
INTERACTIVE WHITEBOARDS AS POTENTIAL CATALYSTS OF PEDAGOGIC CHANGE IN SECONDARY MATHEMATICS TEACHING



KIM BESWICK

University of Tasmania

Kim.Beswick@utas.edu.au

TRACEY MUIR

University of Tasmania

Tracey.Muir@utas.edu.au

It has been established that the use of interactive whiteboards (IWBs) does not of itself imply interactive pedagogy. Indeed it has been argued that precursors for a change from teacher-centred to interactive pedagogy include a high degree of technical IWB competence. Based on the responses of secondary mathematics teachers at one school to a brief professional learning program we suggest that awareness of the potential of IWBs to enhance student engagement and hence learning, and commitment to collaboration and improved teaching, can motivate experimentation with the technology such that technical competence and pedagogical change occur together.

Over the past decade interactive whiteboards (IWBs) have been embraced by school systems in the UK and more recently Australia and New Zealand. Initiatives such as the Schools Whiteboard Expansion project have provided funds for at least one IWB for each subject department in participating UK secondary schools (Moss, Jewitt, Levačić, Armstrong, Cardini & Castle, 2007), while in Australia the significant costs involved have not deterred their rollout in Victoria (Jones & Vincent, 2006) and other states. Lee (2010) used the term “digital take-off” to describe teachers’ rapid adoption of the technology in their classrooms, but others (e.g., John & La Velle, 2004; Serow & Callingham, in press) have reported that a minority of teachers resist IWBs, avoiding their use by citing technical and other difficulties.

In spite of the widespread enthusiasm for IWBs research that demonstrates impacts on students’ learning is scant (Jones & Vincent, 2006). Changes to teaching that have been associated with the use of IWBs include speeding the pace of lessons, providing access to a wider range of multimedia resources, and allowing for greater interaction in lessons (Moss et al., 2007). Although these changes can be positive they are not necessarily so. For example, Biggs (1987) suggested that increased speed of delivery can result in surface learning, while Moss et al. (2007) cautioned that greater access to resources can result in increased reliance on commercially prepared materials and observed that this appeared to be more likely for mathematics teachers than those in other areas. In addition, they noted that the interactive potential of IWBs required intentional planning in order to be realised, and Hodge and Anderson (2007) have suggested that an IWB can result in less interaction and a greater emphasis on whole class teaching.

Beauchamp (2004) proposed a five stage hierarchical model for the adoption of IWBs. The five stages, as described by Muir, Callingham and Beswick (2011, p. 2) are as follows:

1. Blackboard substitute: Turn on IWB, Find relevant files, Use the IWB pen, Students don't use the IWB
2. Apprentice: Use prepared files—predominantly presentation, Save new pages created during lesson, Students have some access planned by teacher, Sometimes use other programs (e.g., Powerpoint), Sometimes use material from Internet or elsewhere
3. Initiate: Have multiple windows open and available, Use “flip charts” created with IWB software, Save work systematically in “favourites” folder, Students have access to choice of IWB tools on teacher direction, Use of a wider range of programs including specialist software, Use of different Internet sites
4. Advanced: Use work from students (scanned or saved), Students have frequent access to the IWB, sometimes spontaneously, Use of media files (e.g., video, sound files) prepared by teachers, Use of hyper-links—non-linear thinking, Use of “improved” lessons with focus on student learning rather than technical capability
5. Synergistic: Teacher *and* students confident and competent with IWB, Teacher has technical and content competence so that lesson structure is fluid and responsive to students, IWB use embedded in lesson activities beyond presentation.

In the study reported here, Beauchamp's (2004) hierarchy was used both as a framework for teachers to reflect on their current and desired IWB use, and to analyse the use of IWBs by five secondary mathematics teacher participants. In light of the conflicting literature about teachers' willingness to embrace IWBs and the impacts of the technology on teaching, we were particularly interested in the extent to which IWBs might be a catalyst for pedagogic renewal in mathematics when they were the focus of shared professional learning. The specific research question addressed by the study was: How might the use of IWBs influence the mathematics teaching of a group of secondary mathematics teachers in the same school?

