*Using a Technology-enhanced Curriculum to Improve the Learning of Important Mathematics for English Language Learners (and **all** students!)*

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Our Challenge

- **Democratizing access to important mathematics for *all* students**

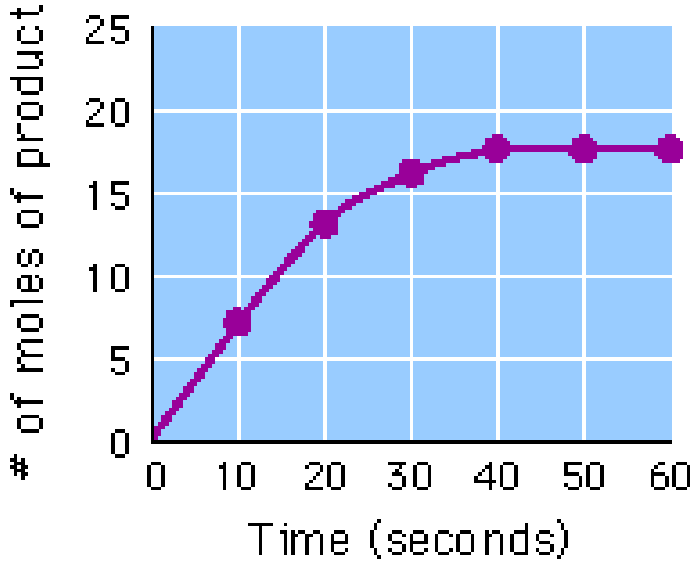
NCTM Focal Points

Proportionality (7th Grade)
…*Students graph proportional relationships and identify the unit rate as the slope of the related line.*

Linear Function (8th Grade)
…*Students translate among verbal, tabular, graphical, and algebraic representations of [linear] functions.*

Rate and Proportionality in High School Science

$$F=ma$$



LEAF SIZE OF MAPLE TREES

Tree	Average Length (cm)	Average Width (cm)
1	16.0	9.0
2	10.0	5.0
3	19.0	10.0
4	15.0	8.0

$$y=-kx$$

Focus on Mathematical Discourse

Build on existing competencies and experiences

Focus on communication

Use multiple forms of representation and expression

Negotiate mathematical meanings

(e.g. J. Moschovitch (2007); Kaput and Roschelle, (1998)).

Dynamic Math Environments: Specific (not unique) Benefits for ELL students

Direct interaction with mathematical objects

- Reduce linguistic load
- Make connections between representations
- Provide access to high-level math

Common objects for discussion

- Gestures can refer to mathematical objects
- Can verbally refer to objects without requiring formal math terms (which is learned after the concepts!)

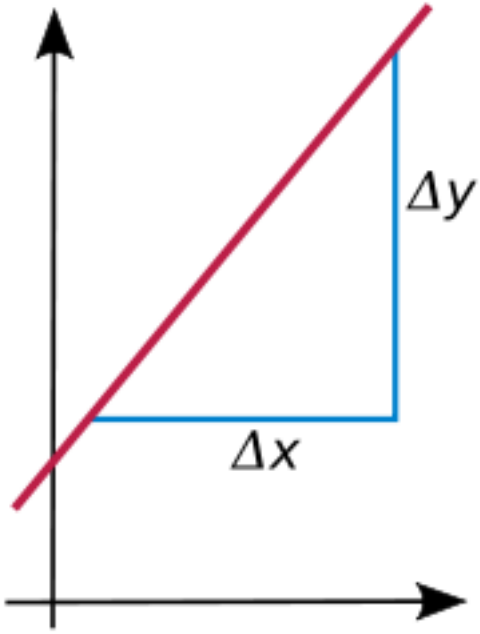
Provide shared experiences

Support for real mathematical discourse in real classes!

The slope m of a line - its steepness, or slant - can be calculated like this:

$$m = \frac{\text{change in y-value}}{\text{change in x-value}}$$

The equation of any straight line, called a linear equation, can be written as: y = mx + b, where m is the slope of the line and b is the y-intercept.



