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Interactive whiteboards: Interactive or just whiteboards?

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Over the last decade, interactive whiteboards have become popular teaching and learning tools, especially in primary school classrooms. Research studies from recent literature report on high levels of student motivation, teacher enthusiasm and whole-school support associated with these technological tools. Much research to date has reported on the potential of interactive whiteboards (IWBs) to improve the quality of teaching and learning processes by enhancing levels of interaction, communication and collaboration. Whether these claims have been substantiated has not yet been fully investigated. This paper reports on the findings from a collaborative research project between university lecturers, school-based primary school teachers and principals, pre-service teachers and district education consultants who worked together on a small, school-based research project. The researchers involved in this project had three main purposes: (1) to investigate different ways that IWBs are used in primary schools; (2) to share ideas and expertise on the use of IWBs; and (3) to document teachers' current practice with IWBs. Field notes from professional development meetings and classroom observations were analysed using a grounded theory methodology. Findings from this research are reported in this paper and compared to other recent research. The paper concludes with recommendations for practice and future research.

Introduction

Interactive whiteboards (IWBs), also known by various brand names such as *SmartBoards* and *Webster Boards*, and as electronic whiteboards, are currently being used in varied educational settings. Their popularity in education has been noted particularly in the UK (Gillen, Staarman, Littleton, Mercer & Twiner, 2007). Although IWBs are used in some higher education settings (Hacifazlioglu, Sacli & Yengin, 2007), kindergarten through to Year 7 (K-7) school settings have been the focus of most of the research so far (Maznah, 2006). Furthermore, research about the use of IWBs in schools has focused on teacher use rather than student use (Kennewell & Higgins, 2007), with some research suggesting that teachers experience varied stages of development as they begin to use and become familiar with these tools (BECTA, 2004; Burden, 2002; Hooper & Rieber, 1995; Miller, Glover & Averis, 2005). The use of IWBs has been reported as ranging from teacher centred, or presentational, to methods which are more student centred, interactive and collaborative.

In addition to their growing popularity, there are increasing expectations that IWBs will be used in classrooms (Dwyer, 2007). The use of IWBs has been documented in a range of learning areas such as mathematics (Ball, 2003; Jewitt, Moss & Cardini, 2007), literacy (Bonk & Cunningham, 1998; Martin, 2007), science (Hennessy, Deaney,

Ruthven & Winterbottom, 2007) and writing (Martin, 2007), and with children with special needs (Keay-Bright, Norris & Owen, 2007). The manner in which teachers are provided with professional development regarding the use of IWBs is also being reported in the current literature (Jones & Vincent, 2006; Miller & Glover, 2007).

The definitions provided in the literature for these technological tools, as well as the descriptions about how they are used, offer an interesting insight into how IWBs are generally perceived. IWB technology typically combines a projector with software and computer technology to produce enlarged and interactive images, animations and text for the purposes of teaching and learning. IWB technology has been described as a computer connected to a data projector which projects images onto a touch or pen-sensitive screen (BECTA, 2004; Bell, 2002; Kennewell & Higgins, 2007; Roberts, 2007). Definitions of IWB technology typically focus on the technology itself or the teacher's ability to show, present, demonstrate and display various images, text, animations and videos to an audience.

Few definitions of IWBs focus on students or the potential of the boards to enhance interactivity and collaboration between students and teachers. When interactivity is mentioned, the term is largely associated with teachers interacting with the boards. In these cases, the locus of control usually remains with the teacher or the person holding the IWB controls (Kelley, Underwood, Potter, Hunter & Beveridge, 2007). Despite the narrow range of use indicated by these definitions and descriptions, there appears to be widespread agreement amongst researchers and educators that, ironically, it is the affordances for interactivity, communication and collaboration that make these boards attractive for use in teaching and learning contexts (Ball, 2003; Haldane, 2007; Jewitt et al., 2007; Latham, 2002). Researchers such as Warwicka, Mercera, Kershnere and Staarman (2010) have suggested that the "vicarious presence" of the teacher can be instrumental if the teacher's role is to develop a learning environment that facilitates collaboration and student learning, instead of being a controller of the board.

The use of IWBs has also been associated with the issue of two-dimensional and three-dimensional interactivity. Given the hands on nature of many tasks in K-7 settings, some reservations have been expressed about the use of virtual manipulatives in the teaching of mathematics (Swan & Marshall, 2010). These reservations stem from two issues; the first being the depiction of a 3D object on a 2D screen; and the second, the lack of a tactile experience. Teaching that makes use of the interactive whiteboard in concert with literal, hands on experience will alleviate these issues. Given that National Assessment Program – Literacy and Numeracy (NAPLAN) tests incorporate images of mathematics manipulatives, it makes sense for students to be exposed to the physical (3D), virtual (2D) and print (2D) environments; and this can be achieved partially by using IWBs.

Benefits, limitations, challenges and cautions

Benefits of using IWBs have been recognised *for* both teachers and students (BECTA, 2004) and *by* students and teachers (Smith, Higgins, Wall & Miller, 2005). Claims have also been made regarding the positive impact they have on social learning processes (Dwyer, 2007). In addition to these affordances of the technology, a full range of other benefits have been reported including: the boards' uniqueness (Haldane, 2007); their capacity as a tool for the constructivist educator (Bell, 2002); their integrative impact on the curriculum (BECTA, 2004; Jones & Vincent, 2006); their positive influence on

children's behaviour (Mildenhall, Swan, Northcote & Marshall, 2008); and, even, the expectation that "they are expected to perform miracles" (Maznah, 2006, p. 79).

