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WHAT WORKS?
Research into Practice

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Research Monograph # 38

How can we maximize the interactive whiteboard as a learning tool?

Technology in the Mathematics Classroom

Harnessing the Learning Potential of Interactive Whiteboards

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Introducing communications technologies into classrooms has historically been met with mixed levels of resistance and enthusiasm. Nonetheless, from pencils through to calculators, computers, and handheld devices, the continually growing range and sophistication of educational technology tools marches forward, impacting classrooms, teaching and learning.

Interactive whiteboards (IWBs) are a relatively new learning tool. While some early studies suggest that they may only be a "slick presentation tool" used to enhance teacher-directed lessons,[1] others have identified a greater potential. Research on use in mathematics classrooms suggests that when we combine thoughtful professional learning with implementation, we enable teachers to maximize the use of IWBs to enhance student learning through multi-modal representations and inquiry approaches.[2]

This mononograph reports on recent Ontario research which suggests there is not one use for IWBs, but a range of them; they can be used very effectively as both a "non-dynamic presentation tool" and a "dynamic thinking tool."

Benefits of IWB Use

Benefits of IWB use, identified by early studies, are: (a) ease of use for whole-class teaching;[3] (b) increased levels of student engagement, possibly due to novelty[4] and (c) integrated use of a range of multimedia resources.[5] After almost a decade of research, the reports are mixed. While IWBs require a steep learning curve for the teacher, including additional time to develop lessons and learning situations, IWB use can strongly enhance student engagement, learning, and

Research Tells Us

1. IWBs have the potential to engage students in shared mathematics thinking and discourse.
2. There are many distinct uses of IWBs during a single lesson.
3. There are varying levels of effectiveness for those uses in relation to student learning.
4. IWBs are timesavers during class, but their effective use requires more preparation time in order to develop expertise.
5. Student use of the IWB is critically important.
6. The ways in which students use IWBs differ from conventional teacher use.

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Technology marches forward ...

Tamin et al. (2011) conducted a meta-analysis of over 1055 studies to find that "the average student in a classroom where technology is used will perform 12 percentile points higher than the average student in the traditional setting that does not use technology to enhance the learning process."[8 (p. 17)]

discourse. Recent studies indicate that greater focus on professional learning and teacher collaboration helps teachers develop and implement more inquiry-oriented practices using IWB's.[6,7]

Findings from Current Mathematics IWB Research in Ontario

Mathematics is a particularly rich field of research on IWB use. Mathematics classroom research on IWB use suggests that digital technologies accelerate learning through accessibility to multiple representations[9] that are unambiguous and clear to students[10] and that encourage mathematics communication.[2] To better understand the nature of IWB use occurring in Ontario classrooms, my research team has conducted two studies over four years. In the first study, teacher teams learned about IWB use through lesson study. Teachers worked in teams (Grades 1–10) to generate inquiry-based lessons using manipulatives and IWBs as mediating tools to tackle difficult-to-teach mathematics concepts. In the second study, two teachers were followed over the course of one year to document the use of the IWB in their classrooms.

One finding was consistent across participants and studies: IWBs can be used and understood as a bridging mechanism for different mathematical ideas and representations.

> "The manipulatives really opened up the conversation between the pairs, and the IWB transferred the talk that was happening at the tables to the front. The IWB was that bridge [that allowed] the conversation to build." (teacher participant)

Designed for rapid movement between websites, diagrams, previous lessons and student records of work, IWBs allowed for flexibility unavailable in a conventional chalk-and-talk environment, increasing the potential for mathematics discourse. As one Grade 6 student explained:

> "Before we were basically talking about what we learned, but now we're actually showing it, with the protractors and rulers and stuff… If it's on the whiteboard, you can go up and move it and change it so that you understand, whereas on a piece of paper it's just fixed there and it doesn't really explain…" (student participant)

Teacher participants reported the following key learnings from the IWB mathematics research program:

1. IWBs are not a magic bullet, but a tool with tremendous capabilities, particularly when physical manipulatives are combined with matching virtual manipulatives to engage students in shared mathematics thinking and discourse.
2. There are many different and distinct uses of IWBs during a single lesson.
3. There are varying levels of effectiveness for those uses in relation to student learning.
4. IWBs are timesavers during class, but their effective use requires more preparation time in order to develop expertise.
5. Student use of the IWB is critically important.
6. The ways in which students use IWBs differ from conventional teacher use.