The slope of a line is defined as the rise over the run, m = Δy / Δx.

Or…

Demo

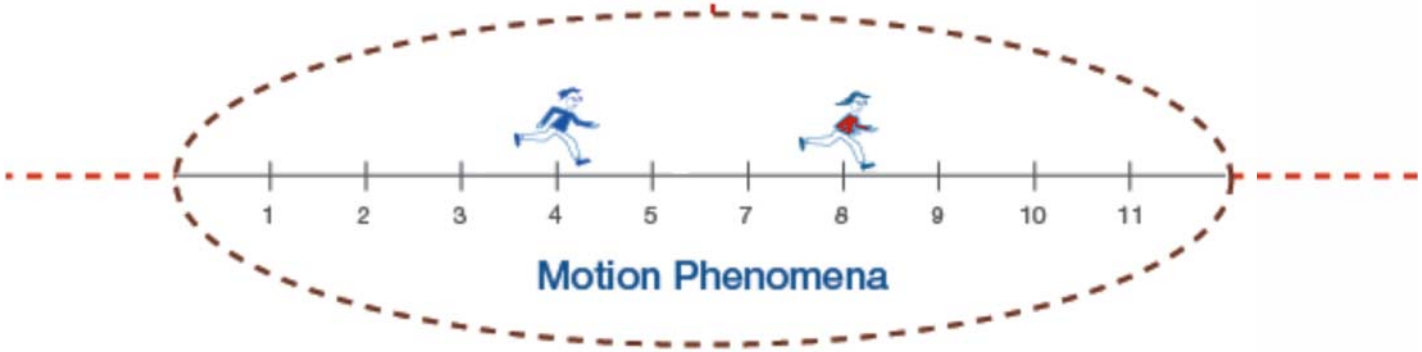
The SimCalc Approach

Narrative

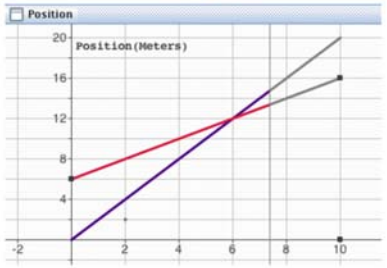
The red one started off ahead, but was running slowly. The blue one started off behind, but ran faster and was ahead by the end.