While reports of the benefits of IWBs are widespread, there are also some cautionary voices. When it comes to interactive whiteboards, teachers are encouraged to look beyond their initial attraction and use them in pedagogically purposeful ways (Burden, 2002; Kennewell & Higgins, 2007):

> Teachers have to set learning in context and be guided by learning objectives in order to take advantage of the many capabilities of the IWB. They can be easily seduced or discouraged by its use while being concerned, at the same time, about providing equal opportunities and experience to all learners in the classroom. Although the IWB is being hailed as a tool where the whole class can be involved in learning, there are still questions that teachers are asking, such as, "When the IWB is being used by one child, what do the other children do?" Teachers want to know how to ensure that all learners are engaged in a lesson. This issue is related to pedagogy and the preparation of teachers to use the IWB as a tool. (Maznah, 2006, p. 79)

To date, a few challenging and controversial issues regarding the use of IWBs in classrooms have appeared in the research, often accompanied by questions about pedagogy. These issues include problems associated with the high cost of IWB technology and challenges related to the professional development of teachers. One typical observation, documented in the BECTA (2004) guide to using IWBs in secondary schools, suggests that use of the boards can encourage teachers to revert to full class teaching with fewer opportunities for multiple student responses:

> Instead of becoming more student-centred, more time was spent on whole-class lessons but fewer pauses and interruptions. Student responses were longer but less open questions were asked in maths lessons (p. 29).

Another concern about IWB use relates to the reported popularity which causes some worry when their cost is factored into the equation. Jones and Vincent (2006) note that the popularity and excitement associated with the use of IWBs has meant that significant financial input is required at the school level to purchase, install and prepare staff and students for use of the boards. Decisions to allocate serious financial resources for the purchase and installation of this technology are made without necessarily being informed by convincing research about how the boards impact learning (Smith et al., 2005).

The manner in which IWBs are used in classroom contexts has been linked to the issue of teacher and student power, authority and control (Hall & Higgins, 2005). That is, does the use of IWBs tend to encourage student centred learning or does the use of such tools continue to promote teacher centeredness? Overuse by the teacher can promote a teacher controlled learning context. Whereas some researchers see the modelling of IWBs by teachers as an opportunity for teachers to be viewed as learners by their students (Ball, 2003), others have reported that use of IWBs has resulted in teachers becoming more active and students becoming more passive (Cross & Hibbs, 2007). One of the main criticisms aimed at IWBs is that some teachers simply use them in a "supported didactic" role (Miller et al., 2005, p. 3) to promote a transmission style of teaching (Åkerlind, 2004; Maor & Taylor, 1995). The potential of the boards to promote interactive teaching and learning is often overlooked.

Levels and stages of IWB use: Pedagogical issues

The ways in which IWBs are used in schools, especially by teachers, have been categorised. Gibson (cited in, Burden, 2002, p. 5) suggests that schools go through a series of stages of technology development: infusion, integration and transformation. Burden suggests that Gibson's stages may be "a means of looking at how we might expect the use of electronic whiteboards to develop over the coming years" (p. 7). The initial *infusion* stage is often characterised by a growing enthusiasm about these new tools alongside a purchasing pattern that is not always reliably informed. The *integration* stage usually sees teachers exploring the IWB as a learning tool, not just as a piece of isolated hardware. During this stage, there is often a more strategic consideration of how IWBs can be used within the school and alongside other types of interactive communication technologies (ICTs). Students are often encouraged to become more involved in this stage. During the final *transformation* stage, which is also reported so far to be the rarest of stages, the role and potential of IWBs are considered in more critical terms. Activities in which IWBs are used tend to be more focused on knowledge construction rather than knowledge memorisation, and the tool is used to promote student interaction rather than being used primarily as a presentation tool. At this stage, the IWB is typically used by teachers and/or students to create resources rather than just showing, using or observing ready made resources.

Gibson's stages are particularly useful when observing and documenting whole school use of IWBs. As the school and the school's stakeholders move from the initial *infusion* stage to the *transformational* stage, the teaching and learning processes associated with IWB use typically shift from being teacher centred to student centred. The learning promoted by such use tends to become more constructivist than objectivist (Herrington & Standen, 2000), and teachers make more purposeful, critically informed and discriminatory use of the tools in association with how learning outcomes are addressed. As schools move towards the *transformational* stage of IWB use, interactivity associated with their use and meaningful integration with other learning tools also increase.

While Gibson's framework is a useful lens through which to view whole school use and adoption of IWBs, Hooper and Rieber's (1995) work is suggested (BECTA, 2004) as a functional method to analyse how individual teachers adopt IWBs. Hooper and Rieber suggest there are five different non-hierarchial levels of technology adoption that teachers experience: (1) familiarisation; (2) utilisation; (3) integration; (4) reorientation; and (5) evolution. At the *familiarisation* level, the teacher characteristically begins to observe and appreciate IWBs, and tends to use them for demonstration purposes. At the *utilisation* level, the teacher is likely to use the IWB in place of previously used teaching strategies and resources. Some affordances of the technology are recognised and used, but access problems can often dampen teacher interest in the tool at this level of use. The *integration* level, just as in Gibson's *integration* stage applied to school use, sees the teacher incorporating IWBs into practice with greater regularity and efficiency. At the *reorientation* level, teachers learn about the tool alongside their students. Teachers tend to be excited about the opportunities that the tool offers to their students' learning and their own teaching. At the *evolution* level, teachers view the IWB as an adaptive tool and use it to respond to their students' needs, while remaining open to new ideas on their use.

