SRI International

PRIME Time for Technology:

What Research Should Every Math Leader Know?

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April 20, 2010

Technology & Math Leadership

3 Reasons to Care: #1 Principles

- ***NCTM Principles and Standards (2000):***

  Technology is essential *in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning.*

Technology & Math Leadership

3 Reasons to Care: #1 Principles

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  Technology is essential *in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning.*

How does it influence the mathematics that is taught?

Technology supports deep conceptual understanding

How does it enhance student learning?

Interactivity among teacher, student and content.

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3 Reasons to Care: #2 Enabling the PRIME Framework

NCSM PRIME Framework

1. ***Equity:*** *high quality mathematics learning for every student*
2. ***Teaching and Learning:*** *high expectations and access to meaningful mathematics every day*
3. ***Curriculum:*** *meaningful and relevant mathematics in every lesson*
4. ***Assessment:*** *high levels of learning for every student*

Doesn't specifically mention technology…

… but don't think of technology as the 5th wheel… instead

TECHNOLOGY is the INTEGRATING ENABLER of Equity, High Expectations, Meaningful Mathematics, and Effective Assessment

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3 Reasons to Care: #3 Supporting Your Teachers

What's it like to be a teacher out there

Florida Bill 6 to link teacher pay to student gains

"Valued Added" Models not going away

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3 Reasons to Care: #3 Supporting Your Teachers

- ***What's it like to be a teacher out there***

Florida Bill 6 to link teacher pay to student gains

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3 Reasons to Care: #3 Supporting Your Teachers

Because if we're going to measure teachers' performance by student gains,

we owe it to teachers to give them…

the very best tools.

Technology & Math Leadership

3 reasons technology is a component of math leadership

1. Fulfill the NCTM Technology Principle
   Use technology to develop conceptual understanding
2. Enable the NCSM PRIME Framework
   Integrate concerns for equity, high expectations, meaningful mathematics and fruitful assessment practices
3. Support your teachers' effectiveness
   Give the tools they need to succeed

What research can guide your action as an effective leader?

How can research help

Providing guidance to mathematics leaders

- Four Cognitive Principles for Highly Effective Interactive Technology
- TPCK: A Framework for PD for Technology-Rich Mathematics
- Three Important Roles for the Mathematics Leaders

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Plan for this talk:

Use research with SimCalc as a central example, but without the intention to be software-specific

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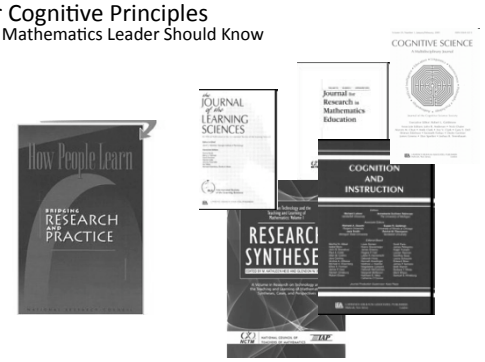
Four Cognitive Principles
Every Mathematics Leader Should Know



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Four Cognitive Principles
Every Mathematics Leader Should Know

Technology	Learning	Best Practices Teaching

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Classroom Connectivity	Collaboration	Mathematical argumentation

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Four Cognitive Principles
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Technology	Learning	Best Practices Teaching
Enhanced Displays	Shared Attention, Conceptual Contrast	Engaging students in rich math tasks
Linked Dynamic Representations	Meaningful = Connected	Conceptual understanding
Classroom Connectivity	Collaboration	Mathematical argumentation
Instant Feedback	Formative Assessment	Responsive to student thinking

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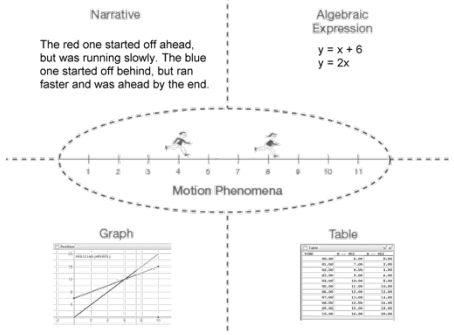
Example: SimCalc

Representations that are:

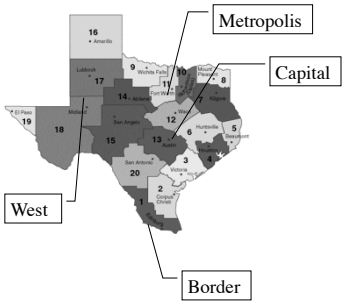
- ✓ **Visual**
- ✓ **Dynamic**
- ✓ **Connected**

