manual whiteboard. Other devices are often used in such environments, including wireless keyboards, tablet computers and input devices, and handheld voting systems, yet it is normal just to refer to 'the board' in discussing these environments. Furthermore, 'the board' is often used to refer the software and resources which it helps users to interact with—the Internet, the notebook/flipchart software, the games. It may even be given an authoritative role in the classroom—in one of our studies, when some students disagreed on the solution to a mathematics problem, the teacher responded 'let's see what the board says' (Kennewell et al. 2007).

This synecdochal use of the term 'board' seems to reflect a role as a hub for pedagogical actions—defined here as actions intended to bring about learning in others, both planned and spontaneous. In the classroom, there will generally be specific learning goals, devised by the teacher, and this can result in the teacher exerting complete control over the board in its role as classroom hub, leading to the

conclusion that the board can be a ‘teacher-centric’ tool (Wall et al. 2005) which encourages teachers to teach ‘from the front’ (Smith 2001). In most of the case studies of good teaching found in the literature, however, this is not the case. Indeed, if allowed by the teacher’s pedagogic beliefs, pupils develop a shared ownership of the IWB and feel more confident in making contributions than with manual whiteboards and overhead projectors. This can allow the teacher to observe and manage pupil activity from anywhere in the classroom (even the back of the class) or while working with a small group. This may be aided by the vicarious presence of the teacher (Warwick et al. 2010), which is often exhibited when pupils are working at the board, but is not seen in individual use of ICT devices (Mercer et al. 2010; Kennewell et al. 2008). The key feature which makes the board a pedagogical hub is the accumulation of resources which are ready-to-hand on the board. A typical expert user will plan lessons around a large number of multi-modal resources and load these at the start of the day or lesson—but is also able to respond spontaneously if required. These typically include a class list, lesson objectives, timing software, random name generator, matching games, quizzes, movies, sound clips, files containing what was recorded on the board in previous lessons, web browser, as well the board-specific software allowing notes and objects to be created and manipulated during the lesson and providing a large library of images.

1.2 Orchestration as the essential action in pedagogy

Orchestration, in its general sense of ‘organising, arranging, or building up for special or maximum effect’ (Collins Dictionary), has been considered by many as an essential element of successful teaching (e.g. Watts 2003) and found to be particularly valuable in characterising good teachers’ use of the IWB (Mercer et al. 2010; Twiner et al. 2010). Kennewell et al. (2008) characterise the orchestration of the features of the classroom in order to bring about learning as the manipulation of the affordances and constraints for learners’ actions when they are carrying out tasks in such a way as to optimise the potential for learning. This extends the idea of scaffolding and fading—providing support when necessary for learners to complete a planned task, and reducing it when the learner no longer requires such a high level of support.

For the teacher, then, orchestration is also an action carried out in pursuit of a goal, and it is worth exploring the affordances and constraints for this action. For the purposes of this paper, only the classroom environment will be considered. If we consider affordances as the potential for action inherent in the features of the environment, then the touch-sensitivity of the IWB affords actions such as the movement of text objects displayed on the board, so that the teacher or pupil standing at the board can label a diagram. Constraints are the conditions or limitations on action imposed by features of the environment; in the example of labelling the diagram, if the text needs to be positioned at the top of the diagram, a small pupil or teacher may not be able to reach the correct position. Constraints are not necessarily seen as obstacles, however, and may be imposed intentionally to structure activity for learning; for instance, the teacher may pre-set the software to ensure that the text cannot be positioned incorrectly in order to give feedback to pupils when they make a response.

1.3 Stages in pedagogical use of the IWB

As teachers develop their confidence (and indeed competence) in using the IWB they typically follow a sequence of transitions in technical and pedagogical expertise and gradually allow more pupil use of the IWB which can be mapped against a transition framework. Beauchamp's (2004) initial model has five stages. In the early stages of this progression the IWB is used by the teacher only as a black/whiteboard substitute using a limited range of tools. As more technical skills are mastered and greater pedagogic imagination (and/or confidence) is developed pupil use of the IWB increases leading to a synergistic use which brings together fluidly a number of pedagogical actions by teacher *and* pupils (Beauchamp 2004; Serow and Callingham 2011). Other models (Somekh and Haldane 2005; Miller and Glover 2007; Lewin et al. 2008; Jones and Vincent. 2010) provide useful indicators, but as the most detailed and well-developed framework, Beauchamp's will be used in this analysis.