Gibson's stages of technology development (cited in, Burden, 2002, p. 5) and Hooper and Rieber's (1995) levels of adoption of technology in the classroom offer two

different methods that can be used to interpret practical issues associated with IWB use. Instead of focusing only on technological issues, Gibson's *stages* and Hooper and Rieber's *levels* address the quality of teaching and learning promoted by such tools. These pedagogical issues are reflected in themes that have emerged from research into IWB use.

Bonk and Cunningham (1998) remind us that the enthusiasm for these new teaching and learning tools needs to be accompanied by assurances that they have a positive impact on classroom learning, especially higher order learning. Recently, researchers have begun to focus on the potential of IWBs tools to foster collaborative learning environments (Gillen et al., 2007) and their ability to enable greater learner participation (Hennessy et al., 2007).

Since the use of IWBs is still in the early stages for many classroom teachers and researchers, whether or not IWBs are actually being used as *interactive* resources is a question that has not yet been fully substantiated by past research. Both possibilities have been reported to date in the literature. Although Gillen et al. (2007, p. 243) suggest that IWBs "seem to be the first type of educational technology particularly suited for whole-class interaction," they also note that such a claim is usually made by manufacturers. Other researchers have reported IWBs being used in very student centred and interactive ways (Ball, 2003). Although the ideal and the enacted uses of such tools may not yet be closely aligned, the success of these tools, like many other ICT tools, is probably more closely correlated with teachers' pedagogical knowledge than the quality or nature of the actual tools themselves.

In consideration of the previously mentioned research about IWBs and other ICTs, the study described in this paper was designed to investigate how interactive whiteboards were being used in early years and primary classrooms (K-7). While the literature suggests that interactive whiteboards are educational tools that increase levels of interaction, communication, collaboration and engagement in learning and teaching situations, this study attempted to provide evidence to support or reject such claims.

Methodology

The study was a collaborative research project involving university lecturers, school-based primary school teachers and principals, pre-service teachers and education district consultants in the northern metropolitan area of Perth, Western Australia. A user group was formed to: explore and share ideas about how interactive whiteboards were being used; consider the potential of these tools; share research that had been conducted; and document these research processes for future use. The members of the user group were all volunteers and freely contributed their time and resources to the project. They were not rewarded in any extrinsic way.

The study was primarily concerned with how IWBs were used in ways that impacted on students' learning. Three specific research questions guided the implementation of the study:

1. What are the teachers' perceptions of this technology in terms of learning effectiveness, motivation, student engagement, interaction and collaboration?

2. How are interactive whiteboards used in early years and primary (K-7) classrooms?

3. Are interactive whiteboards used to enhance interactive and collaborative learning processes or for demonstration purposes?

The study adopted a grounded theory methodology, in much the same way as the study conducted by Hennessy et al. (2007) used case studies, observational records and interviews with practising teachers to gather data about the use of IWBs. Since the experiences of the participants were the focus of the data gathering stage of the study, the grounded theory design employed in this study was characterised by the following processes (Creswell, 2002):

- The strategies associated with IWB use in K-7 classrooms were studied from field notes recorded during regular discussions with all researchers and classroom visits over a six month period.
- Constant comparison of raw data from research meeting and classroom visit field notes was carried out to establish categories of focus.
- Comparison of emerging data trends from research field notes with other emerging theory from literature on the use of IWBs in primary school classrooms.
- A set of findings were generated that emerged from the data trends and were organised into core categories and recommendations for practice.

Research participants

Interest in the use and questions about the value of IWBs initiated informal discussions between university lecturers, their students (who were pre-service teachers) and practising teachers and principals in local schools. From these discussions, the research project was developed. Participants for the project were invited from the student cohort of one teacher education course, various local primary schools and a nearby District Education Office. The participants and the researchers worked together as fellow researchers, investigating the research questions throughout the semester period.

Because the data gathering technique employed in this research study was dependent on a manageable group discussion, the ideal number of participants for the study was considered to be approximately 15-25 (cf. Creswell, 2002), including representation from the five main interest groups: teachers, principals, pre-service teachers, district office consultants and university lecturers. To ensure that all participants were members of one of these five groups, the snowballing sampling technique (Ary, Chester Jacobs & Razavieh, 2002) was employed where initial participants suggested names of other possible participants. This participant selection method was suitable for gathering participants from different sites and also ensured the study's participants were all familiar with the use of interactive whiteboards. However, this sampling method meant that participants who volunteered for the study may have been more enthusiastic about the use of interactive whiteboards than the general teaching population.

In all, the research group was made up of 25 participants. Together, the group investigated the use of interactive whiteboards in K-7 classrooms.

Data gathering techniques

Data were gathered in this study to determine how teachers viewed IWBs, how they were being used in classrooms and whether they were being used to facilitate interactive, collaborative learning. Two main methods of data gathering were used: 1) observational notes from IWB use in K-7 classrooms; and 2) research field notes from regular meetings including the research participants. The data were gathered by all participants who formed the collaborative research group.

