How Does Teaching Numerical Reasoning Benefit the Whole Child?

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Personal Numbers

406

4

14,000

5/7

35

What comes to mind when you think about your experiences with math?

Pencils Paper Quiet

Problems Symbols Confusion

Teacher Mistakes Practice

Fear Speed Tests

Flash cards Worksheets

Timed tests Answers

Satisfaction Memorization

What Is Number Sense?

"... an awareness and understanding about what numbers are, their relationships, their magnitude, the relative effect of operating on numbers, including the use of mental mathematics and estimation."

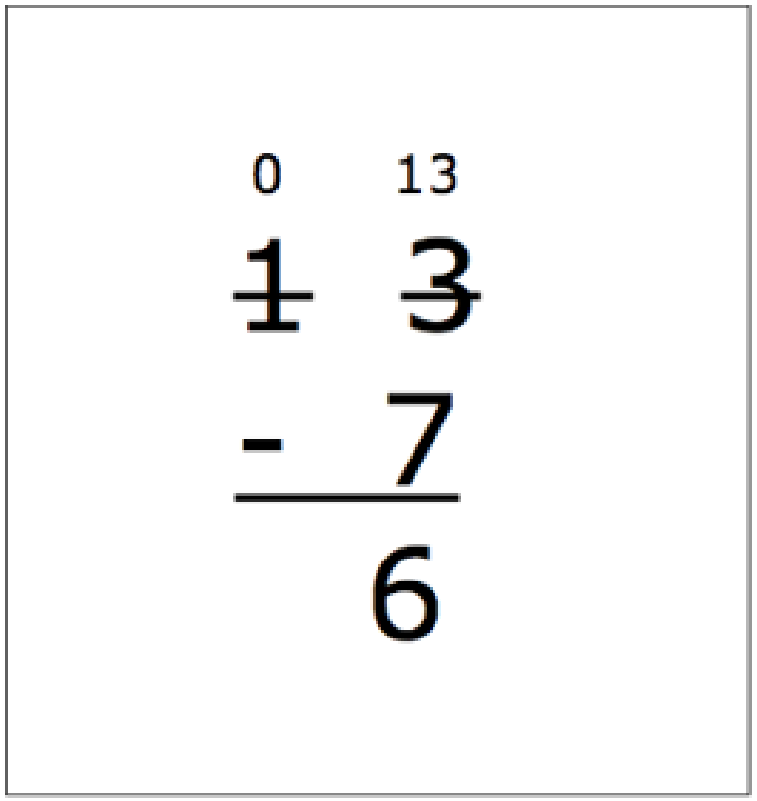
Fennell and Landis (1994)

77% of Community College Students

"Math was not something that could be figured out, or that made sense. It was just a set of procedures and rules to be memorized."

- (Karen Givvin, 2011)

Liza



There are 125 sheep and 5 dogs in a flock.

Kurt Reusser, 1986
Katherine K. Merseth, 1993
Robert Kaplinsky, 2018

3 out of 4 students

will produce a nonsensical answer

1. There are 125 sheep and 5 dogs in a flock. How old is the shepherd?

2. The shepherd is 130 years old because he maybe got an animal each year.

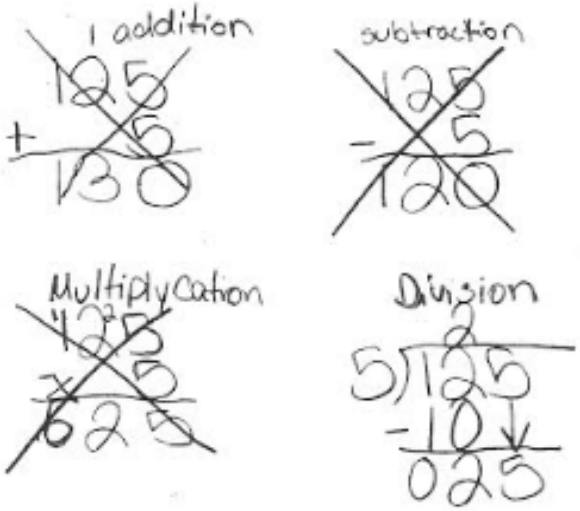
Vinnay

Math Mrs. Nyce

There are 125 sheep and 5 dogs in a flock. How old is the sheep-herd.

I thing they are 120 years old. I got there by subtracting.

There are 125 sheep and 5 dogs in a flock. How old is the sheepherd.



I added, Subtracted, Multiplyed, and divided. I think it is 25 because nobody can live that long as 625, 120, or 130.