Algebraic Expression

$y = x + 6$
$y = 2x$



Graph

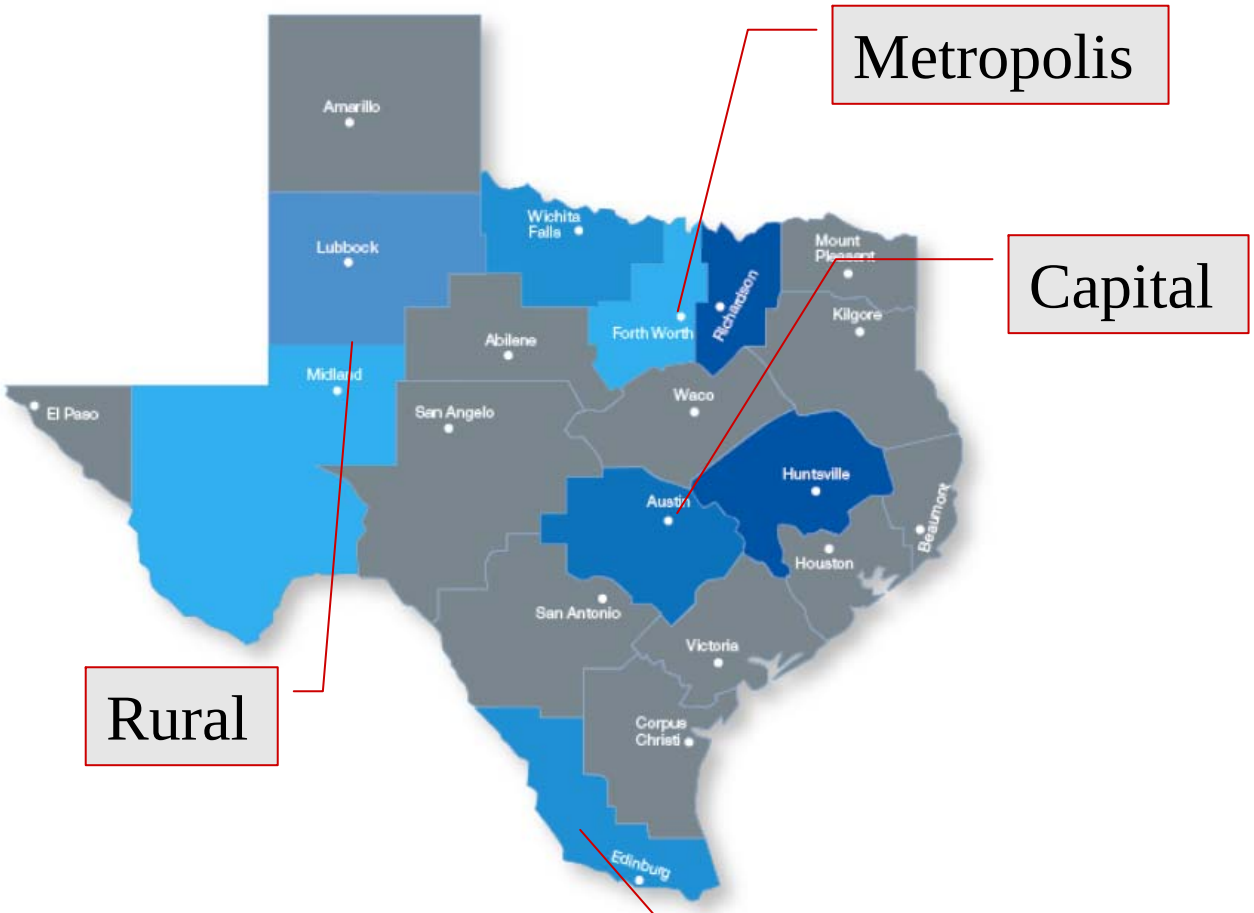


Table

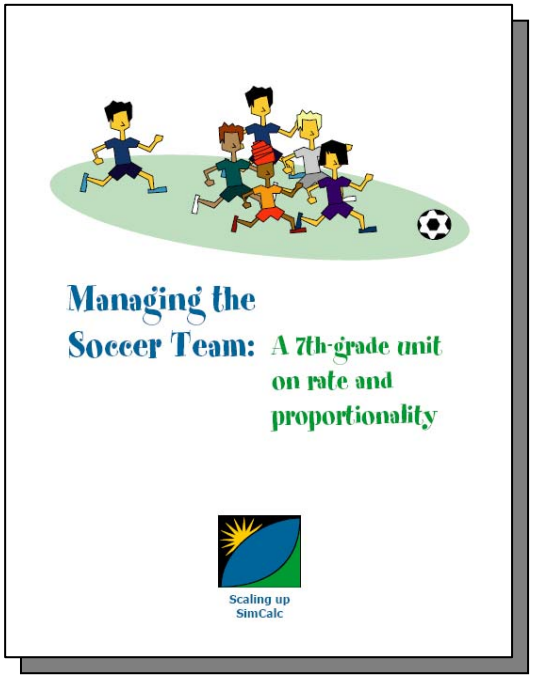
Table

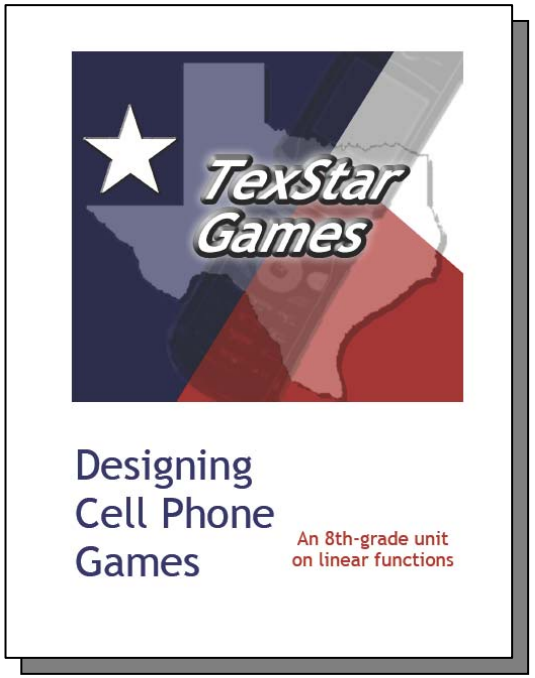
Time	B -- Pos	A -- Pos
00.00	6.00	0.00
01.00	7.00	2.00
02.00	8.00	4.00
03.00	9.00	6.00
04.00	10.00	8.00
05.00	11.00	10.00
06.00	12.00	12.00
07.00	13.00	14.00
08.00	14.00	16.00
09.00	15.00	18.00
10.00	16.00	20.00

Can it work in a wide variety of settings? (yes) Results from Research with 95 Texas Teachers