The group met on a monthly basis for six months and attendance at the meetings ranged from six to twenty members. The meetings provided opportunities for IWB demonstrations, discussions of how IWBs could and should be used in classrooms, documentation of classroom IWB activities and sharing of research reports on the topic. The meetings were held in various locations including university campuses, local Department of Education District Offices and local primary schools. In most cases, an IWB was available for use and demonstration purposes. During the monthly meetings, field notes from observations of IWB use in classrooms were shared. The meetings and classroom observations were guided by the following discussion questions which were posed to the participants over a six month period:

- How have you previously used interactive whiteboards in your classroom?
- How do you use IWBs in the classroom?
- How have you seen IWBs used in the classroom?
- What were the children doing during these IWB lessons/ sessions?
- What was the impact of using IWBs on children with diverse needs (e.g., children with special needs, gifted and talented, ESL, etc.)?
- How do you think IWBs are best used for teaching purposes?
- How do you think IWBs are best used for learning purposes?
- What are the benefits to children's learning?
- What are some examples of how IWBs are used in classrooms?

In addition to these monthly user-group meetings, classroom visits were undertaken by the researchers in order to observe how the IWBs were being used to teach children of various ages ranging from Pre-Primary through to Year 7. During one visit to a school that had been using the IWB for three years, a Pre-Primary teacher, who was very comfortable using this technology, was observed. The teacher introduced the lesson to the whole class. Using a picture created on the IWB (see Figure 1), students volunteered to approach the board, naming one of the shapes that was presented on the IWB. The student was then asked by the teacher to add a new shape on the right hand side of the board, so that the students could create a picture that matched the original picture exactly. The students then created their own shape pictures using attribute blocks that were in front of them. At the end of the lesson the teacher encouraged the different children to share the names of shapes that were used in their pictures with the rest of the class. Most of the children in the class used the IWB during this session.

In another classroom visit to Year 1 students, the teacher worked with a group of ten children sitting closely in front of the IWB which depicted a fairground scene. The teacher explained to the students that she wanted to create two different pictures with the same items but they needed to be in different positions. It was the children's task to explain to the teacher where these items should be placed. This pedagogical approach was empowering for the students as it put the students in charge of the lesson rather

than the lesson being teacher directed. The students were given immediate feedback about their use of locational language and the teacher recorded the locational language on the IWB as the lesson progressed (see Figure 2).

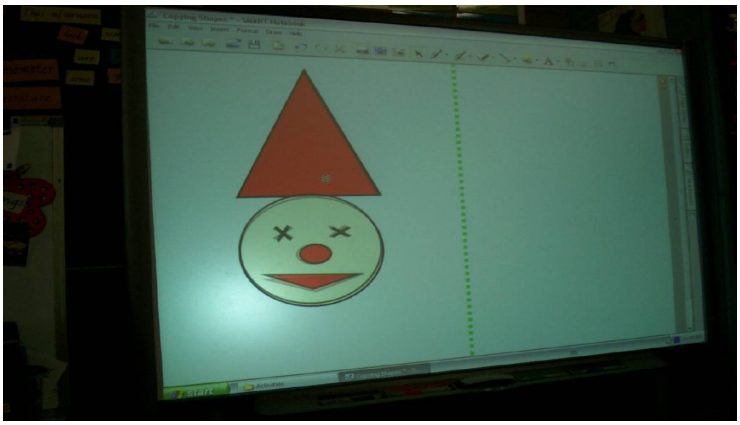

Figure 1: Using an IWB to represent shapes that can be manipulated

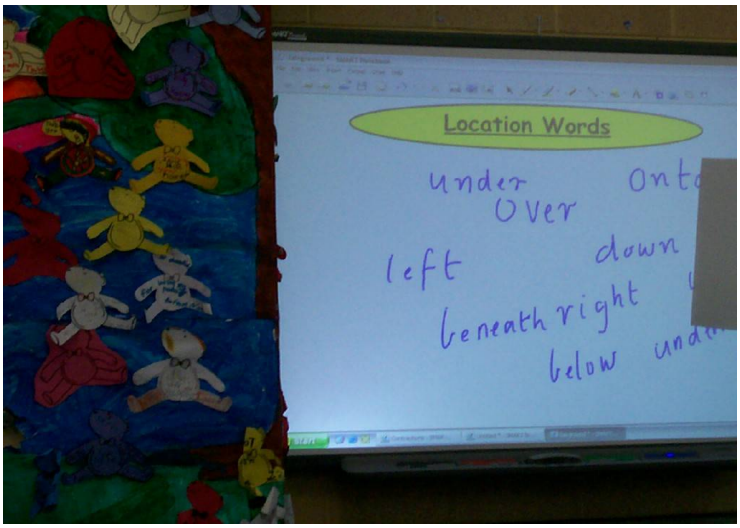

Figure 2: Developing locational language using the IWB's ability to move objects

Data analysis techniques

Records of the researchers' field notes, from classroom observations and monthly professional development meetings, were gathered and categorised according to an open coding method of analysis, adopting the techniques described by Strauss and Corbin (1998). The main purpose of this data analysis technique was to reveal underlying patterns and trends in the data in conjunction with the study's main research questions. During this process of coding, a set of themes were revealed and these were used to classify the research participants' perceptions about IWBs and their experiences of how IWBs have been used. To validate the coding system adopted, two of the researchers completed this process to ensure saturation had occurred. The field

notes from the two data gathering techniques also indicated a set of recommendations for future use.

Findings

An analysis and coding of the comments offered by each of the participants in the study revealed four major themes that were specifically focused on the use of IWBs. A further three themes emerged from the data that provided recommendations for future use (see Recommendations section below). The participants' comments were coded as being focused on:

1. student learning associated with IWBs;
2. teacher use of IWBs;
3. specific contexts that were particularly suited to IWB use; and
4. resource use associated with IWBs.

