

Using a Technology-enhanced Curriculum to Improve the Learning of Important Mathematics for English Language Learners

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Overview

- The math challenge
- Supports for ELL students
- The SimCalc approach
- Findings
- Conclusions



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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.

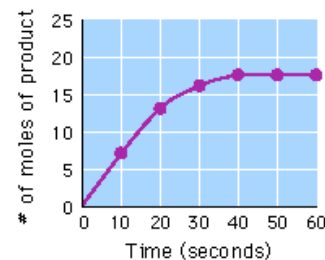


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3

Rate and Proportionality in High School Science

$$F=ma$$



$$V=kx$$

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



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4

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....*



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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)).



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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!**



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Demo



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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.

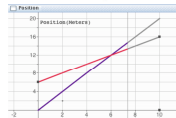
Algebraic Expression

$$y = x + 6$$

$$y = 2x$$

Motion Phenomena

Graph



Table

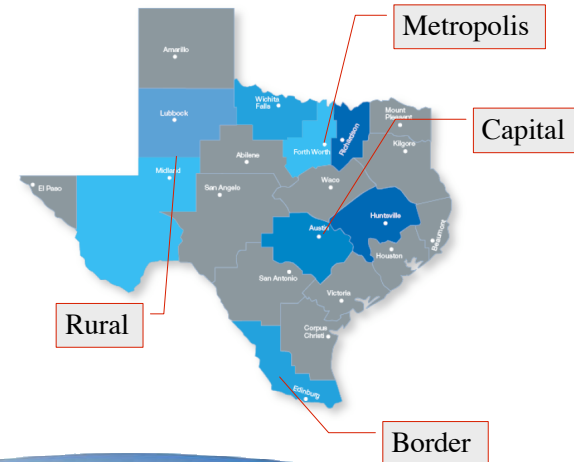
Time	Red	Blue
0	6	0
1	7	2
2	8	4
3	9	6
4	10	8
5	11	10
6	12	12
7	13	14
8	14	16
9	15	18
10	16	20



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9

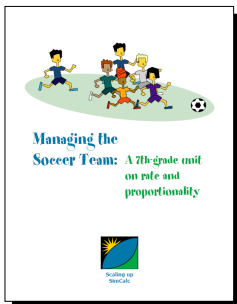
Can it work in a wide variety of settings? (yes) Results from Research with 95 Texas Teachers



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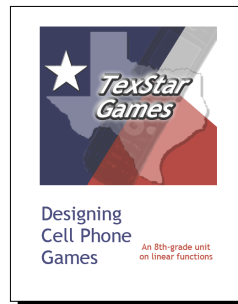
10

Intervention: An Integration of Technology, Curriculum, and TPD



Proportionality (7th Grade)

- Linear function in the form $y=kx$
- Rate



Linear Function (8th Grade)

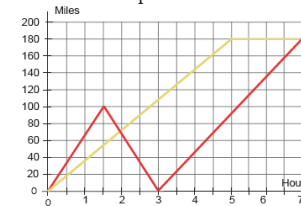
- Linear function in the form $y=mx+b$
- Average rate



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11

4. Three years ago, the trip was not so smooth. Below is the graph of the bus and the van's travel on that trip.



a. What did the van do after traveling for one and a half hours?

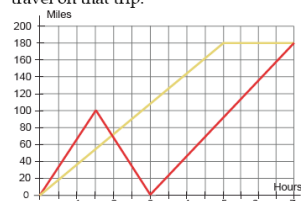
b. What happened here? Tell the story of this trip.



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12

4. Three years ago, the trip was not so smooth. Below is the graph of the bus and the van's travel on that trip.



a. What did the van do after traveling for one and a half hours?

Here is the first time students see a negative slope in this unit. Elicit meaning: It went backwards; it started back toward Abilene. It went from 100 miles out to 0 miles (start point) over a 1.5 hr segment.

Depending on your class, you can calculate the negative slope, talk about velocity vs. speed. Velocity is speed with direction. You can also simply leave this with the interpretation of "went back."

b. What happened here? Tell the story of this trip.

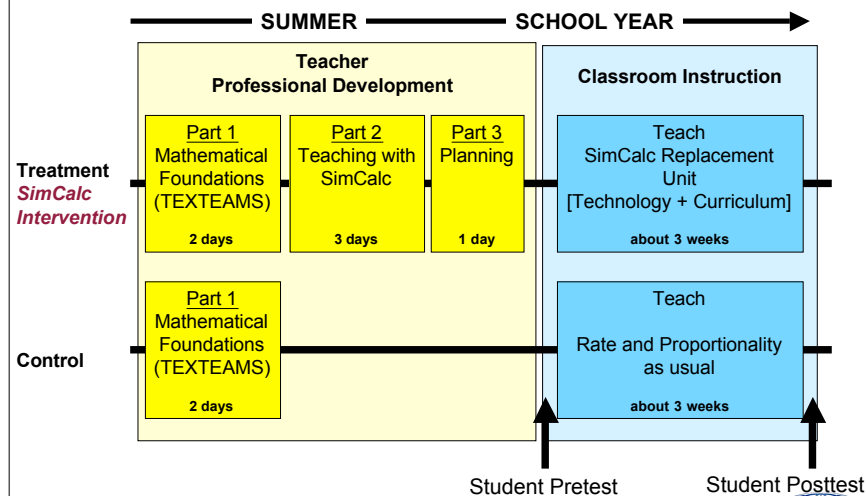
Encourage creativity, step through the simulation to check correctness.