It is at the later stages of this progression that the board features as a hub of activity in the classroom, and combining the transition framework with features of the IWB and other factors which have been identified as contributing to effective pedagogy helps to characterise in more detail the nature of the digital hub phenomenon. First, however, an example lesson is described in order to illustrate features characteristic of the most basic level of IWB use. This lesson, and the subsequent lesson illustrating 'synergistic' IWB use, is not presented as a model of good practice, but has been constructed from features observed in lessons taught by teachers selected in our research studies as effective practitioners.

2 Composite lesson—'blackboard substitute' use of IWB

A primary school class (pupils aged 9–10 years) was studying the Second World War. Before the lesson, the teacher had opened a blank page on the 'flipchart' software that had come with the IWB and at the start of the lesson the teacher wrote the dates and the objectives of the lesson on the IWB using the pen:

- to understand how it felt to be a child in the area during the second world war;
- to find out about the area as it was in this period and the effect of bombing on the city
- to use maps to show where these events occurred
- to plan questions to find out what people remember about the events

The teacher introduced a real scenario concerning a local landmark which had been bombed during the war. The teacher asked some pupils to give out photocopies of a letter written at the time by a child who had lived near enough to see what happened. The pupils who received the sheet first started to talk about them, and those pupils waiting for sheets also started to talk about what they might be going to do. After settling the children, the teacher asked for volunteers to read the letter aloud to the rest of the class. When they had got to the end of the letter a child told the teacher that there was a TV programme on the BBC iPlayer web site which began with some children in their house when a bomb was dropped nearby. The teacher

acknowledged this and asked the others to have a look at home that night if they could. The class then discussed the letter and how it made them feel.

The teacher gave out more photocopied sheets (which caused a small amount of further disruption) with images of the landmark before and after the bombing and other images of local landmarks that were mentioned in the letter. The teacher asked questions to check that the children recognized the landmarks. As the class discussed these pictures and the letter, the teacher used the IWB pen (on the same page as the lesson objectives) to write key words and phrases on ‘the board’ that they would need for later written work. The pupils were then given their final photocopied sheet with a map of the area affected by the bombing. The teacher had scanned an image of the map onto the second page of the ‘flipchart’ and used this to outline the task that they were going to do. The teacher marked the local landmark with a circle on the IWB and checked that all pupils had understood what they needed to do for the rest of the task. The pupils then used their own pens to annotate the paper map showing where the bombs had been dropped based on the evidence from the letter. Questions were raised by the teacher, but these were mainly task related, and the pupils generally gave short replies with little extended discussion. After this activity the teacher suggested that pupils should try to find and interview local people who had experienced the bombing. These interviews would be videoed and then used as part of a presentation later in the term. As the lesson came to an end, the teacher set the class some work to do at home that night. The pupils were asked to write down five questions they would like to ask in the interviews and to bring them in the next day. The lesson ended and the teacher collected the annotated maps which could be used as a record of the lesson, but which could also be revisited by the class at a later date if required. After the class had left the teacher saved the IWB file.

In the next lesson the teacher asked selected pupils to read out loud the questions they had written. These were discussed briefly as a whole class and then the teacher worked with groups of pupils using the pen tool on the IWB to refine their questions and write a ‘neat copy’ of them to be used later. There was some problems in doing this because the pupils wrote in very small letters which could not be read by everybody, and the teacher kept rubbing out more than was intended using the eraser tool so letters had to be re-written which sometimes made text hard to read.

2.1 Orchestration of blackboard substitute lesson activity

The teacher managed the activity during the lesson through a mixture of planned actions and dynamic responses to what pupils did. The focus was particularly on the use of historical sources, with as much as possible found by pupil enquiry rather than teacher input. In order to convey to pupils what they were expected to achieve, however, specific objectives were written up for reference. The momentum at the start of the lesson was adversely affected when material was being distributed, but authentic, interesting source material was used. It was read out loud, but the fluency of the reading and the variations in the volume of the pupils’ voices meant it was not always fluent or audible to pupils who were further away from the reader. It did, however, provide information about the war in a way that engaged pupils rather than just telling them what had happened. Pupil input concerning an alternative source of information from the Internet was acknowledged but not used despite the IWB

providing access to it. The teacher instead maintained the linear direction of the lesson plan by using prepared images as an alternative medium for information. The teacher asked planned questions and wrote up key words. Some were recorded in response to pupils' comments, others because the teacher wanted to ensure that the pupils were familiar with them for future tasks.

