

INTERACTIVE WHITEBOARDS AS MEDIATING TOOLS FOR TEACHING MATHEMATICS: RHETORIC OR REALITY?

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Interactive whiteboards (IWB) are an innovation that is gaining considerable presence in many contemporary classrooms. This paper examines the use of IWBs in mathematics classrooms. Using a productive pedagogies framework to analyse classroom videos, it is proposed that the classrooms observed used a restricted approach in their use of IWBs. It was found that they were used for quick introductions to lessons, were teacher directed, whole class teaching and fostered shallow learning. Through interviews with the teachers, it was found that the approaches observed were based on assumptions about learners and technology.

In this paper, we explore the ways in which teachers use Interactive Whiteboards (IWBs) in mathematics classrooms. There is a sense that this tool may offer considerable potential to enhance student learning. Promoters of the tool provide case studies of the novelty and support that can be achieved through the clever use of the tool for example, (Edwards, Hartnell, & Martin, 2002). How this is enacted in classrooms is the focus of the analysis in this paper. In exploring computer-mediated learning, Waycott, Jones and Scanlon (2005, p.107) reported that there is a reciprocity between the tools and the learner where “the user adapts the tools they use according to their everyday practice and preferences in order to carry out their activities; and how, in turn, the tools themselves also modify the activities that the user is engaged in.” We argue that this is the same for teachers.

BACKGROUND

The introduction of interactive whiteboards into schools in the UK has been strongly supported by the government (Beauchamp, 2004), with over £50m being spent on their implementation in primary and secondary schools (Armstrong et al., 2005). However, it has not received the same fiscal support in Australian schools. Many schools are supporting the introduction of these devices through various means but without systematic support. In most cases, the implementation of IWBs is a school-based decision and as such is supported by funds raised by the schools. How the IWBs are implemented within a given school is dependent upon the resources of the school to provide the equipment and the beliefs of the teaching staff as to the value of the tool. As such, there is considerable variation across Australia as to their uptake and implementation.

Drawing from socio-cultural perspectives on the use and uptake of mediating technologies – in this case IWBs, Armstrong et al (2005) suggest that there is a tendency for teachers to use IWBs as “an extension of the non-digital whiteboard” (p. 458). Beauchamp (2004) argued that the transition from traditional modes of teaching

to the totally integrated use of IWBs in classrooms demands a shift in pedagogical style of the teacher. For teachers to realize the potential of IWBs, Glover and Millar (2002) contend that teachers need to recognize that there is considerable interactivity associated with their use. They argue that the IWB can engender an approach that fails to radicalize pedagogy and where the IWB is used to enhance students' motivation rather than become a catalyst for changing pedagogy.

The extension of the computer through the use of IWBs creates new opportunities and obstacles to learning. In studying the use of IWBs in English classrooms, it was reported that

“IWB can facilitate and initiate learning and impact on preferred approaches to learning. The pupils describe how different elements of software and hardware can motivate, aid concentration, and keep their attention. On the negative side, pupils candidly describe their frustration when there are technical difficulties, their desire to use the board themselves and their perceptions of teacher and pupil effects (Wall, Higgins, & Smith, 2005 p. 851).

Greiffenhagen (2000) argued that the availability of IWBs as a teaching aid is only of value where it becomes part of the regular pattern of classroom life.

In their study of the uptake of IWBs in a secondary school, Glover and Miller (2001) proposed that IWBs offered considerable benefits to learning. They reported that students were more likely to engage in learning due to the surprise element that was offered through the IWB, the large visual cues offered through the IWB presentation format, and the quicker pace of lessons.

As a teaching tool, IWBs have considerable potential to change interaction patterns. In their study of classrooms – both literacy and numeracy in IWB and non-IWB classrooms – Smith, Hardman and Higgins (2006) found that there is a faster pace in lessons using IWBs than non-IWB lessons; that answers took up considerably more of the overall duration of a lesson; and that pauses in lessons were briefer in IWB lessons compared with non-IWB lessons. They also reported a faster pace in numeracy lessons than in literacy lessons. While they reported some support for the potential of IWBs, they concluded that overall the use of IWBs was not significantly changing teachers' underlying pedagogy. The majority of teacher time was still spent on explanation and that recitation-type scripts was even more evident in IWB lessons. They found that while the pace of the lessons increased, there had been a decline in protracted answers from students and that there were fewer episodes of teachers making connections or extensions to students' responses. They also claim that there is a faster pace in lessons but less time is being spent in group work. There is a tendency for teachers to assume a position at the front of the class when using IWBs (Maor, 2003). Similarly Latane (2002) suggested that there needs to be a move from teacher-pupil interaction to one of pupil-pupil interaction. In studying mathematics classrooms, Jones and Tanner (2002) reported that interactivity can be enhanced through quality questioning where the quality of the questions posed and the breadth of questioning needs to be developed to ensure interactivity in mathematics teaching when using IWBs.