The answer is 25

What Are Common Errors Students Make?

$3 + \_\_\_ = 7$	$\begin{array}{r} 45 \\ +\ 27 \\ \hline \end{array}$	$\begin{array}{r} 51 \\ -\ 36 \\ \hline \end{array}$
$\begin{array}{r} 25 \\ \times\ 16 \\ \hline \end{array}$	$\frac{2}{5} + \frac{6}{7}$	2^3

The Big Question

How Can We Foster Numerical Reasoning?

And what does that have to do with making sure students are…

- Safe
- Engaged
- Supported
- Challenged

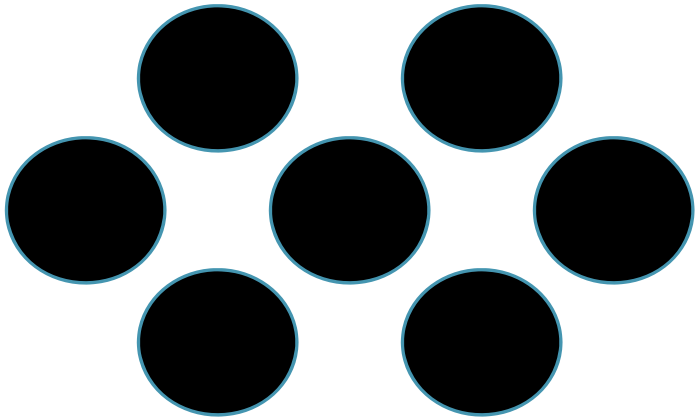
Number Talks

A five to fifteen minute classroom conversation around purposefully crafted problems that are solved mentally

What Does It Look Like?

- Quiet Thumbs/WAIT Time
- Solicit answers
- Me, too signal
- Respectful discourse
- Listen and record 2-4 strategies to reach consensus

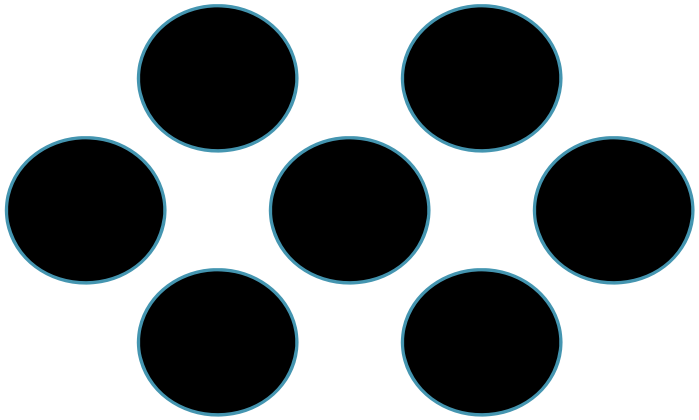
Number Talk



How many did you see?

How did you see it?

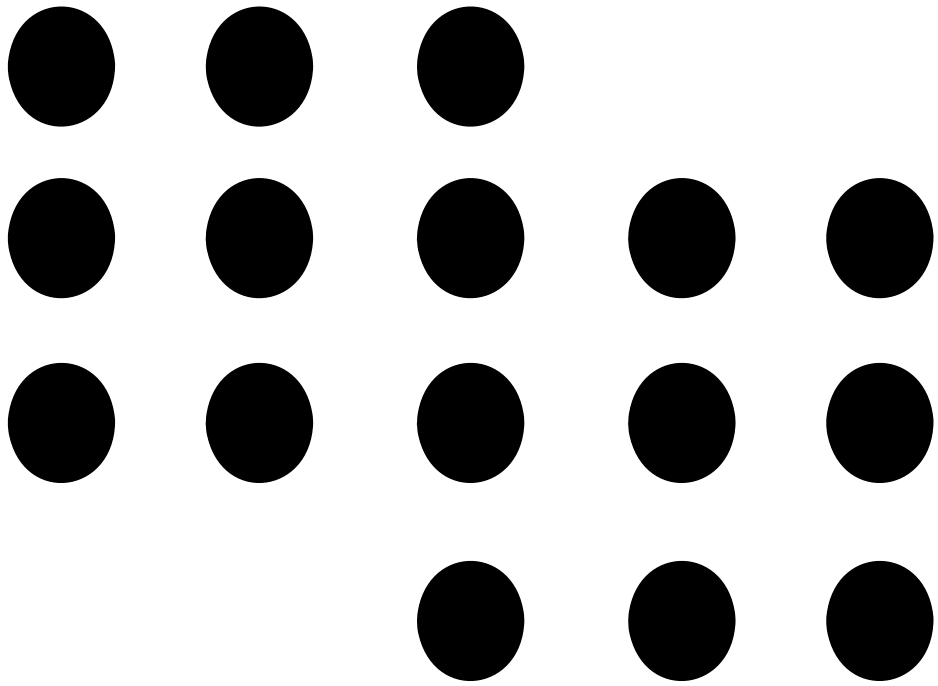
Number Talk



3 Types of Knowledge

- Social
- Physical
- Logico-Mathematical
  - Relationships
  - Student-invented strategies