Pupils used information in the letter/images, combined with their own and each others' existing knowledge of the area, to represent locations on a map which was provided in order that they should develop skills in map representation and gain understanding of the extent of the damage to the city. The teacher modelled what pupils were expected to do, and then supported the task with directed questions and prompts in response to pupils' actions in order to ensure that the task was completed. The pupils' maps and the keywords on the board then formed resources for later work concerned with the next task.

In order to develop their understanding of its effect on people as well as places, a further task was introduced, in which pupils would combine the knowledge they had gained about the bombing with the first-hand knowledge of elderly people. They had to plan how to acquire this information through interviewing. Recognising that pupils' interviewing skills would be limited, the teacher planned to respond to pupils' choice of questions, by means of a discussion of what sort of questions would be good and then supporting groups of children dynamically in deciding together which ones they would use.

At this initial stage of use, only limited features of the IWB are used and it takes a passive role as an object of interaction (Beauchamp and Kennewell 2010). The talk in the classroom is generally authoritative (Mercer and Littleton 2007), with the teacher talking or determining the structure of pupil responses to questions or tasks. The interactivity with ICT, if any, is also authoritative (Beauchamp and Kennewell 2010).

The limited orchestration for learning that takes place is mainly planned in advance and is not affected by the use of the IWB—the lesson takes the same course as with a traditional board and visual aids. Table 1 shows the relationship between the features of the environment and the outcomes observed in a typical lesson.

3 Composite lesson—'synergistic' use of IWB

A primary school class (aged 9–10 years) was studying the Second World War. The teacher introduced a real scenario concerning a local landmark which had been bombed during the war. The teacher had borrowed the school set of iPads and each child had one each. The teacher had scanned an image of a letter written at the time by a child who had lived near enough to see what happened and the pupils opened this on their iPad. Before the lesson the teacher had retrieved a file from the school network and used the IWB flipchart software to display a section of the letter where the child described the bombing itself and the aftermath. In the text of the letter, the teacher had inserted hyperlinks to images of the landmark before and after the bombing and other links to images of local landmarks that were mentioned in the letter. The teacher had also inserted a link to a map of the area, placed on another page of the flipchart. To add further authenticity, the teacher had recorded another child in the school reading the extract and had linked the digital recording so that when the text was clicked in the classroom, the extract was read through the speakers attached to the IWB by a child of the same age as the writer.

Table 1 Black/whiteboard substitute stages of IWB use

	Characteristics of use	Modes, tools and media	ICT role	Interactivity	Predominant type of talk	Orchestration
Features of environment	<p>Teacher learning to write and draw on the IWB</p> <p>Board used by teacher only</p> <p>Use of IWB pen or finger tap to navigate the operating system in place of mouse</p>	<p>Writing, hand-drawn pictures/diagrams with IWB pen and native IWB software</p>	<p>A passive tool for interactions: ICT provides structure and capability to complete a teacher directed task (such as 'writing up') or teacher demonstration/modelling</p>	<p>No interactivity with ICT or authoritative interactivity with ICT</p>	<p>Authoritative</p>	<p>Linear sequence of activity, planned in advance, comprising: - initial visual stimulus - exposition with all structure and most information provided by teacher - simple practice, questioning or gap-filling task for pupils - visual list of expected learning outcomes</p>
Outcomes afforded and constrained by above features	<p>Quicker pace to lessons and more eye contact with class</p> <p>Presentation of information over questioning</p> <p>Domination/ownership of IWB by teacher (both in use and language – 'the board')</p>	<p>Passive display of teacher's ideas, initially created in front of class advancing to presenting slide presentations, texts and pre-loaded web pages</p>	<p>teacher-led demonstration (normally to whole class) or modelling of task with some limited opportunities for pupils to clarify with teacher control of ICT minimal dialogue/discussion about nature of task</p>	<p>Factual recall, following standard procedure or browsing fixed (hyper)text</p>	<p>"the teacher's purpose is to focus the pupils' full attention on just one meaning" (Scott, Mortimer and Aguiar, 2006, p610)</p>	<p>Repeat facts and techniques</p> <p>Response selected from prepared options</p> <p>Pupils have limited choice of options (reactive)</p>



