Extreme Equality

Closing the Math Achievement Gap

John Mighton

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MULTIPLYING POTENTIAL.

RESEARCHERS

Brent Davis
Chair (Mathematics Education), University of Calgary

Michele Mazocco
Director, Math Skills Development Project (Psychiatry), Johns Hopkins

Steven Ross
Professor (Center for Reform in Education), Johns Hopkins

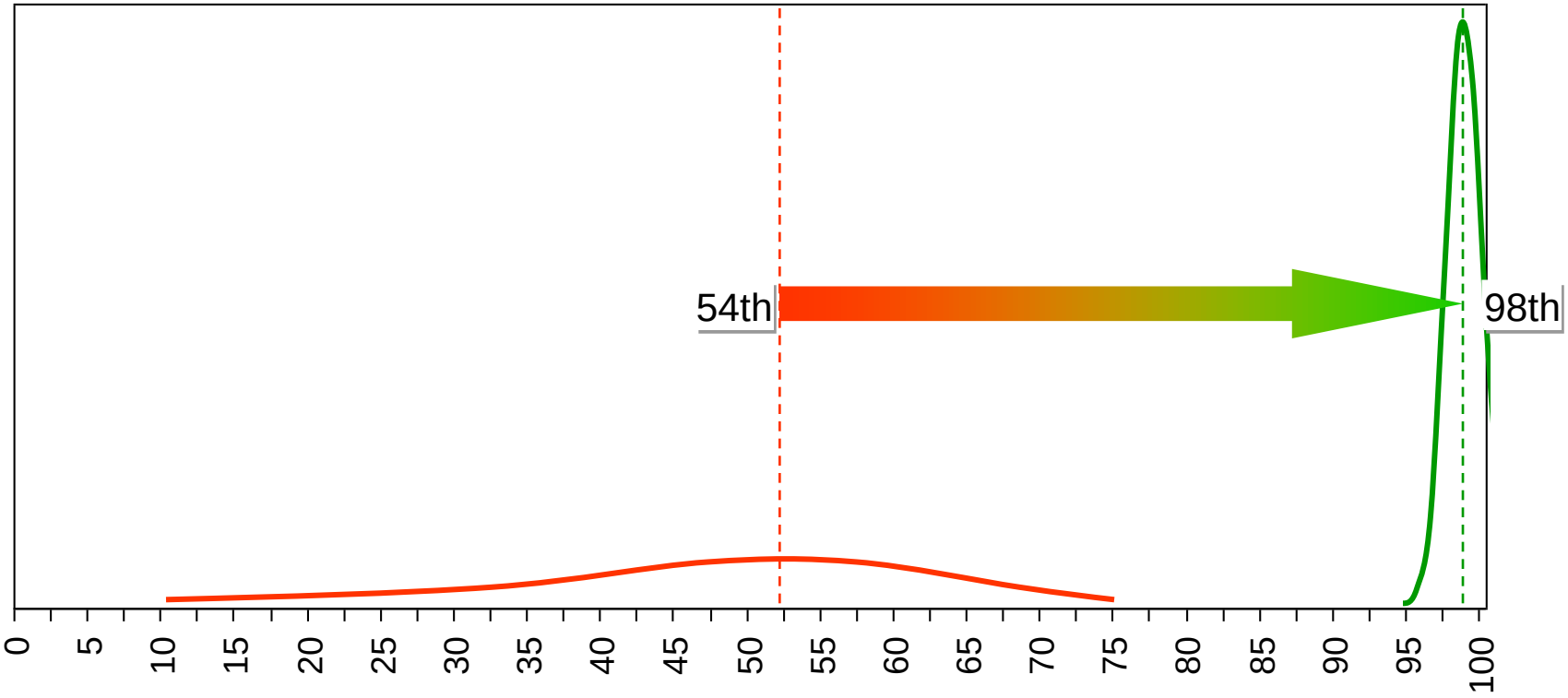
Linda Siegel
Dorothy Lam Chair in Special Education, UBC

Tracy Solomon
Developmental Psychologist, Toronto Hospital for Sick Children

Proof of Concept: Bookend #1

Case Study 1: Mabin School – Toronto, Ontario, Canada

Percentile Rankings*, Grade 5 (2008) vs Grade 6 (2009)



Notes: *Class percentile ranking based on results on the norm-referenced Test of Mathematical Abilities