Intervention: An Integration of Technology, Curriculum, and TPD





Proportionality (7th Grade)
- Linear function in the form y=kx
- Rate

Linear Function (8th Grade)
- Linear function in the form y=mx+b
- Average rate

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

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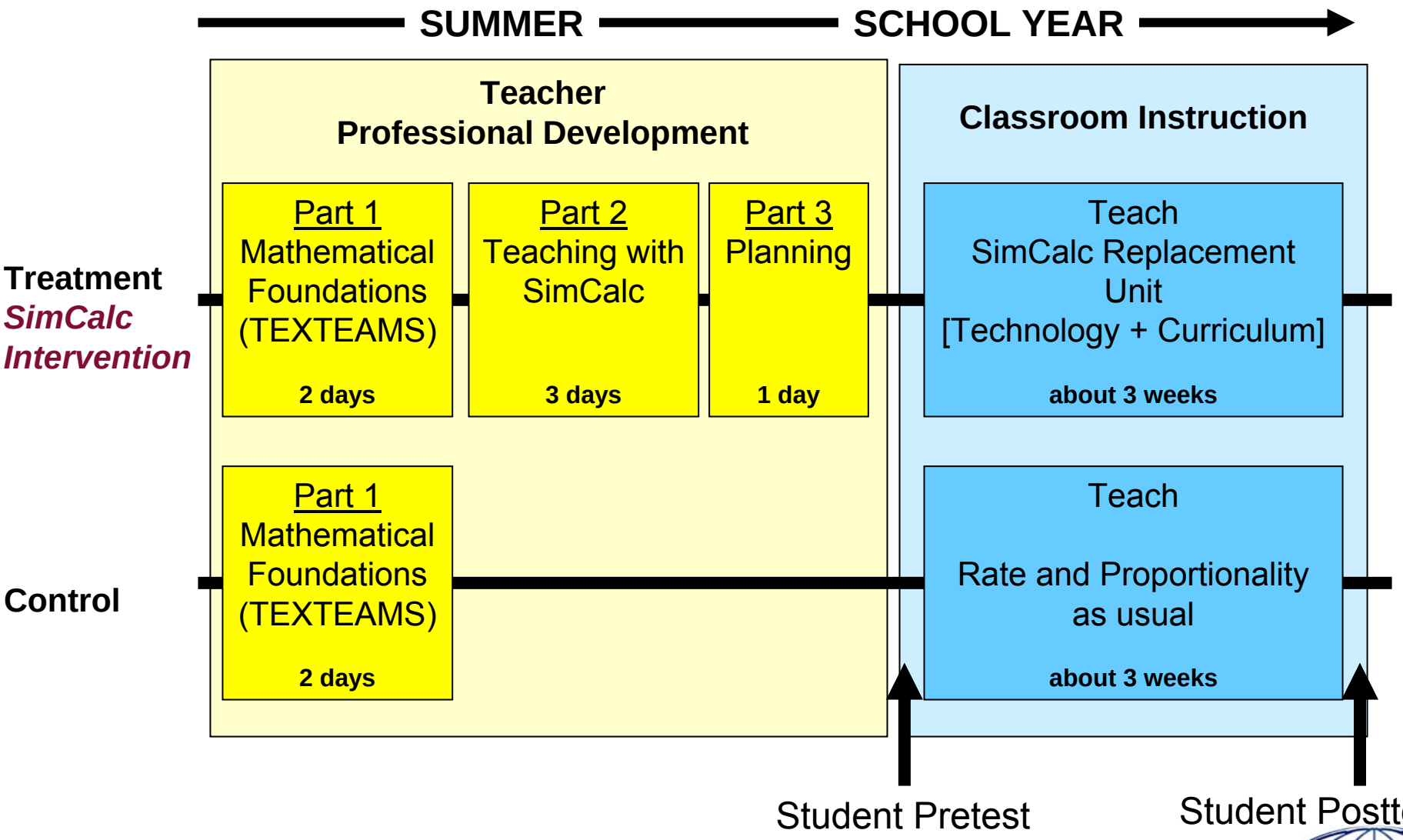
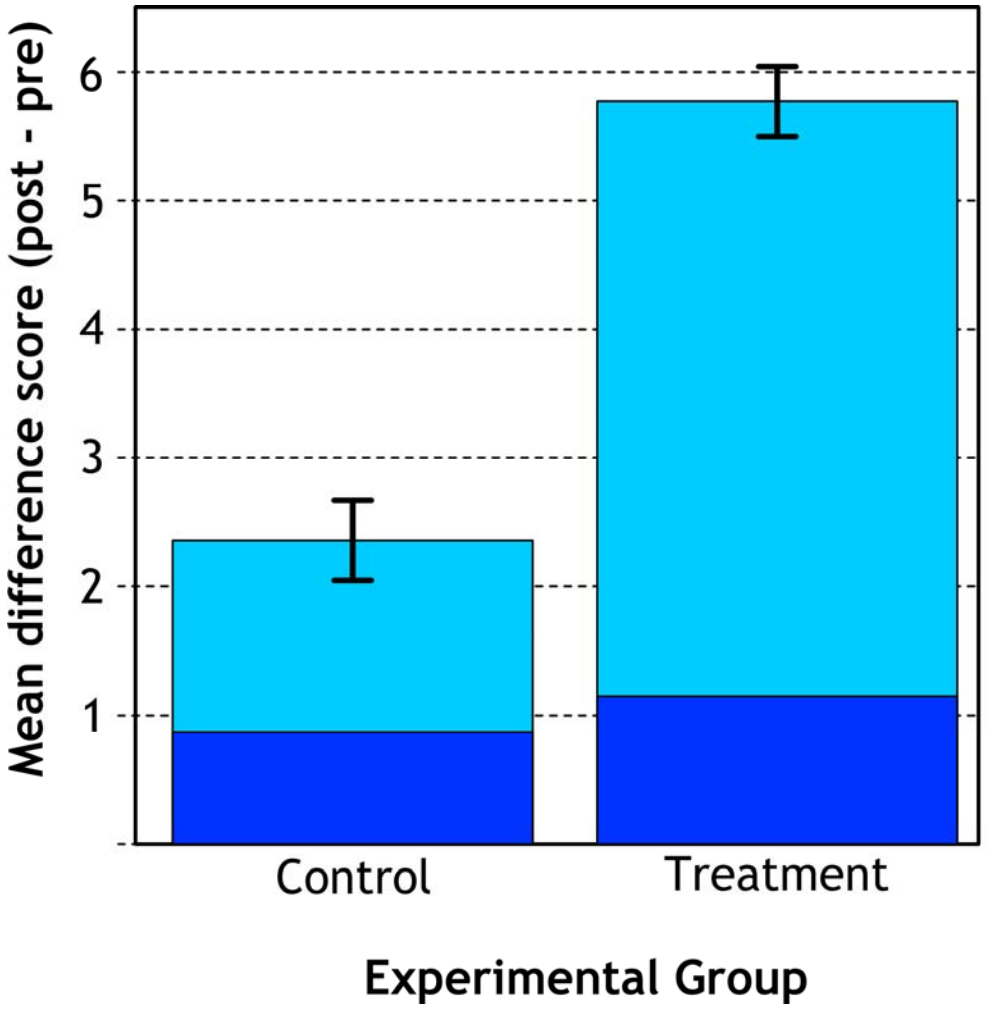
Experimental Design