When the reading was finished, one of the children told the teacher that there was a programme on the BBC iPlayer web site which began with some children in their house when a bomb was dropped nearby. The teacher minimized the flipchart file on the IWB and asked the pupil to come and use ‘our board’ to find the programme to show the rest of the class. The child used the PC and keyboard attached to the board to open a search engine to find the iPlayer site, but then moved to the board to navigate around the site and play the start of the programme. After a few minutes the child stopped the player and returned to their seat. After a brief discussion the teacher used the IWB to minimize the web site and maximize the original file. The class then discussed the letter and how it made them feel. As they did so the teacher invited pupils to come to the board and click on the links to view the images of the landmark. During this activity the teacher also used another blank page of the flipchart (using a split screen) for the pupils to write key words and phrases (using the handwriting recognition tool) they would need for later written work.

The pupils then used the IWB pens to annotate the map showing where the bombs had been dropped based on the evidence from the letter. When a pupil attempted to mark a location incorrectly, other pupils guided them with suggestions about how to work out where the mark should be placed. Throughout this work with the IWB, the teacher facilitated extended discussion about how this would have affected the area and the people that lived there. Questions were raised by both pupils and teachers, and the teacher suggested that pupils should try to interview local people who had experienced the bombing. These interviews would be videoed and then used as part of a presentation later in the term. As the lesson came to an end, the teacher set the class some work to do at home that evening. The class was asked to look at a video of an interview which another class had done last year that was available on the school web site using their class log in details. After watching the video (on home PCs, laptops or ipads) pupils were asked to log on to a password protected ‘post-it’ web site the teacher had set up and leave suggestions for better questions that they would like to ask in their own interview. (The class had been introduced to the ‘post-it’ site for giving their ideas in a recent English lesson, so there was no need to tell them how to do it.) The lesson ended and the teacher saved a version of the IWB file to be used as a record of the lesson, but which could also be revisited by the class at a later date if required. The teacher distributed the list of keywords electronically to individual pupils.

In the next lesson the teacher opened the post-it site on the IWB to see what questions the children would like to ask. These were discussed briefly, as a whole class, in order to stimulate reflection by the pupils on what would make good interview questions. The teacher then worked with different groups of pupils in turn working at the IWB to refine their individual questions through group discussion. Both the teacher and the pupils used a wireless keyboard to edit their work. Using the undo and redo tool, pupils were able to explore different versions of the questions before saving the ‘best’ version for the actual interviews.

3.1 Orchestration of synergistic lesson activity

The structure of the lesson was clearly planned in advance, and an array of multimedia resources compiled and loaded onto ‘our board’ before the lesson. Furthermore, the board was used to facilitate rapid selection of particular web locations at any stage

in the lesson—not in a linear sequence, but chosen by pupils to relate to their existing knowledge.

Pupil seatwork was based on tablet devices, with which pupils were already familiar from previous lessons in a variety of subjects. This allowed resources for pupils to be made available electronically with no loss of momentum in the lesson. Furthermore, the technology allowed the audio reading of the text to be given simultaneously with the visual display on the board, thus providing emphasis to the age of the author as well as aiding pupils with reading difficulties. This ensured that the reading was fluent (with no hesitation for unknown words) and the speakers attached to the IWB also ensured it was audible to all pupils wherever they sat in the classroom. The images could be shown at the time that the corresponding text was being read; this helped those pupils who were unfamiliar with the landmarks, although it did not give them the opportunity to find the images for themselves. The IWB afforded annotation in two ways—overlying the map with written notes, and listing key ideas alongside. This list was left on display whilst the image alongside changed, so that the ideas would accumulate during the lesson, helping to develop collective knowledge from individual contributions.

When a pupil referred to an interesting video on the Internet, the teacher immediately allowed use of this additional resource to be introduced to the lesson and asked the pupil to find it and show the class. The role of the Internet as a vast library allowed a pupil who is familiar with this technology, and how to access it on the IWB, to take over the orchestration of the environment and influence the course of the lesson. The teacher also encouraged the children to discuss what they had found out from it. This was unplanned, but the teacher often encouraged pupils to make contributions in this way and the pupils were motivated to use their home ICT resources (and ICT skills and knowledge) to explore sources of information independently. The pupils also used the IWB confidently, but, more importantly, the classroom culture both encouraged and facilitated this, allowing them an influence over the course of activity at any time.

The use of the IWB for recording locations on the map enabled each image to be discussed amongst the whole class and related geographically to other locations. When a pupil made a mistake, they could be helped to correct it by one of the other pupils without waiting for the teacher to check it, and the whole class could benefit from the discussion of the reason for the error.

