Student perceptions of the influence of IWBs on their learning in mathematics

Abstract

This study investigates primary school students' perceptions of interactive whiteboard technology and its influence on their learning during mathematics instruction. Using Bubble Dialogue templates, group interviews and lesson observations to gather data on student views and the classroom context, a theme-based description of student perceptions was developed. Student reactions were predominately positive and mostly related to the ways in which the multimedia affordances supported their learning. However, the majority of their comments related to engagement factors rather than deep learning and understanding, and the lesson observations revealed teacher-centred approaches, with limited strategies to promote student interaction and higher-order thinking. The findings highlight the need for supporting the professional learning of teachers even though they may have been using an IWB for several years, and particularly in relation to the increased emphasis on using technologies in the new Australian mathematics curriculum.

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INTRODUCTION

It has now been a few years since the New South Wales (NSW) Government launched the Connected Classrooms Program, the largest single investment in public education (Hunter & Beveridge, 2008), encompassing the Interactive Classrooms Project (ICP). This project involved an investment of $158 million over four years to increase ICT usage in schools across NSW to improve teaching and learning (NSW DET, 2010). From that investment, $66 million was dedicated to the ICP, which was designed to equip every NSW public school with an interactive classroom. Over 2200 interactive classrooms, which include an IWB, video conferencing kit and data collaboration software, were planned for establishment by 2011 (Hunter & Beveridge, 2008).

Mathematics instruction is a critical component of primary school education, encompassing up to 20% of the school week, approximately four hours per week (NSW BOS, 2007). While Australia performs significantly higher than average on international numeracy assessments, overall performance is below the world's best and distribution of scores is much wider than most other countries (COAG, 2008). There is evidence that supports the use of ICT in mathematics instruction to improve student motivation and attainment (COAG, 2008). An underlying assumption of the new Australian Mathematics Curriculum, released in 2011, is that digital technologies can be used to "enhance the relevance of the content and processes for learning" (Commonwealth of Australia, 2009, p. 14). Embracing technology in every aspect of the curriculum is thought to be able to engage students in learning as this incorporates the immediacy they have become accustomed to (Ferguson, 2001).

At the centre of many schools' technology developments in recent years has been the interactive whiteboard (IWB). Perhaps the most valuable affordance of IWBs is the ability for multimodality, incorporating visual, audio and kinaesthetic media into one presentation (Hall & Higgins, 2005). Multimodality can assist in enhancing teaching by capturing student attention, maintaining their interest and motivating them to learn (Wood & Ashfield, 2008).

Numerous studies suggest that the introduction of IWBs tends to cause a shift in teachers' pedagogy from a student-centred learning environment to teacher-led, whole class practices, which tends to limit student engagement and learning (For example; Bennett & Lockyer, 2008; Kearney & Schuck, 2008; Serow & Callingham, 2008; Wood & Ashfield, 2008). However Vincent (2007) has shown it is possible for teachers to revert to former student-centred approaches once they have become comfortable with the technology.

A limited portion of IWB research focuses on a mathematical context, particularly in Australia. Examining classroom practices using the Productive Pedagogies framework, Zevenbergen and Lerman (2008) were able to conclude that IWB usage reduced the quality of mathematical learning opportunity. The researchers note that while they believe IWBs have the potential to deepen and enhance learning opportunities in mathematics, this was unlikely to be achieved through the teacher-directed learning environment that tends to accompany IWB use (Zevenbergen & Lerman, 2008). The Serow and Callingham (2008) study reinforced the idea that unless teachers carefully planned their lessons and teaching approaches with the IWB in lessons, there was a negative impact on the achievement of deeper understanding of mathematical concepts. Indeed, Goodwin's (2008) study concluded that appropriate use of interactive multimedia had a significant impact on the development of mathematical knowledge of students.

While investigating issues concerning the IWB from a teacher's perspective is important, gaining the perspective of school students on IWB use can offer valuable insight into how teachers can improve learning experiences. Research has revealed that students liked the multimedia aspects of the IWB, its versatility compared to a plain whiteboard, and the fun and games that can be had with an IWB (Hall & Higgins, 2005). Studies by Wall, Higgins and Smith (2005), and Tanner and Jones (2007) delved deeper into student learning and meta-cognition with an IWB, making more explicit links between the affordances of the IWB and how they assisted student learning.