SimCalc Students Scored Higher

(classroom level)



The overall effect size was 0.84, considered large in education studies

(t(93) = 9.1, P < 0.0001)

N = 95 teachers,

1,501 students

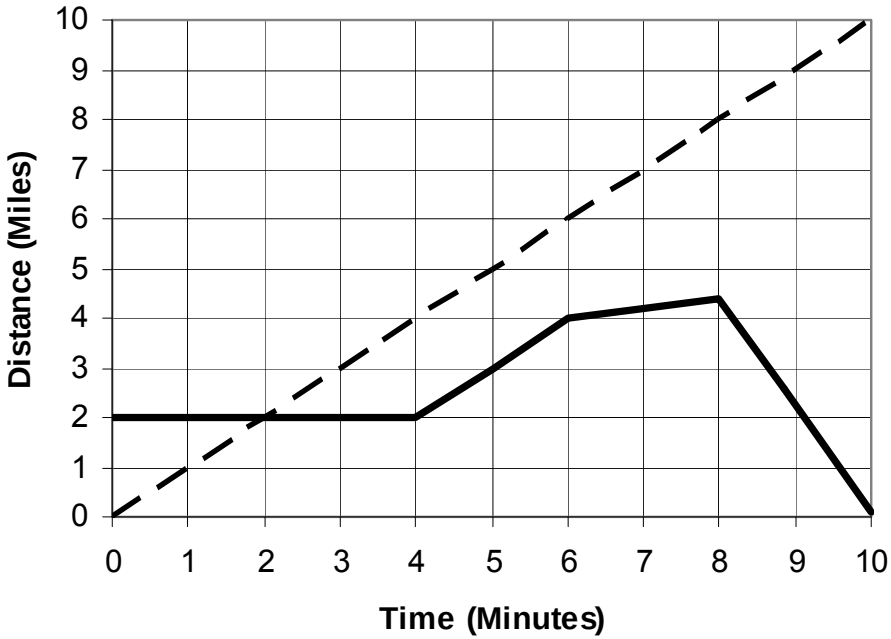
(737 Hispanic; 267 ELL)

Simple

A car of the future will be able to travel 8 miles in 2 minutes.