For this lesson, the teacher had another resource available to help introduce the interviewing task—the video made by last year’s class taught by another teacher—which he used to set pupils the challenge of improving the questions so that they did not just copy the ones that they had seen. The other teacher had also felt that the discussion of pupils’ questions had not been very successful because pupils were unable to see all the questions suggested, and had also suggested the use of the post-it site.

At the most advanced stage, a range of software and hardware is used with confidence by both pupils and teachers so that resources are introduced and put away smoothly and the lesson flows seamlessly. Furthermore, IWB resources are continually available to teacher and pupils for reference in discussion, and others can be accessed quickly in response to ideas that emerge. The board takes an active role as a tool or partner in interaction, the interactivity is synergistic, and talk is generally contributory (Beauchamp and Kennewell 2010).

Clearly a greater range and fluency of technical skills is essential to progress to more effective use of the IWB, but the key to transition is in the idea of orchestration. The IWB and associated technology transforms the ability of the teacher and pupils to initiate actions and respond dynamically to outcomes, and to manipulate the affordances and constraints of the environment so as to generate learning. Features of the IWB such as capacity, range, emphasis, template, provisionality, simultaneity, multimodality, library, linkage, and feedback afford organising actions such as selecting, comparing, retrieving, focusing, transforming, collating, sharing, annotating, revisiting, cumulating, questioning, prompting, and referring (Kennewell and Beauchamp 2007). At this level of use, the affordances of the board do not just support basic pedagogical actions such as presenting and recording, they support the key process of orchestration for learning.

Table 2 shows a simplified view of the complex relationships between features and outcomes in the synergistic category of IWB use.

This lesson illustrates the way that an expert teacher and pupils are able to orchestrate the IWB environment in order to facilitate effective learning by the pupils. The IWB functions as a hub, not just for the flow of information between participants in the lesson (pupils saw the IWB as a means of communicating with the class), but also for the collective construction of knowledge through whole-class reflection on individual ideas.

4 Discussion

The structure of the synergistic lesson was clearly planned in advance, although the flow of activity was more dynamic than the blackboard substitute lesson. An array of multimedia resources was compiled and loaded onto ‘our board’ before the lesson, so that resources could be accessed whenever appropriate. Furthermore, the IWB was used to facilitate smooth and rapid selection of particular web locations at any stage in the lesson—not in a linear sequence, but chosen by pupils to relate to their existing knowledge. This would have been much more difficult with a keyboard/mouse operated by the teacher.

The synergistic lesson demonstrated more pupil influence than the blackboard substitute lesson, even though there was actually more whole class teaching, and less individual seatwork. We believe that this is due, at least in part, to the way in which the IWB functions as a hub, not just for the flow of information between participants in the lesson, but also for the collective construction of knowledge through whole-class reflection on individual ideas (see, for example, Mercer et al. 2010). Clearly, the blackboard substitute lesson could have been carried out with just a computer, projector and screen. Indeed, some aspects of the synergistic lesson too, could have been achieved in a non-IWB environment, particularly if a set of tablet devices were available to the class. However, some of the individual components of the lesson may be difficult to implement, and orchestration of the whole activity (certainly by pupils) would be difficult, if not impossible, without the IWB acting as a hub. This is particularly evident in the use of annotation, the pupil input, the group editing, and in the smooth flow through several phases of the lesson with no gaps or distractions.