Implications for Practice

> "Finding ways of getting the students up there using it is my biggest challenge. It's a captivating tool and students find it pretty cool. But any time you can get them up there doing something on it, that really grabs their attention." (teacher participant)

Illustrative Uses of Interactive Whiteboards

Our research documented the use of IWBs as a non-dynamic presentation tool and as an interactive thinking tool. It is important to note that teachers moved through various uses within a single lesson, based on the needs and purposes of the teaching and learning moment.

	Non-Dynamic Presentation Tool	Dynamic Thinking Tool
	• a presentation tool that conveys information • can also be achieved with other technologies (including chalkboards and chart paper)	• an interactive tool that illustrates and generates ideas • more difficult to achieve with other technologies
Teacher Demonstration	• Present a slideshow that includes key information from the lesson on repeating numeric patterns and present a word problem to solve.	• Display saved patterns that students have generated on the IWB during a previous lesson. • Have students categorize the patterns as growing, shrinking or repeating, justifying their thinking. • Highlight and move each pattern into one of the three categories to generate a table of classified student samples.
Student Practice	• Invite students to work in pairs at the IWB to solve 5 addition questions that have been loaded onto the IWB. • Have students use IWB pens to record their solutions. • Encourage some students to use a calculator available on IWB.	• Have students practise skip-counting by 5's in chorus while one student simultaneously provides a visual representation by clicking on the large interactive 100's chart on the IWB to highlight every 5th number.
Student Investigation	• Have students work on the IWB in pairs to analyze a photograph displayed on the IWB. • Focus students on parallel lines theorem to find relationships between various angles. • Provide students with IWB pens to highlight each example.	• Engage students in an investigation of three figures that look like triangles. • Have some students work with paper figures at their desks and with tools such as rulers, scissors and protractors to determine which of the three representations are actually triangles. • Select a group of three students to work at the IWB with the same three representations, as well as virtual tools to assess the three figures. • Ensure that the group at the IWB records and saves their investigation, using the screen capture tool, for later presentation to peers.
Consolidation	• Invite four groups to use the IWB to illustrate the same linear growing pattern, using different means of representation (geometric, graphical, numeric table, algebraic expression). • Ask students to describe how the four representations are similar and different and have students discuss the effectiveness of each representation.	• Have two groups of students classify a series of geometric figures on the IWB into a Venn diagram with intersecting sets. • Invite the first group to present their sort to the class, using the spotlight feature in the IWB software to focus, alternately, on individual sets in the Venn diagram, and on the intersecting areas. • Invite the second group to put work up using the dual screen feature so both groups' sorts can be viewed simultaneously. • Engage the students in a discussion about mathematical similarities and differences of each sort.

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Shifting practice from teacher use to student use of the IWB requires organizational strategies to ensure that all students have access to the IWB each week. In our studies, for example, secondary and elementary teachers established work stations that students could rotate through, engaging in rich mathematics problems at their desks, on computers, with manipulatives, with the IWB, and with other technologies such as graphing calculators. Combining IWB use with other technologies may further motivate students, as exemplified by one teacher, who gave students IWB-related files on USB sticks for homework. Intrigued by the data stick, the students were eager to receive homework in this format, and often asked for more homework.

Tips for Getting Started with IWBs:

- Dedicate IWBs to classrooms. Secure the IWB in the classroom, rather than using it as a portable IWB. Researchers have noted that non-fixed IWBs are used for less time each day than those that are directly and permanently connected to classrooms.
- Combine professional learning with IWB installation. Pair the installation of IWBs with teacher professional learning models (such as lesson study and collaborative action research) that emphasize collaboration and effective teaching.
- Find ways to maximize student use of the IWB. Student use of the IWB requires careful management of the classroom learning environment, particularly when some students are using the IWB while others are working at their desks.
- Treat the IWB as a tool for production rather than consumption. Encourage students to produce ideas, information, and solutions, using the IWB to solve problems, generate solutions, and clearly illustrate their thinking.

In Summary

The IWB provides (a) visually dynamic support for the illustration of complex mathematics; (b) opportunities for shared student reasoning, including the use of IWB tools to justify and consolidate ideas and to debate multiple student solutions; and (c) opportunities to increase student agency and risk-taking. As the use of IWBs expands into more classrooms across the country, teachers are also expanding their range of IWB-related practices. These practices have the ability to support both academically successful and struggling math students.

To learn more about the innovative and inspiring ways teachers are incorporating IWBs in their classroom practice, visit www.tmerc.ca

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