




Interactive whiteboard use in math classrooms: Grounding theory in practice

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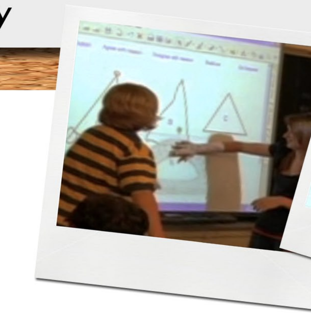
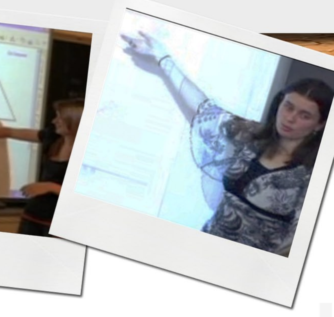
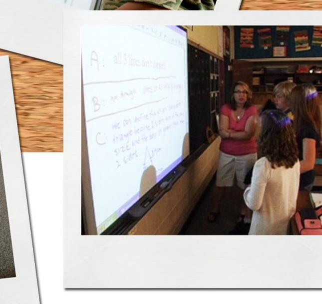







Background

Early studies on IWB use were small scale with an emphasis on teacher testimony and action-research-based approaches (see Higgins, Beauchamp & Miller, 2007; Glover & Miller, 2003). Early research identified benefits that included ease of use for whole class teaching (Stephens, 2000), for incorporating dynamic visual demonstrations (Kennewell & Beauchamp, 2003), and for integrating a range of multimedia resources (Ekhami, 2002).

In subsequent years, as the IWB was established in classrooms, researchers began to examine teacher development associated with IWB use. A variety of models began to emerge with a focus on interactivity (see Davison & Pratt, 2003). These models are often in the form of a continuum from least effective to most effective teaching practices using the IWB.

Our study furthers research on IWB technology, in the context of lesson study in mathematics, by examining purposeful teacher use of the IWB and students' functional beliefs about learning mathematics.

Research Questions

Qualitative:
How does lesson study support teachers in building their capacity in the effective pedagogical use of technology (interactive whiteboards)?

Quantitative:
What is the impact of lesson study activity by teachers on student achievement and attitudes toward mathematics?

Method

Design

The study employed a mixed methods design in which qualitative and quantitative methods were conducted simultaneously (Creswell & Plano-Clark, 2007).

- Qualitative data was collected during one school year at four school sites with grades 4 through 10 (3 IWBs/site).
  - Qualitative Data: focus group interviews, individual interviews, field notes, video documentation of debriefs, observations, artifacts
- The quantitative strategy involved a quasi-experimental design in which control group schools were matched to treatment schools in a pre-post design.
  - Quantitative Data: quasi-experimental pre-post design, student survey on beliefs about mathematics, achievement test (PRIME)

Table 1: Examining Student Achievement and Motivational Effects of IWB use in Lesson Study

Treatment	0_1	X $_{\text{Lesson Study}}$	0_2
Control	0_1		0_2

n=244

Participants

- 1 Ontario district school board (northeast of Toronto)
  - >4 schools (1 rural, 3 urban; 1 elementary, 3 secondary)
  - >3 teachers at each school (12 teachers in total) engaged in Lesson Study
    - -grades 4 - 10
    - -range of experience in teaching (2 – 20+ years)
    - -range of experience with technology (novice to advanced users)
    - -no prior access to interactive whiteboards for almost all participants
- Researchers from Trent University and the University of Toronto

Lesson Study

Lesson Study is a systematic inquiry into teaching practice, carried out by examining lessons. It is:

- Teacher-led
- Embedded in the classroom and focused on students
- Collaborative and ongoing
- Based on teachers' own concerns and questions (Darling-Hammond & McLaughlin, 1995)
- Has the potential to increase research-based knowledge that is critical to improving instruction
- Comprised of a four-stage cycle (goal setting, planning, lesson implementation and reflection) (Lewis et al., 2006)

Quantitative Findings

Student Achievement and Motivation

Students in the treatment group scored statistically better on the post-test for conceptual understanding compared to control group peers, without loss or benefit to algorithmic performance.

Students' beliefs about mathematics learning improved in the treatment group from pre to post, but in the control group beliefs were unchanged. Self-reported effort remained constant in the treatment group, while declining in the control group.