The study

The five teachers whose mathematics pedagogy was the focus of this paper were the secondary teachers in a group of eight teachers who participated in a small study of the potential pedagogical impacts of IWBs. The study was conducted over a period of approximately 12 weeks in the final school term (of three).

Participants

The five secondary teachers all taught at least one mathematics class at the same Grade 7–10 suburban government high school. Details of their teaching experience, qualifications, and current mathematics teaching responsibilities are shown in Table 1. Mathematics Extended is an elective subject chosen by students who enjoy the subject or want a firmer basis for subsequent study of the discipline. Maths Applied and Maths Methods Foundation are preparatory subjects for pre-tertiary subjects available in Grades 11 and 12.

The school, Queensbridge High, had very recently invested in IWB technology but funding had not extended to the provision of training for teachers in their use.

Table 1. Details of participating teachers.

Teacher	Qualifications	Teaching experience	Position in the school	Current mathematics teaching
Tammy	B.App.Sc, B.Ed	10 years	Teacher	8 Maths, 10 Maths Applied
Kylie	B. App.Sc.	12 years	Advanced Skills Teacher, Mathematics leader	10 Maths Methods Foundation, 9 Maths Extended, 7 Maths , 9 Maths
Louise	B.Ed., M.Ed.	24 years	Assistant principal	9 Maths
Steve	B.Ed. (Prim)	5 years	Teacher	7 Maths
Claire	B.Ed. (Prim)	10 years	Teacher	7 Maths, 8 Maths, 10 Maths

Instruments

Data were collected using a range of instruments including student surveys. Although relevant to the current study students survey data are not included here due to space constraints.

Lesson observation

Each teacher was observed teaching one mathematics lesson using the IWB as they normally would. The observer recorded as much detail of the lesson activity as possible focussing on the teacher's actions (e.g., instructions, explanations, monitoring), student activity (e.g., groupings, extent of engagement and participation), and the use of the IWB (e.g., what was displayed on it, who used it). The times at which various episodes of classroom activity changed were also recorded.

Interview

Immediately after the lesson observation each teacher was asked about the degree to which the lesson was typical in terms of their IWB use, the extent to which they believed that the lesson could have been conducted without the IWB, student involvement in the lesson, and specific aspects of IWB use or related resources that had been observed. They were then asked to describe what they regarded as the main advantages of using IWBs in mathematics teaching, how they would like to use the IWB, and what supports they believed would be necessary to help them to achieve this.

Teaching journal

Each teacher was asked to document their IWB use for a period of 10 school days. To this end they were provided with 10 pages, each containing a table in which to record predefined codes which referred to the topics being taught, instructional objectives, the student grouping used (whole class, small group, or individual), role (integral or supplementary) and primary use (whiteboard, data display, IWB) of the IWB, resources used in conjunction with the IWB (internet, virtual manipulative, game, text book, other), IWB features used (e.g., cover and reveal, blinds, spotlight) and the approximate division of IWB use between teacher and students (teacher dominated, 50/50 teacher and students, student dominated), throughout the day.

Workshop notes

Three, approximately monthly workshops were held with the teachers, and notes were made during these by one of the researchers and a research assistant. In the final workshop teacher presentations and other evidence of their work with IWBs was also collected.

Procedure

The lesson observations and teacher surveys were conducted prior to or immediately after the first of the workshops. Teachers were asked to complete the journal for a 10-day period during the four weeks between the first and second workshops. After each of the first and second workshops the teachers were encouraged to try something of what they had learned and to report back on this in the next session.

The first workshop was a half-day event that introduced the teachers to the project and to Beauchamp's hierarchy of IWB use. Each of the researchers involved shared some IWB resources that would be potentially useful for the teachers. These included the Gapminder website, virtual manipulatives, GeoGebra, and Learning Feder@tion objects. The teachers also had an opportunity to share their favourite IWB resources and features.