Study Aims

This paper addresses the research question of, 'How do primary students perceive the influence of IWBs on their learning in mathematics?' The study sought to gain insight into how students see IWBs contributing to their learning, with the view that such information would be useful for planning quality teaching and learning experiences in mathematics.

Method

Underlying the study's focus on student perceptions of learning, is the theoretical perspective of constructivism; that is, that students are better able to apply what they learn when they are active participants in the construction of their own knowledge. This perspective is consistent with the previous research advocating the need for more student-centred approaches in IWB-based lessons, in order to promote deep learning. Also underlying this study is the belief that primary-age students are capable of metacognition, that is, they know about their own cognitive processes, how they learn and can monitor these processes in order to learn more effectively (McInerney & McInerney, 2006; Tanner & Jones, 2007).

A case study approach was used for the study, with the intention of collecting detailed data to compile a rich description of the situation in one classroom (Yin, 2009). As required by case study methods, multiple data sources were planned: Bubble Dialogues (See Figure 1), group interviews and lesson observations. The technique of using Bubble Dialogue templates together with group interviews, was developed by Wall, Higgins and Smith (2005), as an effective means of stimulating talk about IWB learning processes with primary students. The technique was also used successfully with Year 5 and Year 7 students by Erikson and Grant (2007).

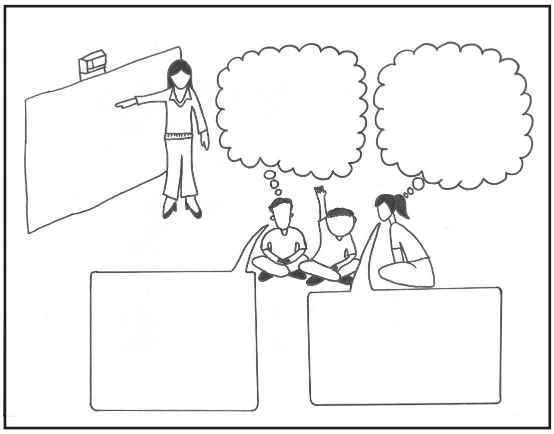

Figure 1: Bubble Dialogue template used during small group interviews

Participants and Procedure

The main selection criterion for the classroom was that the teacher must have incorporated an IWB into their daily teaching for a minimum of two years. (In this case the teacher had been using an IWB for five years). The class was in a large metropolitan public school in Sydney. The pupils were in Stage 3, Year 6 (11 to 12 years old). For most students in the class, it was the first year they had experienced an IWB in their classroom. All students in the class (N=25) participated in the study, and students were selected for the small group interviews by the researcher, based on the lesson observations.

Observations of two mathematics lessons were conducted, with the researcher taking field notes. Included in the field notes were observations of student engagement levels to allow a mixture of students to be selected for the two small group interviews. In the interview session following the lesson, students were asked to complete a Bubble Dialogue sheet with spaces for both speech (external processes) and thoughts (internal processes). The researcher used prompting questions (see Appendix 1) in order to assist students in using the template and to ensure consistency across the two small group interviews. Group discussions were then encouraged (audio-taped and transcribed) to capture those verbal comments that may not have been written down (Wall & Higgins, 2006).

Guided by the research question of “How do students perceive the influence of IWBs on their learning in mathematics?” discussion transcripts and the Bubble Dialogue text were read and reread in order to identify the key points made by the participants. Searching for similarities across the key points allowed themes to emerge. The field notes from the lesson observations were used to clarify participant responses regarding the lesson and check for supportive or contradictory information. The cross-analysis of multiple sources of data, or triangulation (Yin, 2009), allowed assessment of the ‘strength’ of themes, as well as the exposure of a broader range of pertinent issues.