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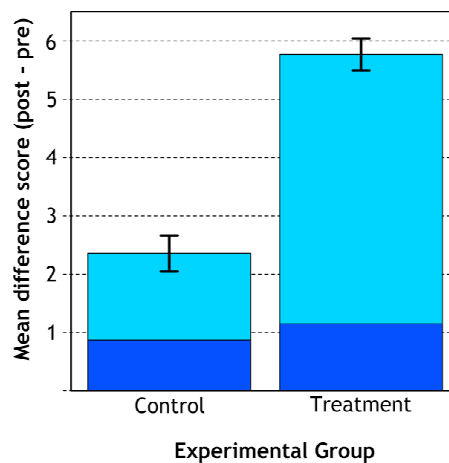
Experimental Design



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14

SimCalc Students Scored Higher (classroom level)



Subscale
 ■ "Complex" proportionality
 ■ "Simple" proportionality

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)



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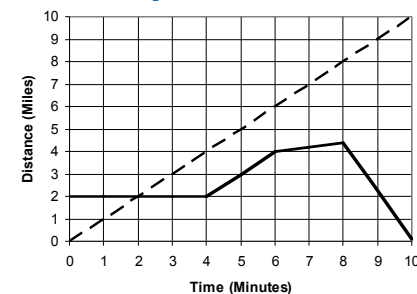
15

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

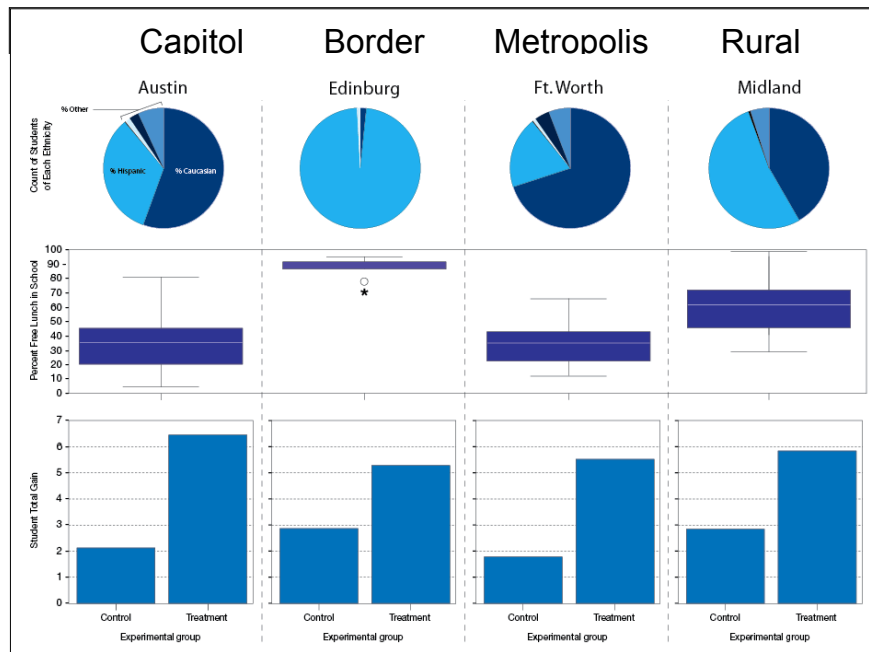


When are they traveling at the same speed?

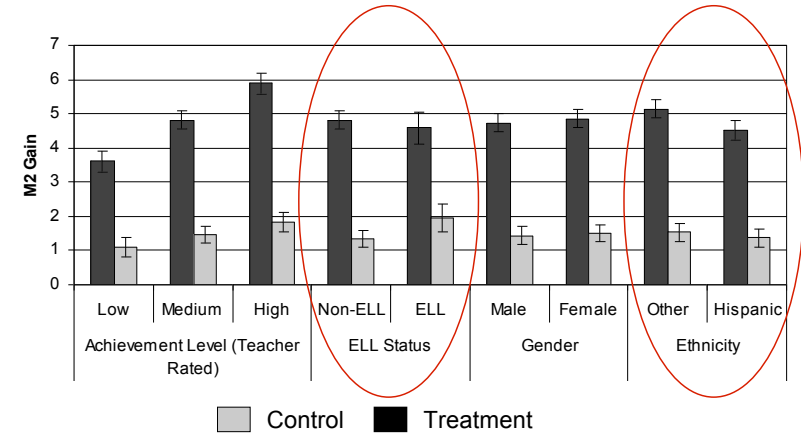


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All student groups learned more with SimCalc



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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!



19

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 (7th, 8th, ...)
- Gains were robust across settings and demographics

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



20

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



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21

Thanks!

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

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