The morning of the second session was devoted to teachers discussing their recent IWB use followed by a presentation from an external IWB professional learning provider that focussed on the features of IWBs, commercially available IWB software packages, and peripheral devices. In the afternoon each of the researchers presented a mini-lesson aimed at provoking discussion of the variety of ways in which an IWB might be integrated with traditional tools, used to enhance activities that could be done without the IWB, or could facilitate learning experiences that would be very difficult to provide in another way.

The final, half day, workshop was an opportunity for the teachers to showcase their IWB use and to report on their experiences of experimenting with new approaches to IWB use in their contexts over the course of the project.

Results and discussion

In the following sections results are presented and discussed chronologically. Due to the short time frames involved and the complexities of school life not all data were collected for all teachers but sufficient were gathered to chart the progress of the Queensbridge High teachers.

Lesson observations and interviews

Four teachers (all but Louise) were observed and interviewed although one teacher, Tammy, was in a room that had no IWB. Kylie, Claire, and Steve were all teaching Grade 7 classes and all used the IWB for an initial activity that involved a puzzle or game to be completed within a limited time. Claire and Steve made no use of the IWB during the main part of the lesson but in each case a group of two or three students who completed their work early were allowed to use the IWB for a further task or game. In Claire's lesson the task related to the lesson focus on expressing patterns algebraically but the number puzzle chosen by Steve was not connected with the lesson. Kylie did not use the IWB at the end of her lesson but did use it at various times throughout the

lesson, primarily to display and record information. She also made use of an online dictionary to show the meaning of ‘round’ in the context of decimal numbers. Consistent with Moss et al.’s (2007) observation, Kylie’s lesson was noticeably fast-paced and although this may have been her practice regardless of whether the IWB was used or not, the IWB did appear to facilitate the pace to some extent.

All of the teachers indicated that the observed lesson involved fairly typical IWB use and all expressed a desire to use the IWB more, and more effectively. For Steve this meant going beyond just using it to start lessons and for early finishers, whereas Kylie was keen to explore how students could be more involved in using the IWB and Claire was interested in finding out what a “really good lesson” with the IWB looked like. They agreed that the activities for which they used the IWB could have been done without it but that it was easier with the technology. For Tammy, access to an IWB was the major issue cited as preventing her from using it regularly and hence developing her skills. Claire taught all of her maths lessons in rooms with an IWB but described being hindered by a lack of technical expertise. For example, she said that it was necessary to check and often to recalibrate the board in the break before lessons, and that she had learned what she had by trial and error in the absence of any professional learning. Steve had also experienced difficulty in his lesson as a result of the IWB needing to be calibrated. In keeping with her desire to have students make more use of the board, Kylie believed that a second IWB in each classroom would be useful.

Workshop 1

Having been introduced to Beauchamp’s hierarchy all of the teachers considered themselves to be at the Apprentice stage except for Kylie who viewed herself as being at the Initiate level. These judgements were broadly consistent with the lesson observations although it was not possible, on the basis of a single lesson, to determine the extent to which students had choices with respect to the IWB tools that they used or the range of software and internet sites that were used. All of the teachers cited new ideas and web-based resources from the workshop that they saw as potentially useful.

Teaching journal

Louise, Claire, and Steve completed teaching journals. Louise’s journal included just four lessons over a 3-week period including one lesson in which the IWB was “not working!” In the remaining three she reported using the IWB in whole class contexts except for part of the third lesson, in which a small group used it. Explicit instruction characterised her IWB use in all three lessons and was accompanied by revision in the second lesson and the introduction of new concepts in the third. In the first lesson the IWB was used to display a text book exercise and was operated solely by Louise. In the second, Louise indicated that some IWB feature was used, in addition to using it to display information, and in the third lesson she described its use as entirely with the IWB. Internet resources were used in lessons 2 and 3 along with a text book exercise display in the third. In both the second and third lessons Louise reported some use of the IWB by students.