Table 2 Synergistic stage of ICT use

	Characteristics of use	Modes, tools and media	ICT role	Interactivity	Predominant type of talk	Orchestration
<p>Features of environment</p> <p>High level of competence by pupils and teacher in using both IWB and programs</p> <p>Teachers demonstrate an intuitive interaction with technology which facilitates a fluid lesson structure</p> <p style="text-align: center;">⇩</p>	<p>Both teacher and pupils are able to construct meaning and influence the direction, momentum and scale of the next step in the lesson</p> <p>Joint ownership of board – reflecting in vocabulary ‘our board’)</p>	<p>Multimodal hub involving live and recorded video, still images, sound</p> <p>Using ‘slate’ device, collaborative software, video conferencing</p>	<p>An active tool for interaction: a medium to interact through (e.g. email/chat, annotation, mind-mapping) where learners usually provide the structure for interactions.</p>	<p>Synergistic</p>	<p>Contributory talk</p>	<p>Teacher identifies/produces resources and makes them available prior to the lesson.</p> <p>Course of lesson is planned in outline to include stimulus material, opportunities for pupils to solve problems, reflect on their learning, and create new resources.</p> <p>Teacher is able to step back and allow pupil to influence the course of the lesson.</p>
<p>Outcomes afforded and constrained by above features</p>	<p>Dynamic interplay of range of modes both planned and spontaneous by pupils and teachers. Use of ICT tools and resources in an almost seamless integration of mind and technology: exploiting both to achieve a sophisticated solution.</p>	<p>Dialogue/discussion/learning/co-construction of knowledge</p>	<p>Open problem-solving or creating product involving identification of context /material, analysis, reflection</p>	<p>Questioning and critical responses by teacher and pupils</p>	<p>Critical application of concepts and processes in a variety of situations</p> <p>Reflective response</p> <p>Structure and information contributed collectively</p> <p>Pupil ideas contribute equally</p>	

5 Implications

In many nations' school systems, IWBs have become established as the classroom norm. Unfortunately, not all teachers are sufficiently skilled orchestrators nor sufficiently practised with a wide range of ICT tools to take full advantage of the board's availability, and the synergistic example described above is not typical of observed practice. This has implications for initial teacher education, which should aim to develop new teachers' IWB skills through the development of their skills in orchestration of the features of the classroom, and not as discrete IWB skills. Similarly, teachers' professional learning, which is increasingly supported by mentoring and coaching from colleagues might also focus on developing skills in orchestration, together with some input concerning board skills which may need to be provided externally to ensure that a sufficiently range of up-to-date techniques is available. The key to progression in IWB-based pedagogy is seeing the board as an aid to orchestration rather than merely a set of tools which substitute or supplement traditional teaching resources.

References

- Beauchamp, G. (2004). Teacher use of the interactive whiteboard in primary schools: towards an effective transition framework. *Technology, Pedagogy and Education*, 13(3), 327–348.
- Beauchamp, G., & Kennewell, S. (2010). Interactivity in the classroom and its impact on learning. *Computers in Education*, 3(54), 759–766.
- Bennett, S., & Lockyer, L. (2008). A study of teachers' integration of interactive whiteboards into four Australian primary school classrooms. *Learning, Media and Technology*, 33(4), 289–300.
- Blau, I. (2011). Teachers for "Smart Classrooms": the extent of implementation of an interactive whiteboard-based professional development program on elementary teachers' instructional practices, interdisciplinary. *Journal of E-Learning and Learning Objects*, 7(26), 275–289.
- Cutrim Schmid, E. (2010). Developing competencies for using the interactive whiteboard to implement communicative language teaching in the English as a Foreign Language classroom. *Technology, Pedagogy and Education*, 10(2), 159–172.
- Freire, A., Linhalis, F., Bianchini, S.L., Fortes, R.P.M., & Pimentel, M.G.C. (2010). Revealing the whiteboard to blind students: an inclusive approach to provide mediation in synchronous e-learning activities. *Computers in Education*, 54(4), 866–876.
- Hennessy, S., & Warwick, P. (2010). Editorial: research into teaching with whole-class interactive technologies. *Technology, Pedagogy and Education*, 19(2), 127–131.
- Holmes, K. (2009). Planning to teach with digital tools: introducing the interactive whiteboard to pre-service secondary mathematics teachers. *Australasian Journal of Educational Technology*, 25(3), 351–365.
- Jang, S.J., & Tsai, M-F. (2012). Exploring the TPACK of Taiwanese elementary mathematics and science teachers with respect to use of interactive whiteboards. *Computers & Education*, 59, 327–338.
- Jewitt, C., Moss, G., & Cardini, A. (2007). Pace, interactivity and multimodality in teachers' design of texts for interactive whiteboards in the secondary school classroom. *Learning, Media and Technology*, 32(3), 303–317.
- Jones, A., & Vincent, J. (2010). Collegial mentoring for effective whole school professional development in the use of IWB technologies. *Australasian Journal of Educational Technology*, 26(4), 477–493.
- Kennewell, S., & Beauchamp, G. (2007). The features of interactive whiteboards and their influence on learning. *Learning, Media and Technology*, 32(3), 227–241.
- Kennewell, S., Tanner, H., Beauchamp, G., Parkinson, J., Jones, S., Norman, N., et al. (2007). *The use of ICT to improve learning and attainment through interactive teaching: Full Research Report ESRC End of Award Report, RES-139-25-0167-A*. Swindon: ESRC.
- Kennewell, S., Beauchamp, G., Tanner, H., & Jones, S. (2008). Analysing the use of interactive technology to implement interactive teaching. *Journal of Computer Assisted Learning*, 24(1), 61–73.
- Lavicza, Z., & Papp-Varga, Z. (2010). Integrating GeoGebra into IWB-equipped teaching environments: preliminary results. *Technology, Pedagogy and Education*, 19(2), 245–252.