Results and Discussion

The analysis of the data collected from interviews, lesson observation and Bubble Dialogue responses revealed some similar themes to those reported by Wall, Higgins and Smith (2005). On the whole, the student perceptions were positive and were grouped under three themes: multimedia affordances of the IWB, its functionality, and the ways in which the IWB assists with different approaches to learning. An additional category of negative comments about IWB lessons was formed.

a) Multimedia

Overall, the participants responded positively to the multimedia affordances of the IWB. The most common positive response from the participants was related to the ability to access the Internet on the IWB. In the first observed lesson, a YouTube clip was played in which a man sang a song about the mathematics concept of volume. It was a repetitive, catchy tune and by the end of the four-minute clip most of the students in the class were singing along. One student commented that he was able to remember the mathematical idea better because of the song. Another student mentioned they found a YouTube clip at home and intended to show the teacher. Being excited by the affordance of the IWB to access the Internet has meant this student has been an active participant in his learning. This shows how the IWB is able to extend students’ learning by allowing them to become facilitators in their own learning, a component of the constructivist theory of learning.

> *… it [IWB] benefits our learning more if we can easily get internet access (Girl F).*
>
> *It encourages us to learn more … because there’s more links to the outer world from the internet (Girl, small group interview 1).*
>
> *… you can access learning websites which allow you to further your learning (Boy F).*

Another feature of the multimedia affordances mentioned was the audio/visual nature of the IWB. In particular, the use of maths games and maths songs were highly noted. Students also found the use of sound appealing to learning with an IWB.

> *Things that help me learn on the IWB are fun games, songs and interacting with the IWB (Boy B).*
>
> *I find that I learn more on the IWB than the black board. The black board doesn’t have sound or Internet connection (Boy D).*

Some caution is needed when interpreting student responses to the multimedia affordances of the IWB as these experiences accounted for a very small part of lesson time. The lesson observations showed that the teacher used prewritten lessons she downloaded from the Internet that contained large amounts of written information. The students remained seated at their desks and were instructed to copy information from the IWB into their books. Wood and Ashfield (2008) note that such digital resources can support direct teaching methods, such as modelling and demonstrating. This can lead to the passive role of the learner, limiting opportunity for interaction with the teacher, other pupils and the IWB.

b) Functionality

Several positive responses by participants were made regarding the functional affordances of the IWB, such as it being fast and efficient, easy to see and use, saving lessons for later and being able to freeze the board. Students were able to make connections between the functionality of the IWB and the benefits to their learning. Students noted that with the white- or chalkboard you have to rub everything off and spend time writing up the next part of the lesson.

The fast pace of lessons has come under scrutiny by some researchers (Gillen, Staarman, Littleton, Mercer & Twiner, 2008; Wood & Ashfield, 2008) as it is felt this limits opportunity for higher ordering thinking, decreases student understanding and decreases meaningful, extended teacher-pupil dialogue. The lesson observations in this study provided some supporting evidence for these positions. Interactions between the teacher and the pupils were limited to mainly closed questions with pupils seated at their desks for the duration of instruction with the IWB. Once students had copied the information from the IWB, the teacher moved on to the next step. Assumptions cannot be made as to whether there was a lack of understanding of mathematics concepts due to these approaches as this is beyond the scope of this research. Even though pupils were quickly and easily able to recall the YouTube volume song from the first observed lesson, whether students understood the underlying concept itself is unknown. However, according to some of the participants in this study, they enjoyed the speed of the lessons the IWB brings into the classroom. As well as being fast and efficient, participants noted that the IWB was easy to use and child friendly.

> *I would definitely recommend the IWB to all schools because it is extremely efficient and child friendly and easy to use for children of all ages (Girl D).*

> *I think the IWB is a very easy and good way to teach and learn (Boy B).*

Although it was noted by participants that the IWB is easy to use, during an observed lesson there appeared to be a bit of difficulty in moving objects around the board during an activity. This frustrated not only the student trying to move the objects, but also the teacher and other students in the class. Students in other studies noted having difficulties in operating the IWB, such as having their shadow cast over what they were writing, or not being able to move objects on the board (Hall & Higgins, 2005).