Steve reported on six mathematics lessons over a 10-day period, with the IWB used in the first four of these, and always in whole class contexts. It was used for explicit instruction in the first and second lessons and for revision in the remaining two. Steve reported using the IWB as an IWB only in the third lesson but as a data projector on the

other occasions. Resources used included internet sites in all four lessons, games in the first three, and as a text book in the first two. He reported approximately equal use by students and teacher in the first two lessons, student dominated use in the third and teacher dominated use in the fourth.

Claire reported on nine mathematics lessons in a 2-week period. Of these the IWB was used in seven. In each of these lessons small groups used the IWB, accompanied by whole class use in the first three lessons and individual use in the final three. Claire reported using the IWB for explicit instruction (3 lessons), revision (3 lessons) and introducing a new concept (2 lessons). All of the lessons made use of the IWB as an IWB with just one lesson (the third) in which it was also used as a whiteboard. Claire reported using internet sites in each of the first four lessons; virtual manipulatives in the first, third, and final three lessons; and games in the first two lessons and the final three. For the first three lessons Claire reported a balance of student and teacher use of the IWB, and student dominated use for the final four lessons.

The differing patterns of IWB use that were reported in the teachers' journals is likely to be related to their differing roles in the school—Louise's AP responsibilities meant that her teaching load was relatively light and frequently disrupted—and differing levels of commitment to the project and/or to changing their use of the IWB in their teaching. Nevertheless, there was some evidence of a willingness to experiment on the part of all three teachers. Overall the reported IWB use was consistent with the tendency reported in the literature (Hodge & Anderson, 2007; Muir, Callingham, & Beswick, 2011).

Claire's teaching journal was unique in both the number of lessons documented and the progression in her IWB use that was evident. Specifically there was a trend toward to less whole class use, greater use of manipulatives, and greater student access to and use of the IWB. Although there is insufficient evidence to conclude that Claire progressed from the Apprentice level (Beauchamp, 2004), the changes evidenced were in the direction of more sophisticated use.

Workshops 2 and 3

As described already the second workshop provided the major professional learning component of the program focussing on features of the IWB and ways in which its use could be incorporated into existing mathematics teaching approaches. The third workshop was primarily a forum in which the teachers could share their learning.

In that workshop the Queensbridge High School teachers chose to make a group presentation lead by Claire and assisted by Tammy and Steve. They described how they had collaboratively planned and implemented a Grade 8 algebra unit that incorporated the use of hands-on tasks, interactive tasks using the IWB, and traditional tasks. The unit was divided into weeks each with a list of objectives and pathways for working through the activities. No whole class teaching was used, but the weekly overviews were supplied to students at the start of each week and they were expected to be self-directed. Access to the IWB was rostered to ensure that all students had opportunities to complete the interactive tasks. An important feature of each lesson was a 10 minute reflection time at the end during which students wrote at least 50 words about what they had achieved that lesson. The teachers shared three reflections from each of two students, and two of these from one of the students are shown in Figure 1. The mention

of the “electronic whiteboard” in the Thursday reflection was the only reference to IWBs in the examples they presented.

The teachers explained that IWB resources were easy to find but that the availability of technical support on just one day per week meant that technical issues with the IWBs remained a frustration and necessitated always having a back-up plan. In addition, they had found that access to several PCs as well as an IWB was very useful when this was possible. Overall they believed that the approach taken in the unit had resulted in improved student engagement and a more rewarding teaching experience.