Table 2: Means and Standard Deviations by Motivational Variables, Test Occasion, and Experimental Condition

Motivation Variable	Treatment (N=142)		Control (N=108)		Comparison
	Mean	SD	Mean	SD	
Math Self-Efficacy O_1	4.22	1.06	4.26	.94	t(248)=-.308, p=.759
Math Self-Efficacy O_2	4.23	1.01	1.16	.99	
Beliefs about Math O_1	4.14	.81	4.11	.66	t(248)=.319, p=.750
Beliefs about Math O_2	4.23	.86	4.11	.72	
Quick/fixed Learning O_1	2.41	.94	2.31	.83	t(248)=.920, p=.359
Quick/fixed Learning O_2	2.26	.87	2.49	.93	
Fear of Failure O_1	3.10	1.16	3.03	1.03	t(248)=.516, p=.606
Fear of Failure O_2	3.09	1.10	2.94	1.14	
Effort O_1	3.97	1.00	3.96	1.01	t(248)=.123, p=.903
Effort O_2	3.94	.92	3.71	1.04	

Qualitative Findings

Teacher and Student Learning

"I think it's positive when a teacher is forced a little bit out of their comfort zone because it keeps things fresh. It keeps you [the teacher] thinking and learning and being challenged."

"We've had a lot of personal learning around math and technology and that makes me a better teacher and that's my job…to make myself better, so that I can help the kids."

"The kids who are really struggling with math saw my vulnerability too and I think that was a neat opportunity for them to know that I don't know everything."

Enhanced Awareness of Teacher Moves

"It's a great way to do more of the on-the spot teachable moments that have to do with technology – because a moment has a lot of potential."

Student Interaction/Student Exploration

"The manipulatives really opened up the conversation between the pairs. And then the work being done on the IWB transferred the talk that was happening at the tables to the front….the IWB was that bridge to the abstract and [allowed] the conversation to continue."

"They are more interactive when answering questions. They are wanting to help me by telling me what to do and sometimes they'll come up and work by themselves and I will step away or we will work together and the rest of the class will give suggestions."

"It's definitely interaction [that] is the major thing. For the kinaesthetic learner it is so much easier to implement. We can use the virtual manipulatives online…The students want to come up, they want to touch it."

Framework for Effective Mathematics Teaching using the Interactive Whiteboard

The Framework for Effective Mathematics Teaching and Learning using the Interactive Whiteboard initially consisted of five stages of a sequential continuum. Researchers theorized that as teachers began to feel more comfortable using the IWB, the types of use would progress along the continuum, in concurrence with the work of Glover, Miller, Averis & Door (2007).

However, teachers were not static in their IWB use, but moved through the types of use within a single lesson based on the needs and purposes of the teaching and learning moment. The continuum changed to a descriptive framework illustrating types of IWB use.

Go to www.tmerc.ca for the framework and links to video, lesson plans and Notebook files.

Non-Dynamic Demonstration

Teacher presents information to the class using the IWB as a static screen or series of static screens.

Example: In an introduction to a lesson on linear functions, the teacher shows a photograph of one trapezoid table with 5 chairs from the school library. The students will be representing the relationship between the number of tables and the number of chairs.

Dynamic Demonstration

Teacher demonstrates to the class by manipulating words/images/objects on the IWB.

Example: The teacher shows interactive manipulatives that students will be using in the lesson on the IWB. The students are given the physical tools that mirror the virtual manipulatives.

Student Practice

Students use the IWB to replicate teacher demonstration or model.

Example: The teacher demonstrates how to measure angles on the IWB using a virtual protractor. A small group of students then practices on their own at the IWB as part of a station activity, while other groups work on similar concepts at other stations.

Investigation

Students use the IWB for solving a problem /investigating a situation / exploring a concept.

Example: A small group of students works together at the IWB, using virtual manipulatives to investigate the properties of triangles.

Math Talk

Students use the IWB to communicate ideas to one another or to the class.

Example: Opposing groups use IWB tools (e.g., IWB protractor, websites, rulers, rotation feature, back and forward navigation through pages) to summarize how certain shapes presented may or may not fit the definition of a "triangle". The teacher invites students to summarize their findings on the IWB.

Consolidation

Teacher uses the IWB to support the synthesis of ideas brought forth in the lesson.

Example: The teacher saves student IWB work and then displays four examples of student representations of a given linear function (growing pattern) on the IWB in order to review student ideas and consolidate mathematical understandings of linear functions. Students discuss how the representations work together to show the same idea in different ways.