Jean Piaget



Computation Goals

Accuracy

Flexibility

Efficiency

Addition Number Talk

35 + 38

$$35 + 38$$

$$= 35 + (35 + 3)$$

$$= (35 + 35) + 3$$

$$= 70 + 3 = 73$$

$$35 + 38$$

$$= (30 + 5) + (30 + 8)$$

$$= (30 + 30) + (5 + 8)$$

$$= 60 + 13 = 73$$

275 + 128

$$275 + 128$$

$$= 275 + (100+25+3)$$

$$= (275+ 25) + (100 + 3)$$

$$= 300 + 100 + 3 = 403$$

$$275 + 128$$

$$= 275 + (125 + 3)$$

$$= (275 + 125) + 3$$

$$= 400 + 3 = 403$$

$$275 + 128$$

$$= (200+70+5) + (100+20+8)$$

$$= (200+100) + (70+20) + (5+8)$$

$$= 300 + 90 + 13 = 403$$

70 - 34

What tenets of the whole child approach do you see in the following Number Talk video?

- Safe
- Engaged
- Supported
- Challenged

https://players.brightcove.net/5387496875001/default_default/index.html?videoId=5441380862001

Pilot Study on Effects of Number Talks

Little research currently available

Our research questions:

1) What effect do NTs have on student achievement?

2) How do NTs affect students' attitude about mathematics?

Research Site

- Inner-city K-5 school; 71% Free/Reduced lunch
  - "Failing Schools" list (bottom 6% State student achievement scores)
  - Number Talks were not already happening