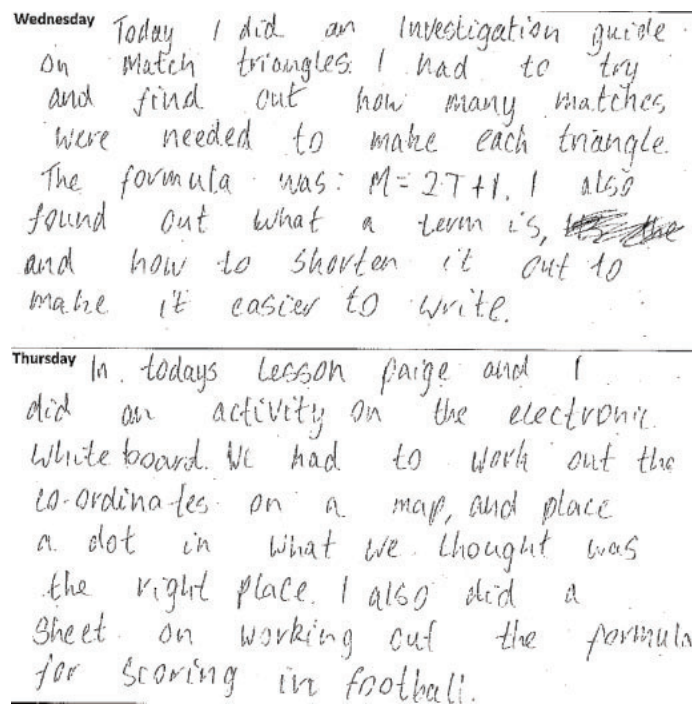


Figure 1. Examples of student reflections.

Although the teachers appeared to rely on pre-prepared materials there was no evidence of negative effects of this as suggested by Moss et al. (2007). Rather, they integrated the online resources with others in a purposeful way as part of their planning. In contrast to Hodge and Anderson's (2007) warning, the use of the IWB, in the context of their overall revised approach, did not have the effect of increasing teachers' reliance on whole class teaching but had, on the contrary, reduced it. This was also a change from the lesson observations made at the start of the project.

Conclusion

The short duration of the study meant that large changes in teachers' IWB use or mathematics pedagogy were unlikely to be observed. Nevertheless, Beauchamp's (2004) hierarchy was effective in facilitating teachers' reflection on their IWB use and in setting goals for its development. Apart from Kylie, all placed themselves at the Apprentice level at the start of the project and all, including Kylie, were able to identify specific ways in which they wanted to develop their IWB use.

The teachers' presentation at the final workshop showed evidence of development and suggests that one or more of the individuals involved in preparing the unit had

moved to the Initiate stage (Beauchamp, 2004). Compared with the lesson observations at the start of the project, where the IWB was used primarily as something of a novelty to engage students at the start of the lesson and to reward early finishers, its use in the Grade 8 algebra unit was integral to the achievement of the unit's objectives. Importantly, these changes occurred without any change to the availability of the technology or technical assistance with its use. Improvements in these areas would undoubtedly be helpful and appreciated by the teachers but they did not present an insurmountable obstacle to teachers progressing their objectives in relation to IWB use.

Arguably the most positive aspects of their work were not directly related to IWB use. Rather, it appeared that planning collaboratively was a relatively new way of working, perhaps prompted by the need to "have something to share". In addition, the teachers had not set out to use the IWB at every possible opportunity but had incorporated it purposefully into their overall plan as a part of varied menu of tasks for students to undertake. The incorporation of reflection time for students was a successful innovation to assist students to be aware of and to take responsibility for their own learning and also constituted a lesson ending that focussed students on what they had achieved. The student reflections that the teachers selected to share provided further evidence that they were not preoccupied with using the IWB as an end itself but in improving their teaching and using the IWB as one of range of tools to this end.

In terms of the research question that was the focus of this study, the data point to the potential of a challenge to incorporate IWB use to be a catalyst for more fundamental pedagogical change. Of course, the study was small and the intervention brief but it raises questions that warrant further exploration. For example, what role is played by teachers' existing pedagogical repertoires in their uptake of new technologies and their ability to rethink their teaching approaches? What role might teachers' pedagogical content knowledge play? How and to what extent might other specific innovations be used as catalysts for pedagogical change?

The results also support the inclusion in professional learning around new technologies of a pedagogical focus from the outset. The Queensbridge High School teachers were novice IWB users but were able to change their pedagogy at the same time as developing their technical skills. Indeed it could be that the pedagogical possibilities presented in relation to IWB use may have motivated them to engage with the technology. This is yet another avenue for future research.

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