DATA COLLECTION

The data reported here compares data collected as part of a larger study (Lerman & Zevenbergen, 2006) with subsequently collected data where teachers have been using IWBs. In this paper, we present the analysis of classroom lessons using a particular framework. A total of nine schools participated in the study. Over the three years of data collection, some schools dropped out of the study, and others came in. Five schools remained in the study for its duration. Purposive sampling techniques were used in the selection of schools. The schools were selected on their representativeness of the diversity found in Australian schools in terms of social groupings being served (high, medium and low SES), geographical location (city, rural, remote); technology implementation (high or medium; integrated into classroom, computing laboratories); and school structure (single age classes, multi-age classes). Classrooms from the upper primary sector were involved in the data collection.

Video data were collected in two classrooms where the teachers had access to IWBs. The teachers video-taped their lessons which were then analysed using the productive pedagogies framework.

DESCRIPTIVE ANALYSIS OF PEDAGOGY

Two analyses were conducted on the video data. In the first instance, a running record was taken of the lesson with a transcript developed of the lesson. This record consisted of both description of the lesson and the interactions between teacher and students. Our data confirm that of Smith, Hardman and Higgins (2006) where we could observe the level of questioning being used by teachers in these lessons. It was of a lower level format where teachers were asking more recall questions than those requiring deeper levels of understanding. This type of questioning also allowed for a quicker pacing of the lesson since teachers were able to ask quick fire questions where there was little depth in the responses required.

The predominant approach used by teachers when using the IWBs was that of whole class teaching. In these settings, the teacher controlled the lesson, inviting students to participate in manipulating the objects. In all cases, only one child was involved in such manipulations at any one time. The remaining students sat on the floor or in their desks. However, in observing the students, there were very few behavioural issues one would expect to see when children are seated for such lessons, and that they were predominantly focused on the teacher talk and actions. This observation was consistent across the lessons and schools suggesting that even though the lessons were whole class and teacher lead, the students appeared to be engaged with the lesson.

In all cases, the teachers used the IWBs as the introduction to the lesson. Typically, the orientations with the IWBs were between 5-15mins and were used to orientate the students to the topic that would then be followed. The introduction was whole class and quick pacing. In some cases the teachers used pre-existing lessons that had been developed by other teachers and were available through the resources. In other cases,

they used the tools (such as fractions, calculator or clocks) that came with the IWBs. In all cases, they used the resources that were part of the packages supplied with the board. Once the students had been involved in the introductory component of the lesson, they returned to their desks to work on activities related to the topic being introduced.

Depending on the resources used by the teacher, there were instances where the IWB made possible a rich introduction to aspects of mathematical language. For example, in one lesson the teacher was using the fraction tool in which a shape (chosen by the teacher - circle, rectangle and square) were used to represent various fractions. These could be shown in a variety of ways such as pies in the case of circles or through horizontal, vertical or grids on the rectangles and squares. Through the ease with which the shapes could be selected and how they were represented, the teacher was then able to draw on a repertoire of language to discuss the shapes, representations and fractions. The ease and speed at which shapes and denominators could be selected enabled a lot of talk/questions about the numbers being represented. As with other lessons, the speed of questions and delivery meant for fast pacing. However, there was little to no evidence of deeper probing of concepts or for mathematical thinking in terms of drawing patterns across the experiences. In the lesson on fractions, for example, while students saw a range of fractions (halves, quarters, thirds, sixths, eighths, tenths), these were simply representations of denominators and with different numerators being used. In some cases, equivalence was discussed - such as $\frac{4}{8}$ was talked about as being equivalent to $\frac{1}{2}$. However, this discussion was only undertaken when the 4 shaded pieces were adjacent so that it was clearly $\frac{1}{2}$. The discussion did not occur when it was possible for the 4 segments to be scattered. Similarly, there was no discussion about the relationship between the size of the segments and the number in the denominator – that is, the inverse relationship between the segment and number. So while the students were exposed to a range of experiences, the richness of the mathematics was not being drawn out of the lessons.