"Democratizing access to the mathematics of change"
- Jim Kaput

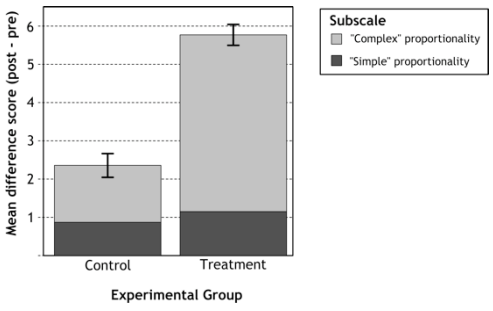
Dynamic Linked Representations



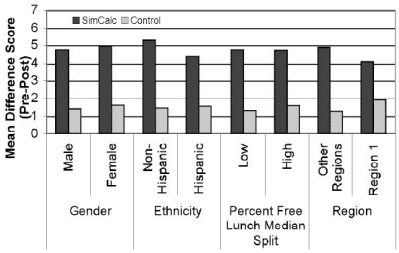
Research Study: Over 100 Classrooms



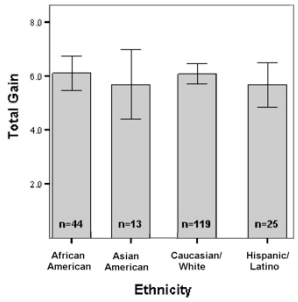
Student Learning Results



Equity Results



Equity Results – Florida

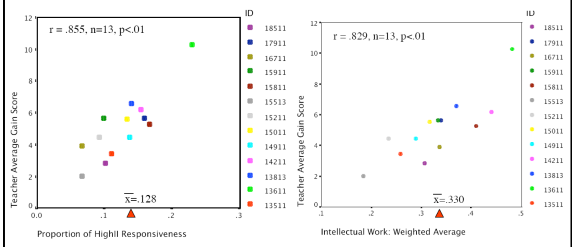


Pedagogical Effectiveness: Responsiveness

- Substudy with 13 teachers by Jessica Pierson, SDSU
- Videos of the same SimCalc lesson
- Looked at:
  1. Teacher asks question
  2. Student responds
  3. WHAT HAPPENS NEXT?

Pedagogical Effectiveness: Responsiveness

- Substudy with 13 teachers by Jessica Pierson, SDSU
- Teachers who work with students ideas
- Teachers who require more intellectual work

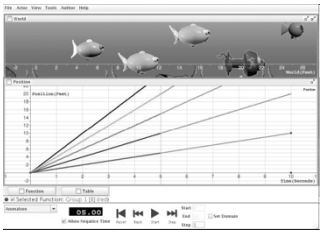


Example: SimCalc

- Extending to connectivity & formative assessment
- Work of Stephen Hegedus & team
  Kaput Center, University of Massachusetts, Dartmouth

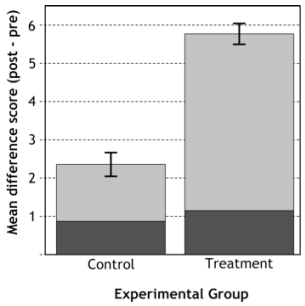
SimCalc: Extensions to Connectivity and Formative Assessment

Work of Stephen Hegedus & team
Kaput Center, University of Massachusetts, Dartmouth
see http://www.kaputcenter.umassd.edu/



Recall: Technology Principle

Technology changes the content we can teach



While still covering "simple" proportionality, we were able to layer in substantial pre-Algebra content

$\frac{a}{b} = \frac{c}{d}$

$y = kx$

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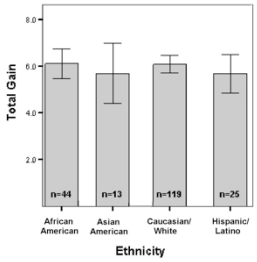
Recall: NCSM Prime

Equity, Teaching and Learning, Curriculum, Assessment



Technology helped all students to learn more…

Technology is an occasion to integrate the four principles in PRIME

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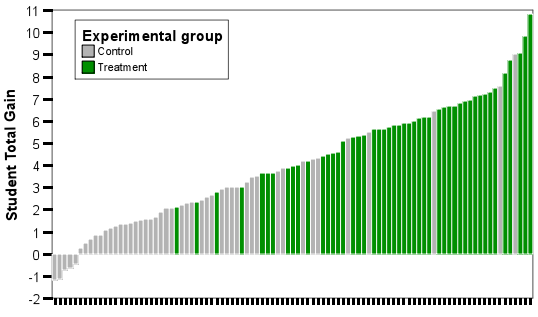
Recall: Giving Teachers the Best Tools

Variation among teachers, but big advantage to using SimCalc



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Other Cognitive Technologies
With a strong research base

- Other Dynamic Representation Tools:
  Dynamic Geometric-- The Geometer's Sketchpad, Cabri,
  Dynamic Statistics -- TinkerPlots, Fathom…
- Graphing Calculators and Handhelds
- Cognitive Tutors: Carnegie Learning
- Classroom Response Systems: TI-Navigator….
- Programming Languages