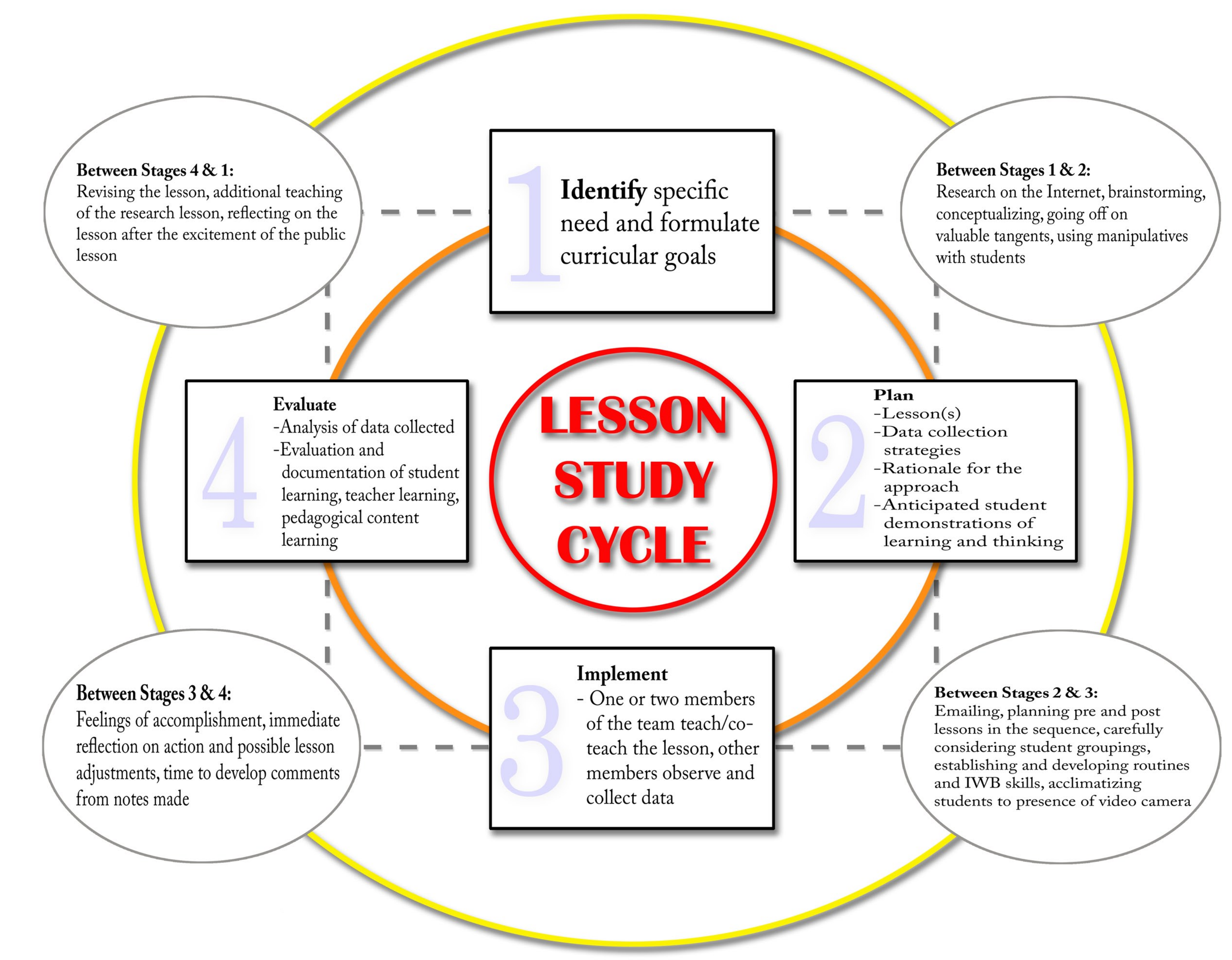
Significance

This study offers several new contributions to research on the use of IWBs in the math classroom:

1. This study offers new quantitative data on students with small but measurable positive effects on student beliefs about learning mathematics.
2. The study illustrates the importance of collaboration between teachers and researchers to gain practical and theoretical insights into IWB use in classroom contexts.
3. The IWB framework may prove useful for teachers in extending their range of uses and familiarizing themselves with types of IWB use in mathematics classrooms.

Unexpected Findings

This research highlights the backstage work of the Lesson Study cycle, contributing to a more nuanced and enhanced understanding of Lesson Study activity.



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