Theme 1: Student learning associated with IWBs

Of all of the participants' comments recorded in the field notes from classroom observations and professional development meetings, 39% were coded as being related to how IWBs influenced student learning. These codes were classified into associated groups and this organisation revealed categories which contributed to the overall theme of student learning: active learning, knowledge construction and concept development, reviewing and reinforcement of learning, and positive influence on students' attitudes to learning, especially in relation to motivation and interest (see Table 1 which also includes samples of quotes from the raw data).

Table 1: Participants' comments about how IWBs facilitate student learning

Codes	Category	Samples of quotes
Collaboration, discussion, sharing ideas, engagement, games, interaction, participation, problem solving, group work, student movement and creation of objects	Active learning	"The children are keen to participate when they are called upon, and even if they are not." "Children are more engaged in lessons and willing to participate." "My students used it to project the activity that children were working on and made it interactive so the children would use it to check their work."
Advancement of learning, achieving learning outcomes, support content learning, high level learning, conceptual understanding	Knowledge, concept understanding	"Both the Maths and English learning outcomes will benefit greatly with the ability to match sounds/ blends, number partitions." "I would like to see higher end learning being promoted not just bells and whistles." "They talk a lot more (sharing) and you can see students' understanding of concepts."
Lesson revision, requesting clarification, reinforcement of concepts	Review and reinforcement	"Lessons can be recorded and revisited by students who miss the lesson or need to have the content reinforced." "Reinforcement of specific skills (maths, viewing etc.)." "As a way of revising what was covered in the lesson." "Reinforcement of classroom activities."
Enjoyment, excitement, interest, motivation, risk taking, focus and concentration	Student attitude to learning	"I believe the IWB is a very powerful teaching and learning tool that engages students in their learning, and caters for diverse learning styles." "I have heard of the many positives associated with IWB and am sure my Pre-Primary/ Year 1s will be excited to have one in the room."

Theme 2: Teacher use of IWBs

Of all of the participants' comments recorded in the field notes from classroom observations and professional development meetings, 32% were coded as being related to how teachers used IWBs. These codes were classified into associated groups and this organisation revealed categories which contributed to the overall theme of teacher use of IWBs: presentation, communication, teacher organisation, teacher as a learner and teacher attitude (see Table 2 which also includes samples of quotes from the raw data).

Table 2: Participants' comments about teacher use of IWBs

Codes	Category	Samples of quotes
Display, modelling, exhibition of work, demonstrations	Presentation	"I have used it to exhibit students' work for parent nights." "I have recently used the whiteboard in Maths for chance and data activities (spinners, dice, etc.), science to show the flow of blood through the heart and lungs)."
Giving instructions, daily messages	Communication	"List of classroom rules for using the IWB." "Write a daily message on it (with clipart)." "Explicit instruction."
Regularity of use, assessment, sharing resources, saving files	Teacher organisation	"Teachers are better organised and better at sharing resources." "IWBs are timesaving." "They help you save your work."
Learning to use the IWB, professional development needs, learning from colleagues	Teacher as learner	"By hands on experience and by listening and sharing with others at school who have had PD, I am continually discovering new things to use this resource for." "I would like to upskill myself in this area of teaching, learning and assessment and, at the same time, ensure higher levels of learning are reached, not just low end use of technology."
Expectation, enthusiasm, enjoyment	Teacher attitude	"Really enjoyed seeing the potential of them – to see how they could become part of the teacher's classroom practice." "In my use of this resource I first began using it as a normal whiteboard. As time goes on I find myself learning more about this fantastic learning tool." "I am very excited about the idea of using this tool in the classroom."

Theme 3: Specific learning contexts that were particularly suited to IWB use

Of all of the participants' comments recorded in the field notes from classroom observations and professional development meetings, 16% were coded as reflecting the participants' ideas about how specific learning contexts were particularly suited to IWB use. These codes were classified into associated groups and this organisation revealed categories which contributed to the overall theme of how specific learning contexts were suited to IWB use: diversity and learning areas and varied teaching contexts (see Table 3 which also includes samples of quotes from the raw data).

Table 3: Participants' comments about specific contexts that were suited to IWB use

Codes	Category	Samples of quotes
Diverse learners, students with English as an additional language, cater for diversity, cater for varied learning styles, Indigenous student, special needs, children with learning difficulties	Diversity	"They … cater for visual learners, tactile learners and so on." "Engagement of students (low literacy) in using activities." "ESL (English as a Second Language) collaboration, joint construction of text software so that children can hear language." "To cater for special needs children."
Writing, reading, speaking, mathematics, integration with ICT, integration with other learning areas	Learning areas	"The ability to visit a website on the big screen is great for science and S&E (Society and Environment) etc." "I use them as a starter activity in Maths, English, T&E (Technology and Enterprise), Science and the potential is endless."
Pre-Primary, Years 1-7, Team teaching	Varied teaching contexts	"I have used it with young Pre-Primary students and more recently with Year 6/7s."

Theme 4: Resources use associated with IWBs

Of all of the participants' comments recorded in the field notes from classroom observations and professional development meetings, 12% were coded as reflecting the participants' ideas about various resources used with IWBs. During visits to classrooms it was particularly noticed that teachers used software to create their own learning tasks. For example, one teacher used visual images to create story boards. These codes were classified into associated groups and this organisation revealed categories which contributed to the overall theme of how various resources could be used with IWBs: internet and software use (see Table 4 which also includes samples of quotes from the raw data).