A strong theme throughout the Bubble Dialogues and in the small group interviews was how easy it is for everyone in the class to see the IWB, presumably in comparison to using a computer in the classroom to access information.

> *We can all see it [IWB] we don't have to huddle around the computer! (Girl B)*

A comment made in both the small group interviews and in the Bubble Dialogue was about the benefits of being able to freeze the IWB. This was observed during the first lesson. The teacher paused the current display on the IWB screen by using the projector's remote control, and proceeded to use the computer connected to the IWB to arrange the next part of the lesson. Although the teacher was using the computer, the image being display on the IWB remained as it was previously so the students were able to continue working without interruption.

> *I also think it [IWB] is helpful because the teacher can freeze the board and prepare other lessons for us on the computer while we are writing down what's on the board so not only do the students benefit from the IWB but also the teacher (Girl B).*

> *… you can freeze it [IWB] whenever you want so that the teacher can prepare another lesson or do whatever while the students are [working] from the frozen page (Boy B).*

The idea that the teacher can prepare the next part of the lesson while the students are still working could add to the notion of the immediacy with which children of the technology age have become accustomed. The lesson can move seamlessly through its steps without interruption. Perhaps this is why being able to freeze the board is such an important affordance of the IWB for these students. This affordance has not arisen in previous research. Rather, smooth presentation of lessons has been attributed to the technical affordances of the IWB compared to, for example, when a teacher would use a video player, write on the whiteboard, and move back to the video again (Gillen, et al, 2008).

Although typically a comment made by teachers in other studies (Benjamin & Hughes, 2006; Beeland, 2002; Bennett & Lockyer, 2008; Kearney & Schuck, 2008), a positive aspect mentioned by the students in this study was the affordance of being able to, … "save things for another time" (Boy C). The affordance of saving lessons for use in later lessons has great potential to boost student learning through activating prior knowledge, but it is the teacher's decision whether or not to do so. However, in the observed lessons little advantage was taken of this affordance.

c) Approaches to learning

Students in this study showed they were capable of reflecting on their meta-cognitive processes in relation to learning with an IWB. Some students were also able to comment on how the IWB helps to cater for differences in students' learning preferences. Many of the comments regarding the IWB assisting in learning were related to the multimedia affordances of the IWB and the ability to move objects around the board.

> *… [the IWB] helps children of all learning abilities and ways of thinking (Girl D).*

> *… instead of your teacher showing you what you have to do you actually do it on the smartboard yourself. You learn better when you're doing it yourself (Boy, small group interview 1).*

Interestingly, during the observations, students were rarely able to get up and interact directly with the IWB. In fact over both occasions, only three students were invited to use the IWB even though there were many other opportunities for interaction to occur. These findings are similar to those of other studies, where student interaction with the IWB was limited and the board mainly used as a teacher tool (Shenton & Pagett, 2007; Zevenbergen & Lerman, 2008).

When students were questioned about how often they get to use the IWB themselves, the response was 'only sometimes' for mathematics, which was "*not as much as science and other subjects*" (Girl, small group interview 1).

Students commented they were able to learn better when they could see things on the IWB, not just hear the teacher talking. In addition, they also liked being able to see other students using the IWB as they can gain a different perspective on the topic.

> *It is easier to learn when you see things, not just hear things (Girl F).*

> *You can show your working out and see how the other class finds things out (Boy C, see Figure 4).*

> *Even watching other children using the IWB helps me learn (Girl D).*

Students were able to comment on the benefits of the visual nature of the IWB and its positive relationship to learning. These findings are similar to those of other studies (Beeland, 2002; Erikson & Grant, 2007; Wall, Higgins & Smith, 2005) where the students most commonly associated the IWB with visual learning, and whose students commented that the visual nature of the IWB made it easier to learn.

b) Negative comments

Overall, the number of negative comments was far less than expected based on previous research (e.g. Wall, Higgins & Smith, 2005). This could be due to the fact that the IWB was new to most students who participated in the small group interviews (N=9). It is possible that the IWB was still having a novelty effect for these students.