Research basis for graphing calculators
National Center for Educational Statistics

- "**Eighth-graders whose teachers reported that calculators were used almost every day scored highest**. Weekly use was also associated with higher average scores than less frequent use. In addition, teachers who permitted unrestricted use of calculators and those who permitted calculator use on tests had eighth-graders with higher average scores than did teachers who did not indicate such use of calculators in their classrooms. The association between frequent graphing calculator use and high achievement holds for both richer and poorer students, for both girls and boys, for varied students with varied race and ethnicity, and across states with varied policies and curricula (National Center for Education Statistics, 2001, p. 144).
- Ellington, A. J. (2003). "A meta-analysis of the effects of calculators on students' achievement and attitude levels in pre-college mathematics classes." *Journal for Research in Mathematics Education 34(5):* 433-463.

How can research help
Providing guidance to mathematics leaders

- ✓Four Cognitive Principles for Highly Effective Interactive Technology
- TPCK: A Framework for PD for Technology-Rich Mathematics
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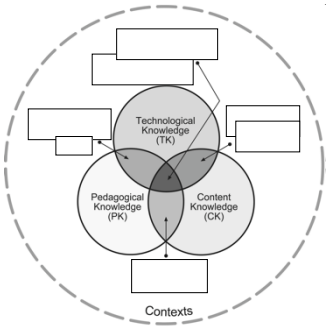
Technological Pedagogical Content Knowledge
A Framework for Planning PD for Technology-Rich Math



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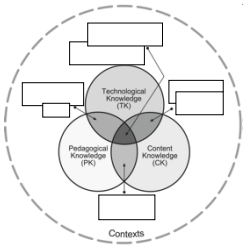
TPACK Examples: SimCalc
A Framework for Planning PD for Technology-Rich Math



Example: Content Knowledge

Slightly different slope formula

$$\frac{y_1 - y_2}{x_1 - x_2}$$

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Does teachers' mathematical content knowledge predict student learning?
Pop Quiz

1. Yes, it strongly predicts student learning
2. Yes, it weakly predicts student learning
3. No, it does not predict student learning

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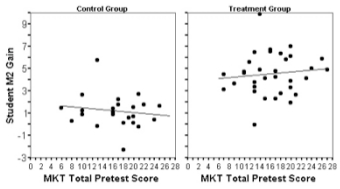

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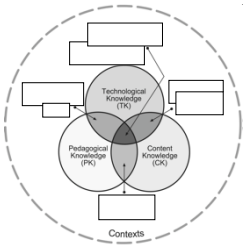
TPACK Examples: SimCalc

A Framework for Planning PD for Technology-Rich Math



Example: Technology-Content Knowledge

Piecewise functions

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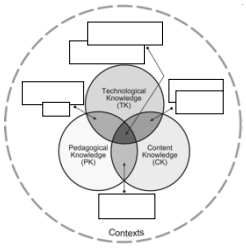
TPACK Examples: SimCalc

A Framework for Planning PD for Technology-Rich Math



Example: Pedagogy-Technology Knowledge

Getting students to make predictions

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TPACK Examples: SimCalc

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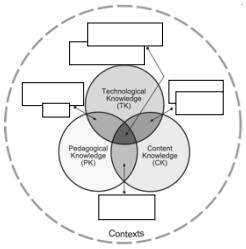

Important Take Away:

Knowledge for technology-rich math is richly interconnected with content and pedagogical knowledge

Therefore takes time to build…

Need for PD that is ongoing and integrative!

Roles for Leaders

My wish list for adding technology to PRIME

1. **Advocate** for the needs of math teachers
   see TI Research Notes
2. **Focus** on deeply mathematical and cognitive technologies
3. **Integrate and align** equity, pedagogy, curriculum, assessment…

What parents think:…

- Fun
- Game-like
- Career-preparation
- Colorful
- Anytime, Anywhere
- Individualized
- Personalized

What research shows:

- Use shared displays to engage students in rich mathematical tasks
- Use dynamic representations to develop conceptual understanding
- Use connectivity to enhance classroom collaboration
- Use formative assessment to understanding student thinking

Conclusion

- Four Cognitive Principles
  - Shared Displays to engage students in rich mathematical tasks
  - Dynamic Representations to develop conceptual understanding
  - Classroom Connectivity to enhance collaboration & math argumentation
  - Instant Feedback for formative assessment & adaptive teaching
- One Framework for PD
  - Technological Pedagogical Content Knowledge
    effective teaching evolves from mutual influence of T, P, and C
- Three Roles for Math Leaders
  - **Advocate** for the technology & PD needs of math teachers
  - **Focus** on deeply mathematical and cognitive technologies
  - **Integrate** technology & equity, curriculum, pedagogy, assessment…

Thank You!

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And special thanks to Melendy Lovett and TI

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