PRODUCTIVE PEDAGOGIES ANALYSIS

While the observations provided us with some indicators of how the IWBs were being used in the classroom, we also employed a quantitative measure to document the use of IWBs. This measure allows us to more rigorously analyse the lessons. We have used this approach in analyzing the use of ICTs in classrooms (Lerman & Zevenbergen, 2006) so are able to compare those data against the use of IWBs. The process involves three observers observing the lessons which had been videotaped. Each observer rates the lesson against nominated criteria on a scale of 0-5 where 0 indicates that there was no evidence of that criterion in the lesson and 5 indicates that it was a strong feature that was consistent throughout the lesson. The ratings are made at the completion of the lesson and the score is for the overall lesson. If there is some evidence of a criterion in the opening phase of the lesson but does not appear again, then this means that it was not a strong feature of the overall lesson. The three observers rate their observations independently and then come together to come up with a common score. This involves a process of negotiation to arrive at the common outcome. In most cases, there was

usually a difference of 1 between the ratings and the ensuing discussion meant that the observers needed to negotiate their ratings with the other two.

The framework we have used draws on the work of the Queensland Schools Longitudinal Reform Study (Education Queensland, 2001) in which the researchers analysed one thousand lessons in terms of the pedagogies being used by teachers. The method was that described above and where the criterion for each rating was based on the Productive Pedagogies. There are four dimensions within the framework – Intellectual Quality, Relevance, Supportive School Environment and Recognition of Difference – in which there are a number of items that are evidence of that theme.

Within the Productive Pedagogy approach, there is a strong emphasis on raising the quality of teaching in terms of the intellectual experiences and social learning. The outcomes of the Queensland study (Education Queensland, 2001) indicated that teachers were very good at providing a supportive learning environment but that the intellectual quality was quite poor. When the analysis was undertaken across key learning areas, it was reported that the learning environments in mathematics scored the least favourably suggesting that the intellectual quality in mathematics (across all years of schooling) was poor.

In seeking to explore the use of IWBs in mathematics classroom, we undertook the same analysis of the classroom videos. As can be seen in Table Two, the scores are low in most areas. We have included the analysis of classroom data where ICTs were used in mathematics classrooms as a comparison.

Dimension of Productive Pedagogy	ICTs		IWBs	
	Mean	SD	Mean	SD
Depth of knowledge	1.64	1.36	1.5	1.46
Problem based curriculum	2.19	1.38	.92	0.83
Meta language	1.69	1.07	1.25	1.87
Background knowledge	1.76	1.16	1.67	1.63
Knowledge integration	1.48	1.27	0.42	0.45
Connectedness to the world	1.38	1.44	0.42	0.45
Exposition	1.19	1.64	0.83	0.82
Narrative	0.31	0.78	0.17	0.18
Description	2.24	1.02	1.42	1.25
Deep understanding	1.43	1.47	1.25	1.19
Knowledge as Problematic	1.14	1.47	1.33	1.36
Substantive conversation	1.26	1.40	0.5	0.46
Higher order thinking	1.31	1.55	1.33	1.36
Academic engagement	2.23	1.38	1.5	1.46
Student direction	0.79	0.92	0.33	0.28
Self regulation	3.24	1.12	2.5	2.45
Active citizenship	0.30	0.78	0	0
Explicit criteria	2.83	1.17	1.33	1.28
Inclusivity	0.33	0.75	0	0
Social support	2.51	0.25	1.25	0.62

Table Two: Productive Pedagogy Analysis of IWB use in Upper Primary Classrooms

We have reported the data for when teachers used ICTs to support numeracy learning elsewhere (Lerman & Zevenbergen, 2006) and this showed very low levels of quality learning potential. However, when using the same framework to analyse the use of

IWBs, the results were even lower. Nine out of the twenty pedagogies (those in italics) scored substantially lower when using IWBs. Most of the lower scores were in those two dimensions that relate to the intellectual aspects of mathematics learning. From these data we can conclude that the use of IWBs actually reduces the quality of mathematical learning opportunities; provides fewer opportunities for connecting to the world beyond schools; and offers little autonomous/independent learning opportunities for students. After these scores were obtained and analysed, we returned to the schools and interviewed teachers to seek some explanation of the findings.