Table 4: Participants' comments about resources used with IWBs

Codes	Category	Samples of quotes
Internet research, accessing interactive Internet sites, *GoogleEarth, RainForest* maths, *Wishball, Learning Federation* resources, webquests	Internet	"There are many sites that are interactive and students can work with these either at the board or using the wireless keyboard." "Use of Internet for research." "I use *SmartBoard* software and online resources for counting."
Multimedia, *PowerPoint, Word, Click5, Notebook*	Software	"Year 2/3 class have done a webquest on the solar system. They used the Internet to research, *Word* to write their report and *PPT* to present their report." "We have the *Easiteach* and *Mult-e-maths* programs installed to use with it."

Discussion

There were some clear similarities and differences when the findings from this study were compared with findings from past and current research on the use of IWBs. In terms of the practical issues related to the use of IWBs, the participants in this study referred to a number of concerns associated with using IWBs in classroom situations that have been previously reported (BECTA, 2004) such as ease of use, reliability, visibility and positioning. The participants in this study were very enthusiastic about the use of IWBs, especially if this enthusiasm was also demonstrated by their students.

This theme has already been reported in the literature (Burden, 2002; Maznah, 2006; Mildenhall et al., 2008) and appears to be largely associated with claims of higher student engagement, excitement about technology and enthusiasm for being involved.

There were some distinct differences when the findings of this study were compared to the research reported thus far in the literature on IWB use. Although much of the literature presented to date outlines a concern that IWBs tend to be over-used as presentation tools, the teachers who participated in this study did not appear to be using them in this limited manner. Although a significant proportion of their comments were focused on teachers' use of IWBs, the purposes for using the boards in these cases ranged from communication through to teacher organisation and resource manipulation. According to the participants, if the boards were used for demonstration or presentation purposes, these instances were often followed by student centred learning activities that involved increased levels of interaction. Also, apart from one participant who reported IWBs save time in the classroom, the other participants did not mention any benefit related to lesson pace or time efficiency associated with the use of IWBs. This is contrary to the literature to date which specifically cites a reported advantage of using IWBs as time saving devices that frequently improve the pace of lessons by ensuring time is not wasted on setting up or locating resources (Ball, 2003; BECTA, 2004; Miller & Glover, 2007).

The use of IWBs for review and revision purposes was revealed in the data gathered throughout this study but this has not appeared as a strong theme in the literature to date. Although some researchers (e.g., Ball, 2003) have mentioned the use of IWBs for these purposes as an incidental issue, no research to date has been located that has investigated IWBs being used primarily for revision and review. Teachers who participated in our study spoke of "saving their work" and explained that "lessons can be recorded and revisited by students". This process would be helpful both for children who were present as well as children who may have been absent during the initial teaching session. Their comments reflected a use of IWBs for reinforcement purposes: "reinforcement of specific skills", "reinforcement of classroom activities" and "practising basic skills".

Similar to the findings reported in Burden's (2002) paper about how research and school-based practice can inform the use of IWBs, the comments offered by the participants in this study about the use of IWBs appeared to focus on the *potential* use of these tools rather than their *actual* use. These comments about the actual and potential uses of IWBs may just reflect the participants' ideal and working beliefs, or espoused and enacted beliefs (Leonard & Leonard, 2001; Raymond, 1997), rather than indicating any problems in the way they are being used. On the other hand, this focus on the potential of IWBs may just indicate that the participants in the study were operating at an early level of adoption (BECTA, 2004; Burden, 2002; Hooper & Rieber, 1995).

Recommendations

Three major recommendations for future practice were also noted amongst the four themes, documented in the Findings section above. Some of these recommendations are unique to this study whereas others reinforce similar suggestions reported in the literature to date. These recommendations are offered to practitioners who use or intend to use IWBs in their teaching and learning practices.

Recommendation 1: IWBs can be used in teacher and student driven ways

Participants in the study frequently mentioned how IWBs were used by students and by teachers. In this study, many of the participants' comments were focused on student use although much of the current literature laments how IWBs are often used in a teacher-centric manner.

When the findings from this study are considered in conjunction with the available literature on IWB use, there appears to be a common understanding that IWBs are most useful when learners' needs are considered above and beyond the content being taught or the technology being used. It appears that these tools can become truly learner-centred tools when their use is extended beyond teacher-controlled demonstrations. Gillen et al. (2007) further recommend that a focus on the technology should be replaced by a focus on teachers' and students' needs:

> … there is a danger that the introduction of this expensive, potentially valuable piece of equipment is 'technology-led' (i.e. it is introduced because it is available) rather than 'education-led' (i.e. it is introduced because it is known to meet the professional needs of teachers and the educational needs of children better than existing educational tools). (Gillen et al., 2007, p. 244)

Recommendation 2: IWBs can be used to initiate various types of interaction

Instead of just interacting with the IWB software and resources, more effective use of the board has been reported when interaction is expanded beyond the board to include students, teachers, and other concrete and text-based resources. As Jewitt et al. (2007) suggest, teachers define interactivity in different ways – as technical, physical and conceptual interactivity. Mildenhall et al. (2008, p. 12) describe this as three-way interaction between teacher, student and learning material: "This three-way interaction of teacher, pupil and learning material appears central to the IWB's potential contribution". In these ways, the IWB may be used to enhance all three types of interactivity, as indicated by the study's participants.

Many of the participants mentioned the potential of these classroom tools to engage students in their own learning and to act as catalysts to interaction with other students and with other resources:

> I believe the IWB is a very powerful teaching and learning tool that engages students in their learning.
>
> They talk a lot more (sharing) and you can see students' understanding of concepts.