- Lewin, C., Somekh, B., & Steadman, S. (2008). Embedding interactive whiteboards in teaching and learning: the process of change in pedagogic practice. *Education and Information Technologies, 13* (4), 291–303.
- López, A.S. (2010). The Digital Learning Classroom: Improving English Language Learners' academic success in mathematics and reading using interactive whiteboard technology. *Computers & Education, 54*(2010), 901–915.
- Mercer, N., & Littleton, K. (2007). *Dialogue and the development of children's thinking*. London: Routledge.
- Mercer, N., Hennessy, S., & Warwick, P. (2010). Using interactive whiteboards to orchestrate classroom dialogue. *Technology, Pedagogy and Education, 19*(2), 195–209.
- Miller, D., & Glover, D. (2007). Into the unknown: the professional development induction experience of secondary mathematics teachers using interactive whiteboard technology. *Learning, Media and Technology, 32*(3), 319–331.
- Nihat Şads, S., & Özhan, U. (2012). Honeymoon with IWbS: a qualitative insight in primary students' views on instruction with interactive whiteboard. *Computers & Education*. doi: 10.1016/j.compedu.2012.05.010.
- Serow, P., & Callingham, R. (2011). Levels of Use of interactive whiteboard technology in the primary mathematics classroom. *Technology, Pedagogy and Education, 20*(3), 161–173.
- Slay, H., Sieborger, I., & Hodgkinson-Williams, C (2008). Interactive whiteboards: Real beauty or just “lipstick”? *Computers & Education, 51*, 1321–1341.
- Smith, H. (2001). *Smartboard evaluation: final report*. Kent County Council. http://www.kenttrustweb.org.uk/kentict/kentict_iwb_smart_final.cfm. Accessed 15th August 2012.
- Somyürek, S., Atasoy, B., & Özdemir, S. (2009). Board's IQ: what makes a board smart? *Computers in Education, 53*(2), 368–374.
- Somekh, B., & Haldane, M. (2005). A typology of interactive whiteboard pedagogies. Paper presented at BERA Conference, University of Glamorgan, Wales, 15–17th September 2005.
- Tanner, H., Jones, S., Kennewell, S., Beauchamp, G., et al. (2009). An investigation of the affordances of ICT for the development of effective pedagogy in mathematics and science classrooms—the i-ped project. *Welsh Journal of Education, 14*(2), 137–143.
- Turel, Y. K. (2011). An interactive whiteboard student survey: development, validity and reliability. *Computers in Education, 57*(2011), 2441–2450.
- Türel, Y. K., & Johnson, T. E. (2012). Teachers' belief and use of interactive whiteboards for teaching and learning. *Journal of Educational Technology & Society, 15*(1), 381–394.
- Twiner, A., Coffin, C., Littleton, K., & Whitelock, D. (2010). Multimodality, orchestration and participation in the context of classroom use of the interactive whiteboard: a discussion. *Technology, Pedagogy and Education, 19*(2), 211–223.
- Wall, K., Higgins, S., & Smith, H. (2005). 'The visual helps me understand the complicated things': pupil views of teaching and learning with interactive whiteboards. *British Journal Of Educational Technology, 36*(5), 851–867.
- Warwick, P., Mercer, N., Kershner, R., & Staarman, J. (2010). In the mind and in the technology: the vicarious presence of the teacher in pupil's learning of science in collaborative group activity at the interactive whiteboard. *Computers in Education, 55*(1), 350–362.
- Watts, M. (2003). The orchestration of learning and teaching methods in science education. *Canadian Journal of Science, Mathematics, and Technology Education, 3*(4), 451–464.
- Winzenried, A., Dalgarno, B., & Tinkler, J. (2010). The interactive whiteboard: A transitional technology supporting diverse teaching practices. *Australasian Journal of Educational Technology, 26* (4), 534–552.