TEACHER INTERVIEWS

In this section for reasons of space, we provide commentary on just 3 aspects of teachers' pedagogy that appear to us to be the most salient in their responses.

Motivation

One of the observations in the earlier findings was that the IWBs seemed to be used for the introduction to the lessons. In following this observation, teachers were asked if this were the case and if so, why. In the interviews, it was confirmed that the teachers tended to use the IWB to orientate the lesson and to motivate the students.

Marcie: When the kids are all sitting and we are doing with the whiteboard, there are very few behaviour problems. They seem keen to be involved, and very eager to be the one to come to the board. You can see that they are all really wanting to get up the front and have a go. Some of my quiet kids getting really animated when we do the whiteboards whereas in the normal work, you hardly know they are there.

Heidi: I use it to get the lesson started. The kids are all together, there are all on the one task, they know what we are doing. That is a good way to start the lesson. It is also good as the kids are very motivated by the boards so they are keen to get into the lesson.

Pacing

When using the IWBs, it would appear that the teachers were aware of the faster pace of the lessons. They articulated that they posed a lot more questions and the students had greater opportunities for participating in the lessons due to the increased questioning.

Maxine: One of the things that I like about the whiteboards is that I can ask a lot more questions. You just have to click on the menu and there is the lesson or the things you need so you are not wasting a lot of time putting up overheads or drawing things on the board. I can ask more questions to the kids to see what they know and to get them to think about things. Like when we did the lesson with the clocks. You just click on the clock and there it is. You can just move the time around as quick as they kids respond. I think they like the quicker speed. They seem to enjoy the race of the lesson. If they answer quickly, then we can do another one or something a bit different.

Saves Time

Most of the teachers had some comment about the time factor in the use of IWBs. It was seen to save preparation time in two different ways. In the first instance, one

teacher commented on how he drew on the resources that had been made by other teachers as these were ‘tried and proven’ examples of lessons that worked. In observing his lessons, he would select from the databank and then implement the lesson.

Shane: I find that there are a whole lot of really good lessons that I can just use. If I am doing something on area for example, there are lessons already made up. Some other teachers have developed them so they have to be good ones. I am sure that the company only puts up the best examples. I have found these to be very handy and they save me doing the preparation work. I guess I change them a bit to suit me and the kids but they are pretty much there.

Another teacher commented on how, when using the IWB, the toolkit meant that the resources were all in the one place so she did not have to hunt around for them. Knowing that the protractor, ruler, clock, calculator were all on the screen and at the touch of the board, was seen to be a considerable timesaver.

Jemima: I think the whiteboard is a great resource. You have the tools there on the board, you just need to click and they are there.

CONCLUSION

There is little doubt that IWBs have the potential to enhance learners’ opportunities to experience mathematical representations and develop their mathematical thinking. As with all resources, mathematical or other, internalising a tool, be it the number line or a calculator, LOGO, dynamic geometry or Graphic Calculus, or presentation tools such as overhead projectors or IWBs, transforms the world, in this case of mathematical pedagogy for the teacher. That transformation is always mediated by other experiences, however. However, by themselves they will not transform pedagogy, no matter what their potential. Indeed, as we have reported in this paper, the technologically impressive features of the IWB can lead to it being used to close down further the possibility of rich communications and interactions in the classroom as teachers are seduced by the IWB’s ability to capture pupils’ attention. We suspect, also, that teachers’ advance preparation for using the IWB, often via the ubiquitous powerpoint package or pre-prepared lessons for the IWB, are leading to a decreased likelihood that teachers will deviate in response to pupils’ needs and indeed might notice pupils’ needs less frequently through the possibility to increase the pacing of mathematics lessons. Elsewhere (Zevenbergen and Lerman, in preparation) we apply an activity theory framework to try to understand the tensions and contradictions in teachers’ use of the IWB and to identify possible developmental trajectories for realising some of their potential to change pedagogy for the better.

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