Although much of the literature to date does report on how IWBs can foster interaction and collaboration, this study's participants reported on IWBs being used in ways that reflect a more diverse understanding of interaction associated with IWB use. Many of the teachers in the study were observed facilitating learning activities where groups of children were involved using the IWBs to solve a problem, to gather information or to interact with a range of resources. The study's participants acknowledged that the interactivity associated with IWB use can also be viewed in terms of how they can enable student interaction with multiple resources in the same lesson or learning activity.

Recommendation 3: IWBs can encourage student contribution and involvement

As well as providing a platform for demonstration and presentation purposes, one of the great affordances of IWB technology is its capacity to provide a tool that enables regular student involvement. Throughout many of the participants' comments, as illustrated in the four major themes of the study, the theme of active learning was evident:

> Children are more engaged in lessons and willing to participate.

In association with such comments was the acknowledgment of how learning activities can be particularly transformational and valuable when students are provided with opportunities to create, construct and be involved in contributing to their learning environment:

> My students used it to project the activity that children were working on and made it interactive so the children would use it to check their work.

The participants in this study reported on how opportunities could be provided for students to contribute to activities such as resource development, active knowledge construction and reporting of their own learning. When teachers utilise this technology to facilitate such student centred activities, the type of learning these students experience is more likely to be challenging, responsive and participatory. Instead of solely relying on the teacher for examples, students in the class may contribute their own examples or recall examples presented by their peers.

Conclusion

This study was led by the question, are "interactive" whiteboards interactive or not?

Despite findings reported in the literature to date about the teacher centredness of IWB use, participants in this study did not just focus on how IWBs were used by teachers. Instead, much of the data gathered during this study indicated how the research participants valued IWBs as student centred tools. Although not mentioned as a major theme in previous studies, findings from this study revealed that IWBs could be used for revision, review and reinforcement purposes.

The research suggests that the use of IWBs has the *potential* for enhancing interactivity in learning contexts, especially considering their motivational impact on students and their capacity to involve students in using and viewing a range of media. Participants in this study certainly provided a range of examples of how students use IWBs in conjunction with other resources and how they provided motivation, especially in the early stages of learning a new concept. Interactivity was described in terms of connecting with other students, resources and ideas.

Whether or not this interactivity can be realised in terms of technical, physical and conceptual interactivity (Jewitt et al., 2007) on a wider scale remains to be seen. Furthermore, whether or not the motivational impact on student learning is short or long term is, as yet, unclear. Participants in this study indicated some scepticism about this claim.

Much of the recent literature suggests that the true value of these tools can be realised when the IWB itself is considered in terms of relevant learning goals and outcomes.

This conclusion is also borne out by the findings reported in this paper. Teachers are keen to use IWBs if they enhance intended learning outcomes and if they are able to enhance the quality of their students' learning experiences. The data from this study and previous studies suggest that an initial analysis of the learning outcome itself with a subsequent consideration of how and if the IWB would be useful to achieve the outcome, is the most productive approach to using this technology. In this way, IWBs would support, rather than dominate, teaching and learning in ways that provide opportunities for both individualised and collaborative learning experiences for students:

> I have learnt that the successful use of the IWB is not about technology but about embedding technology within the curriculum to create personalised learning experiences for each pupil and transform the classroom into a collaborative learning environment. (Maznah, 2006, p. 83)

This paper has reported on some of the potential uses and some of the actual uses of IWBs in early years and primary classrooms (K-7). Examples of practical use range from "stand and deliver" type teaching through to using the boards as a way to actively involve students in their own learning and to motivate them to think, understand and create for themselves. This and other research into the use of IWBs for learning purposes suggests that, to be effective and meaningful, IWBs should be considered as a tool to support the achievement of learning outcomes for students rather than just a tool for motivation and presentation purposes. Their *potential* may yet to be realised.

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References

Åkerlind, G. S. (2004). A new dimension to understanding university teaching. *Teaching in Higher Education,* 3(9), 363-375.

Ary, D., Chester Jacobs, L. & Razavieh, A. (2002). *Introduction to research in education* (6th ed.). Belmont, California: Wadsworth/ Thomson Learning.

Ball, B. (2003). Teaching and learning mathematics with an interactive whiteboard. *Micromath,* 19(1), 4-6. [verified 12 Jun 2010] http://www.atm.org.uk/journal/micromath/mm191ball.pdf

BECTA (2004). *Getting the most from your interactive whiteboard: A guide for secondary schools*. Coventry, UK: British Educational Communications and Technology Agency. [verified 12 Jun 2010] http://foi.becta.org.uk/display.cfm?resID=35754

Bell, M. A. (2002). Why use an interactive whiteboard? A baker's dozen reasons! *Teachers.Net Gazette*, 3(1). [verified 12 Jun 2010] http://teachers.net/gazette/JAN02/mabell.html

Bonk, C. J. & Cunningham, D. J. (1998). Searching for learner-centered, constructivist, and sociocultural components of collaborative educational learning tools. In C. J. Bonk & K. S. Kim (Eds.), *Electronic collaborators: Learner-centered technologies for literacy, apprenticeship, and discourse* (pp. 25-50). New Jersey: Erlbaum.

Burden, K. (2002). Learning from the bottom up – the contribution of school based practice and research in the effective use of interactive whiteboards for the FE/HE sector. Paper presented at the Making an Impact Regionally Conference, The Earth Centre, Doncaster, June.