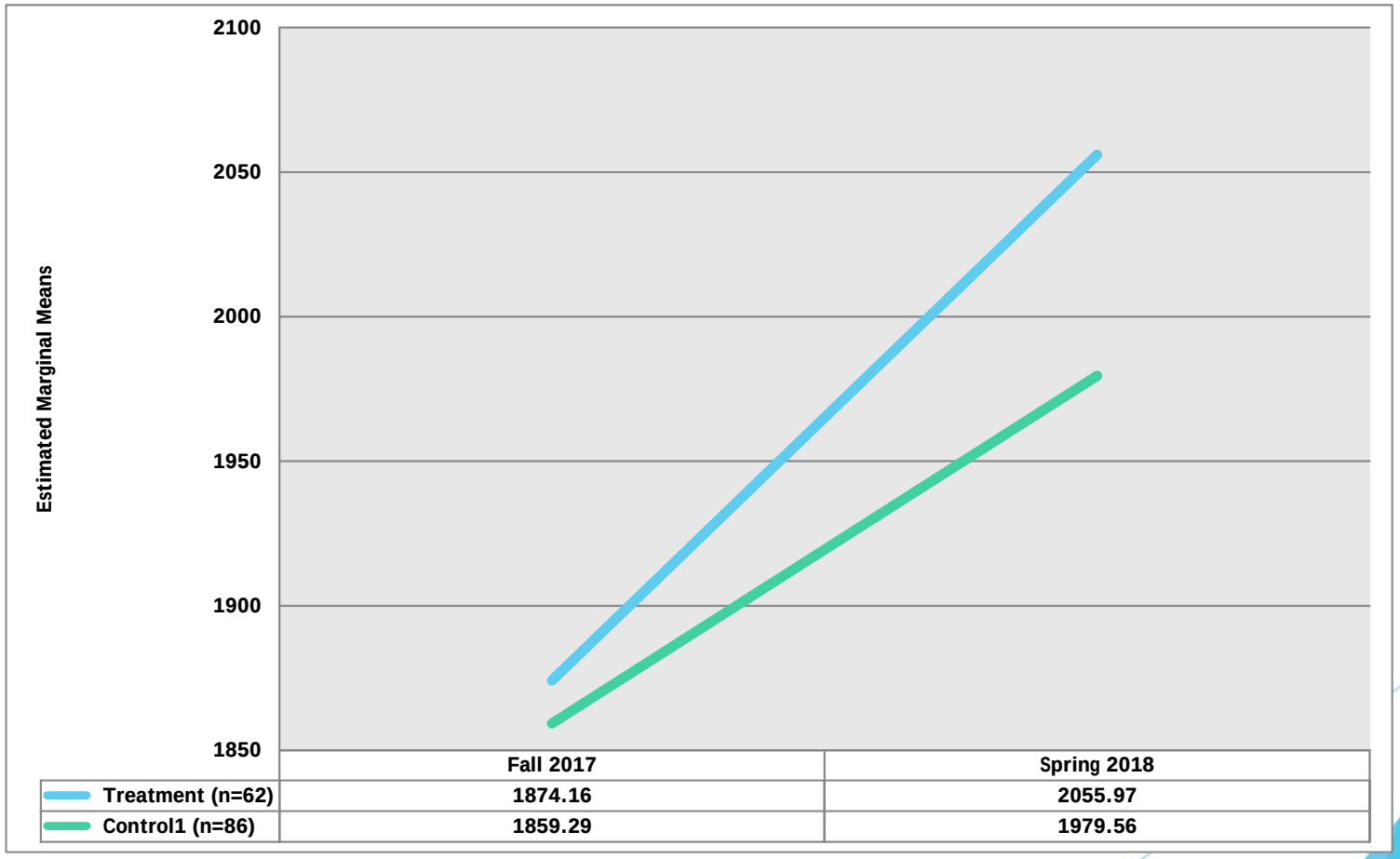
Treatment

- Experienced Number Talk facilitator
  - 30+ years experience as teacher and K-5 mathematics coach
- 15-minute Number Talks 2-3x a week; 2nd and 3rd grades
- October-end of April

Data Collection

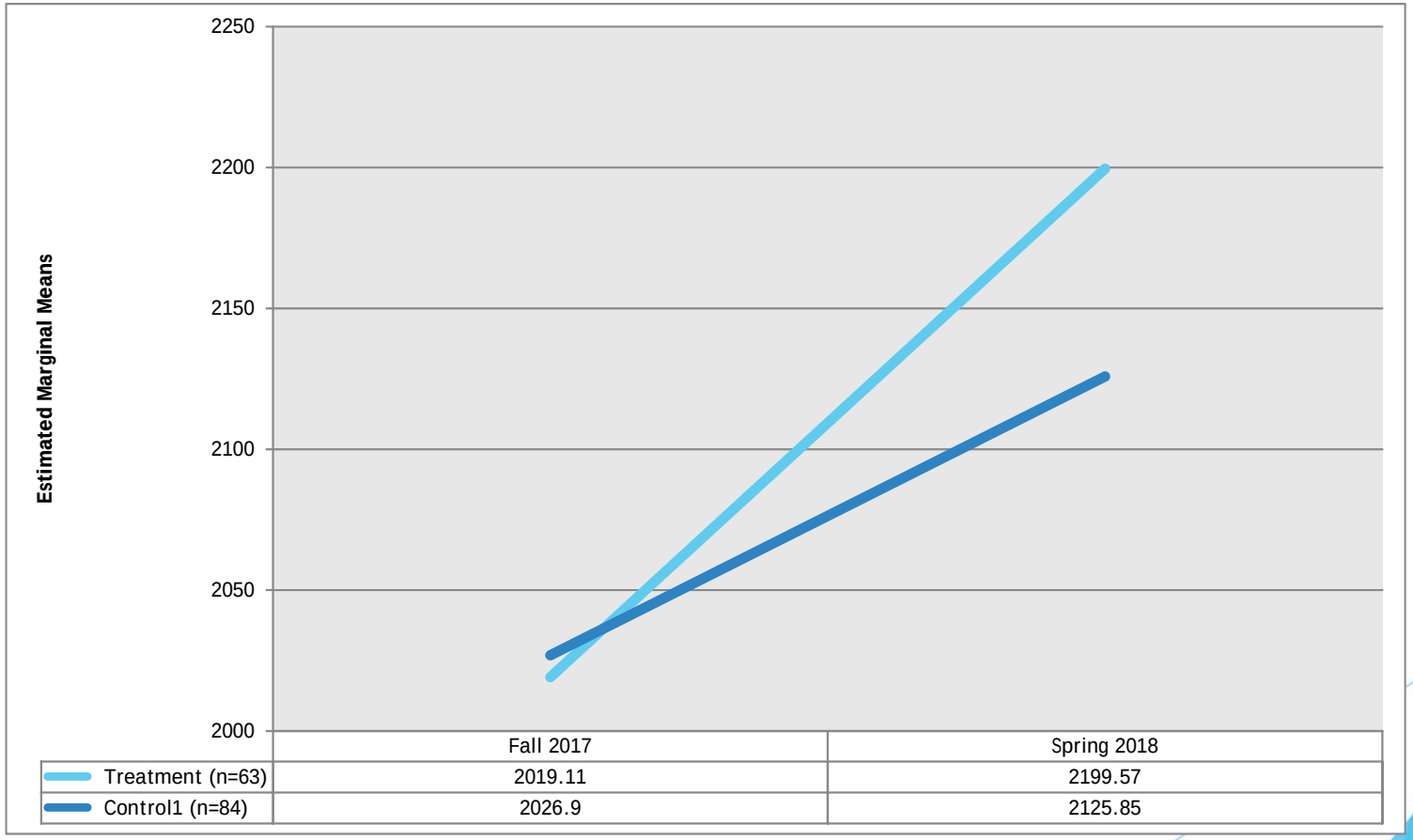
- Classroom Observations of Number Talks
- Number Talk Facilitator Notes
- State Achievement Test Results (Scantron Test)
  - Fall, Winter, and Spring
- Teacher Focus Groups