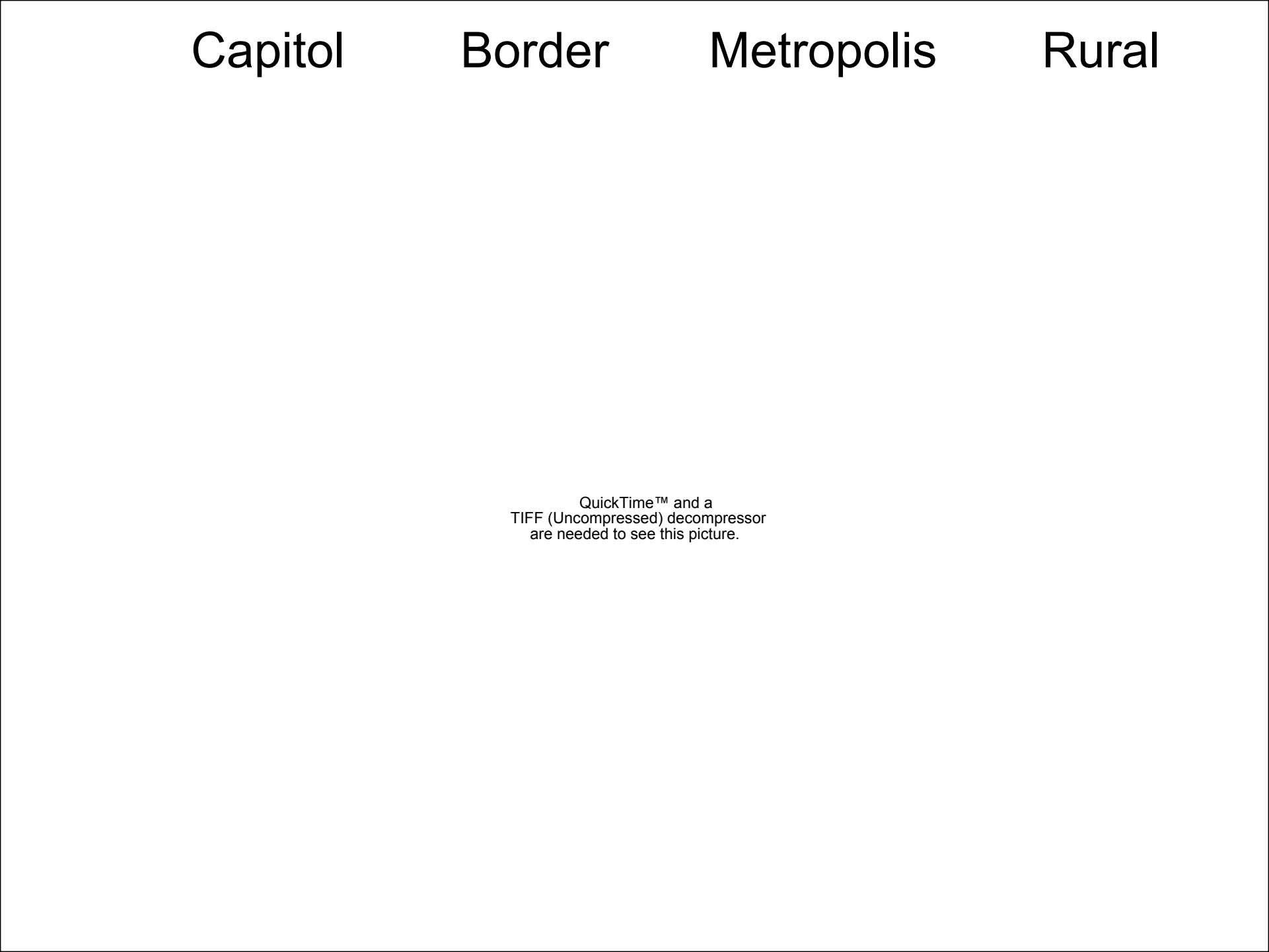
- **How far will it be able to travel in 5 minutes?**