Creswell, J. (2002). *Educational research: Planning, conducting and evaluating quantitative and qualitative research*. New Jersey: Pearson Education.

Cross, K. & Hibbs, J. (2007). Mathematics lessons without. [viewed 25 April 2008] http://www.highbeam.com/doc/1P3-1093568241.html

Dwyer, J. (2007). Computer-based learning in a primary school: Differences between the early and later years of primary schooling. *Asia-Pacific Journal of Teacher Education,* 35(1), 89-103.

Gillen, J., Staarman, J. K., Littleton, K., Mercer, N. & Twiner, A. (2007). A 'learning revolution'? Investigating pedagogic practice around interactive whiteboards in British primary classrooms. *Learning, Media and Technology,* 32(3), 243-256.

Hacifazlioglu, O., Sacli, O. A. & Yengin, I. (2007). Lecturers' attitudes towards the use of technology: Alternative strategies for faculty administrators. Paper presented at the 7th International Educational Technology Conference, North Cyprus. [verified 12 Jun 2010] http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/3c/ff/0d.pdf

Haldane, M. (2007). Interactivity and the digital whiteboard: Weaving the fabric of learning. *Learning, Media and Technology,* 32(3), 257-270.

Hall, I. & Higgins, S. (2005). Primary school students' perceptions of interactive whiteboards. *Journal of Computer Assisted Learning,* 21, 102-117.

Hennessy, S., Deaney, R., Ruthven, K. & Winterbottom, M. (2007). Pedagogical strategies for using the interactive whiteboard to foster learner participation in school science. *Learning, Media and Technology*, 32(3), 283-301.

Herrington, J. & Standen, P. (2000). Moving from an instructivist to a constructivist multimedia learning environment. *Journal of Educational Multimedia and Hypermedia*, 9(3), 195-205.

Hooper, S. & Rieber, L. (1995). Teaching with technology. In A. Ornstein (Ed.), *Teaching: Theory into practice* (pp. 154-170). Boston, MA: Allyn and Bacon.

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. (2006). Introducing interactive whiteboards into school practice: One school's model of teachers mentoring colleagues. In *Australian Association for Research in Education Conference*, Adelaide. http://www.aare.edu.au/06pap/jon06333.pdf

Keay-Bright, W., Norris, B. & Owen, A. (2007). *Interactive whiteboards as therapy to help autistic children*. Cardiff: University of Wales Institute.

Kelley, P., Underwood, G., Potter, F., Hunter, J. & Beveridge, S. (2007). Viewpoints: Interactive whiteboards: Phenomenon or fad? *Learning, Media and Technology,* 32(3), 333-347.

Kennewell, S., & Higgins, S. (2007). Introduction: Special edition on interactive whiteboards. *Learning, Media and Technology,* 32(3), 207-212.

Latham, P. (2002). *Teaching and learning primary mathematics: The impact of interactive whiteboards*. London: Beam Education.

Leonard, P. & Leonard, L. (2001). Assessing aspects of professional collaboration in schools: Beliefs versus practices. *The Alberta Journal of Educational Research,* 47(1), 4-23.

Maor, D. & Taylor, P. C. (1995). Teacher epistemology and scientific inquiry in computerised classroom environments. *Journal of Research in Science Teaching,* 32(8), 839-854.

Martin, S. (2007). Interactive whiteboards and talking books: A new approach to teaching children to write? *Literacy,* 41(1), 26-34.

Maznah, R. M. R. (2006). Deployment of ICT: A case for the interactive whiteboard. *Malaysian Online Journal of Instructional Technology,* 3(1), 78-84. [verified 12 Jun 2010] http://pppjj.usm.my/mojit/articles/pdf/0406/09-Raja-Maznah_UM-final.pdf

Mildenhall, P., Swan, P., Northcote, M. & Marshall, L. (2008). Virtual manipulatives on the interactive white board: A preliminary investigation. *Australian Primary Mathematics Classroom,* 13(1), 9-14. [verified 12 Jun 2010] http://www.eric.ed.gov:80/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/3d/af/ff.pdf

Miller, D. J. & 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.

Miller, D. J., Glover, D. & Averis, D. (2005). *Developing pedagogic skills for the use of the interactive whiteboard in mathematics*. Glamorgan: British Educational Research Association. [verified 12 Jun 2010] http://www.keele.ac.uk/media/keeleuniversity/fachumsocsci/sclpppp/education/interactivewhiteboard/BERA%20Paper%20Sep%202005.pdf

Raymond, A. M. (1997). Inconsistency between a beginning elementary school teacher's mathematical beliefs and teaching practice. *Journal of Research in Mathematics Education,* 28, 550-576.

Roberts, P. (2007). Using interactive whiteboards to improve student ICT skills. [viewed 4 May 2008, verified 12 Jun 2010] https://www.det.nsw.edu.au/media/downloads/detawscholar/scholarships/yr07report/part2/pr.doc

Smith, H. J., Higgins, S., Wall, K., & Miller, J. (2005). Interactive whiteboards: Boon or bandwagon? A critical review of the literature. *Journal of Computer Assisted Learning,* 21(2), 91-101.

Strauss, A. L. & Corbin, J. M. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Thousand Oaks, California: Sage Publications.

Swan, P. & Marshall, L. (2010). Revisiting mathematics manipulative materials. *Australian Primary Mathematics Classroom,* 15(2), 11-17.

Warwicka, P., Mercera, N., Kershnera, R. & Staarman, J. K. (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 & Education*, 55(1), August 2010, 350-362.

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