Scaled Scores-2nd Grade



	Fall 2017	Spring 2018
Treatment (n=62)	1874.16	2055.97
Control1 (n=86)	1859.29	1979.56

Scaled Scores 3rd grade



	Fall 2017	Spring 2018
Treatment (n=63)	2019.11	2199.57
Control1 (n=84)	2026.9	2125.85

In the beginning, most students…

- Used one strategy to solve problems
- Rarely listened to each other
- Were NOT tolerant of wait time
- Did not talk in terms of place value

2nd Semester students regularly…

- Used multiple strategies to solve problems
- Listened to each other
- Expected and were tolerant of WAIT TIME
- Talked about and used Place Value understanding

In the beginning, most students…

- Used vague language i.e. "those over there"
- Did not estimate because they "didn't know the answer yet"
- Did not make relationships to anything else they might know

2nd Semester students regularly…

- Used precise language i.e. "two on the left," or "20" for the "2" in 28
- Could use estimation as justification for what an answer "should be close to"
- Said, "I know because…."

In the beginning, most students…

- Did not recognize dice patterns or other visual patterns—had to count everything
- Did not have fluency, even with small numbers
- Were very procedural

2nd Semester students regularly…

- Quickly recognized dot patterns without counting by ones
- Displayed fluency
- Offered solutions based on logic

Teachers' Comments regarding Number Talks

- "Students enjoy Number Talks."
- "It's (NTs) helping with the rest of math."
- NTs increase children's enthusiasm for doing math outside of NT time."
- "I like that it helps them construct their own understanding."
- "I'm amazed that kids can come up with their own strategies!"
- "Students are more confident in sharing answers."

What teachers said about how NTs helped them

- "I am better with place value and I'm more consistent with my own math language because of Number Talks."
- "Meeting students where they are (instead of only presenting grade level content) is helpful."
- "Students are used to us (teachers) telling them how to think, and this is helping *them* to do the thinking--and it's helping *me!*"

Teachers report that NT help not only with math

- “Social interactions are improving. Students use “point of interest” signal when they disagree.”
- “Number Talks have helped my children be better at waiting and it’s helped them to be more patient when someone else is talking.”
- “Students are able to talk to each other without arguing. Instead of saying ‘That’s wrong,’ or ‘That’s dumb,” now it’s ‘Why did you do that?”

To do Number Talks well teachers have to:

- Respect that children have important ideas
- Listen
- Engage students in thinking
- Build confidence/Support
- Challenge

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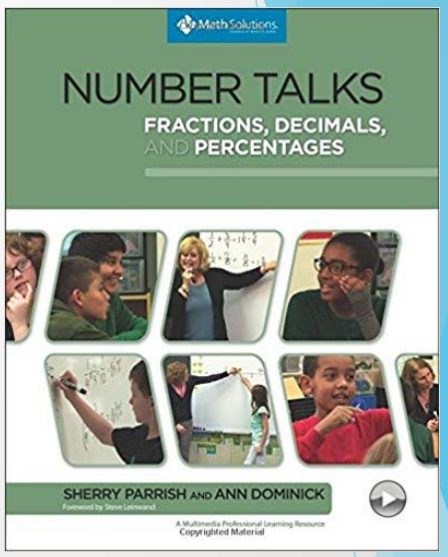

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