Complex

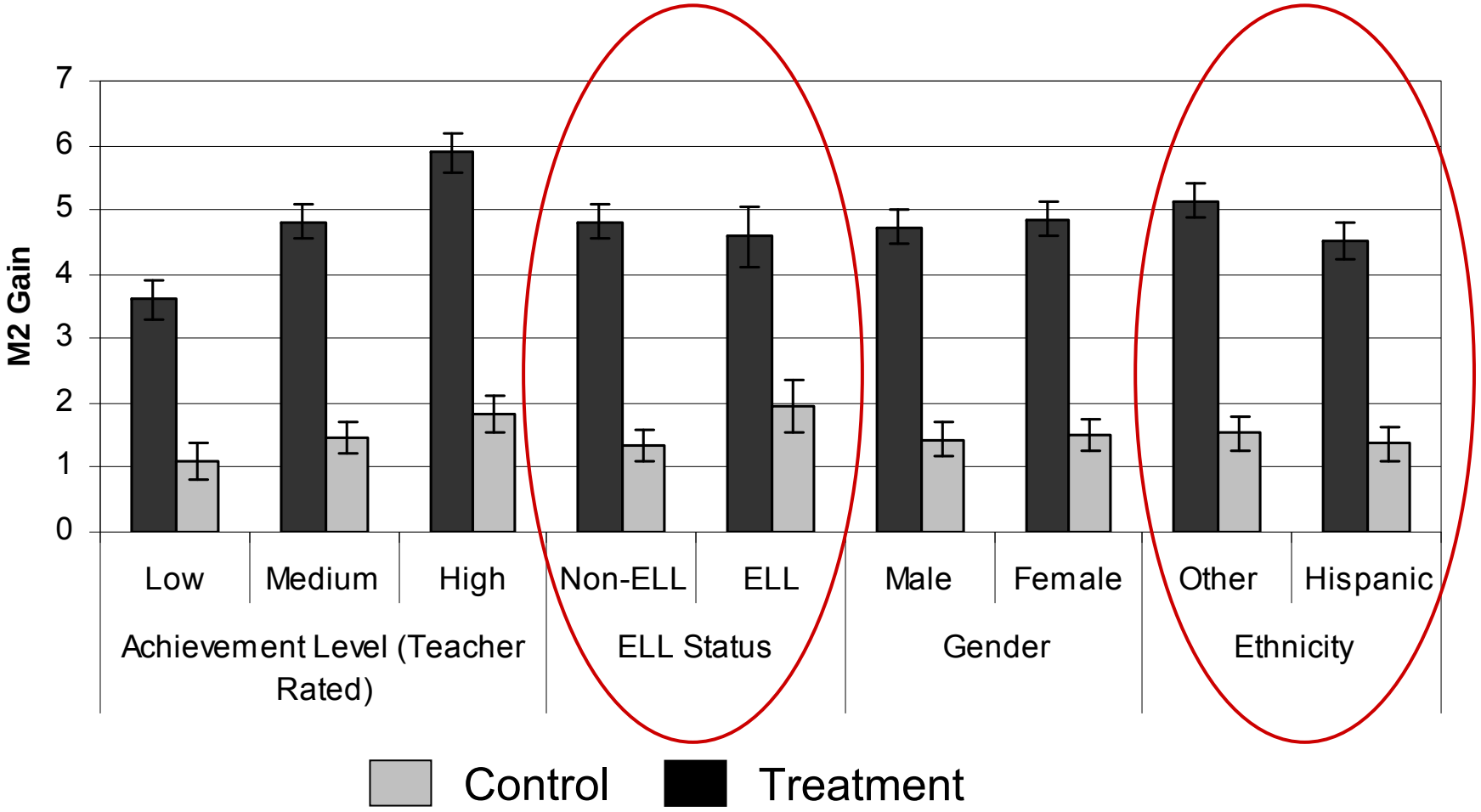


When are they traveling at the same speed?

Capitol Border Metropolis Rural



All student groups learned more with SimCalc



Common Strategies in Use for ELL students

- ~~Focus exclusively on "the basics"~~
- ~~Repeat instruction slower and louder~~
- Vocabulary preview
- Instruction in the "math register"
- Translation to language spoken at home
- Use of children's native language for instruction

Useful, but we didn't support them....

Ongoing work

Las Cruces Public Schools, NM

- Working with teachers to create differentiation strategies
- Focus on low-achieving students
- Third largest school district in New Mexico (24K students)
- “Small city” settings

Teacher Cadre

- Professional Development for teacher leaders, primarily in Texas (up to 180 new SimCalc teachers)

Continuing research and partnerships

- Investigating how to improve SimCalc for ELL students
- Please contact us!

Points to Remember

Top level: not “see, technology works!”

We studied an integration of dynamic math, curriculum & TPD

Key Points:
Challenge: Democratizing Access to Complex Mathematics

Strategy:
- Representational Use of Technology
- Rich tasks
- Transformation of how we engage students

Findings:
- Gains across multiple experiments (7^{th}, 8^{th}, …)
- Gains were robust across settings and demographics

ELL students **can** learn complex math in such environments

Recommendations

- While software alone has sometimes been shown not to make a difference, integrated systems of curriculum, dynamic math software, and TPD can make a difference.
- Dynamic mathematics software can be suitable for both advantaged and disadvantaged student populations.
- Dynamic mathematics software has benefits that may be particularly suitable for ELL students

Thanks!

http://math.sri.com or google "SimCalc"

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