When students were asked what they did not like about the IWB, a number mentioned the need for the board to be recalibrated. As the IWB is a touch-sensitive screen showing a projected image, the two components need to be aligned in order for proper function to occur. If the calibration is out the writing may appear in a different position to where the user is touching the screen. The recalibration process only takes a short amount of time, however if alignment is incorrect during a lesson, this makes it more difficult to operate the IWB effectively.

The issue of the IWB allowing more work to be produced for the students was mentioned as being a negative aspect of the IWB.

> *It's easier for the teacher to get heaps and heaps of work for us to write in the books … because she doesn't have to write it (Boy, small group interview 2).*

This issue was observed during both lessons. The *Notebook* software on the IWB was used in order to convey a large amount of written work to the students on the topic, which they were then required to copy into their books. The pages being used were downloaded lessons from the Internet, which the teacher had adapted more specifically for her lessons. The lessons were mainly designed as instructional information with few opportunities for student participation. This made the lesson very teacher-centred with students working individually at their own desk. This replicates ideas put forward by Wood and Ashfield (2008).

Conclusion

In responding to the research question regarding how students perceive the influence of IWBs on their learning in mathematics, this study found that students value highly the multimedia affordances of the IWB, such as Internet access, music and games. Students felt these aspects made mathematics learning 'fun' and motivating. The visual nature of the IWB was a strong factor in students' comments on their learning. The approach to teaching observed was a direct teaching method, with the teacher leading the class through pages of notes on the IWB with students situated at their desks. Although the multimedia affordances of the IWB engaged the students, the question remains as to whether the IWB was actually beneficial to their learning. There is a distinct difference between engagement in lessons and understanding lesson content. The purpose of this study was not focused on exploring the intellectual quality of the lessons or the depth of learning. However from the observations and student comments, it would appear that the low-level uses of the affordances of the IWB were not eliciting higher-order thinking skills from the students. Many of the students' comments were concerned with 'engagement' and 'remembering' rather than analysing and evaluating knowledge, as is typical of higher-order thinking skills. In line with a constructivist view to teaching and learning, in order for students to gain maximum benefits from learning they should be active participants in the construction of new knowledge through higher order thinking skills. Indeed, a recent study by Gregory (2010) suggests that when this can be achieved, students recognise that the IWB makes the most significant impact in mathematics, compared to other subject areas.

The use of the Bubble Dialogue templates was valuable in obtaining the data required for this research. Students were capable of using the thought bubbles to reflect on their meta-cognitive processes in relation to learning with an IWB. In future research, conducting one-on-one follow-up interviews with students after reading through their responses would have been useful for gaining a deeper understanding of individual perspectives. A question that would have proved most useful to ask during these follow-up interviews would have been: 'How could the teacher use the IWB to help you learn better?' This would have allowed greater insight into individual students' personal learning preferences. Also, rather than providing students with the template that pictured the teacher situated at the front of the room operating the IWB, students could have represented how they see the role of the IWB, and how they see the IWB being used, and by whom.

Considering the amount of time dedicated to mathematics instruction in the classroom, the two observations that were conducted in this study offer only limited insight into the workings of this classroom. Despite this limitation, this study contributes information to the rather small body of research regarding student perceptions of learning with an IWB, and therefore adds to the pool of cases needed to substantiate the emerging knowledge in this aspect of contemporary education (Freebody, 2003). This study also demonstrates there is a need for further research to delve past the motivational aspects of IWBs to explore ways to promote deep learning of mathematics and higher-order thinking in students.

Appendix 1: Prompt questions used during small group interviews

Speech Bubble	Thought Bubble
What does the teacher do on the IWB in maths?	What did you learn about maths when using the IWB?
What was good about using the IWB in maths?	What new skills did you achieve when using the IWB?
What was not so good about using the IWB in maths?	What did you learn about how you learn using the IWB?
Why would you tell another school/teacher/child to use the IWB?	What types of things were done on the IWB that helped you learn?
What would you tell people that you felt about using the IWB?	How did the IWB help you learn in maths?
Who do you think would benefit most from learning using the IWB?	How is learning different with an IWB compared to a traditional whiteboard?

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