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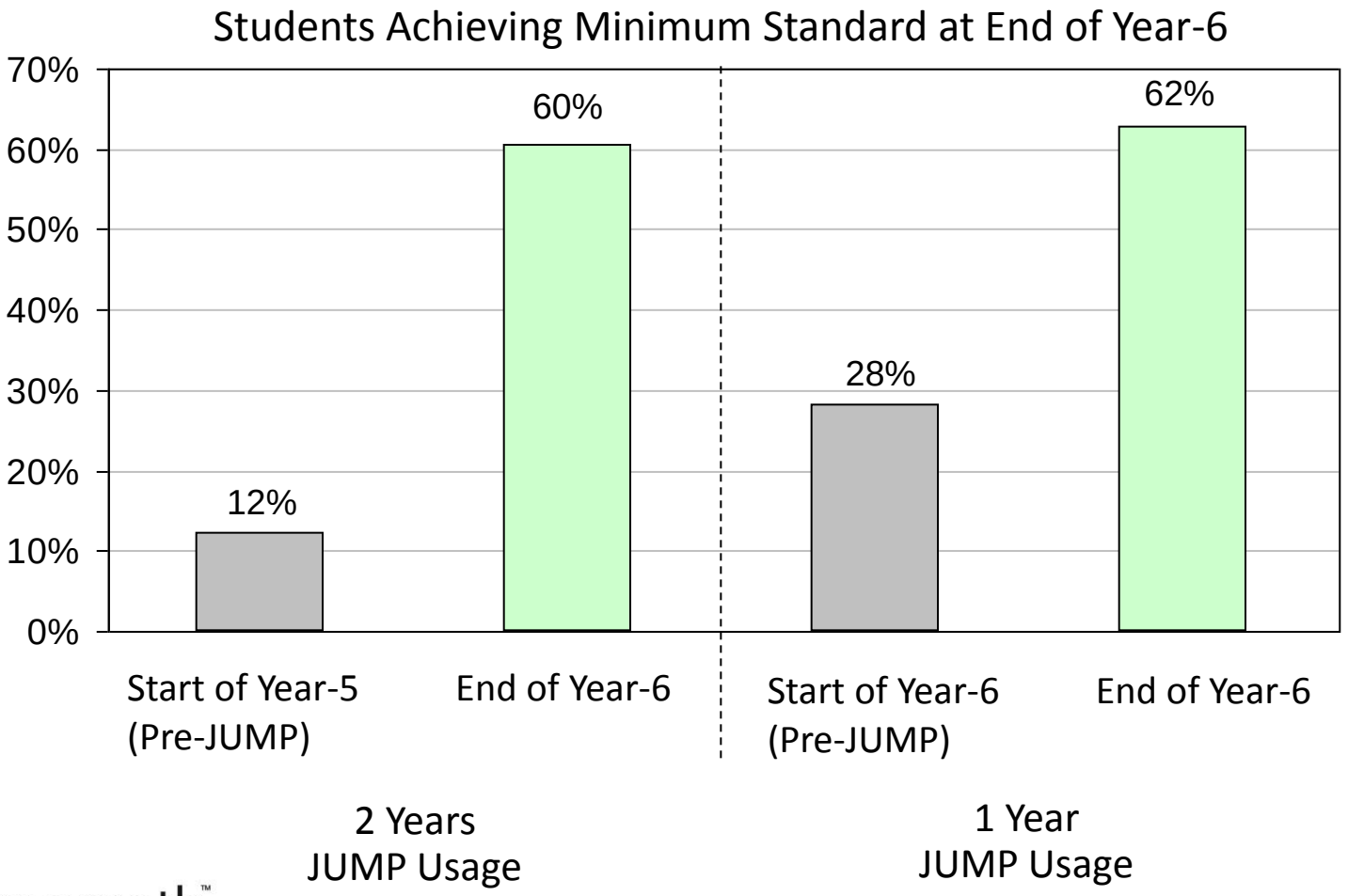
Proof of Concept: Bookend #2

Case Study 2: Lambeth School Board – Borough of Lambeth, UK



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Proof of Concept: Randomized-Controlled Study #1

Randomized-Controlled Study: Rural Canadian School Board

Findings:

- JUMP students' math knowledge "grew twice as much"
  - Outperformed on all measures (fluency, calculation & quantitative)
- JUMP and control groups very well matched

Study Design:

- 29 grade 5 classrooms, in 18 schools
- 1-day training plus 1-day follow-up for each of JUMP and incumbent program
  - No JUMP contact with board outside of two training days
- Extensive pre- and post-assessment of teachers & students

•Source: *Solomon et al (Hospital for Sick Children, Ontario Institute for Studies in Education, University of Toronto), 2011. Investigation of a Cognitive Science Based Approach to Mathematics Instruction, data presented at Society for Research in Child Development Biennial Meeting, Montreal, March 31 - April 2, 2011. Awaiting publication.*

- Range of Students
- Attitude of Students (and parents)
- Language
- Lack of basic skills and concepts
- Time
- Difficulties with problem solving
- Teacher's comfort with math

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"Unassisted learning does not benefit learners, whereas feedback, worked examples, scaffolding and elicited explanations do."

- L. Alfieri (et al), "Does discovery-based instruction enhance learning?", Journal of Educational Psychology (2011)

Herb Simon (et al), "Applications and misapplications of cognitive psychology to mathematics education", Texas Educational Review (2000)

More information at: jumpmath1.org/supporting_research

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GUIDED DISCOVERY

- Adequate Review
- Rigorous scaffolding
- Adequate practice
- Challenges in steps
- Differentiated instruction (without differentiated outcomes)

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PA5-7
Identifying Pattern Rules

GOALS

Students will identify simple pattern rules.

PRIOR KNOWLEDGE REQUIRED

Addition
Subtraction

VOCABULARY

increasing sequence
decreasing sequence
term

Tell your students that today you will make the task from the previous lesson harder—you will give them a sequence, but you will not tell them what the rule is; they have to find it themselves. Give them an example—write a sequence on the board: 2, 6, 10, 14… Is it an increasing or a decreasing sequence? What was added? Let students practice with questions like:

Write the rule for each pattern:

a) 69, 64, 59, 54, subtract _____

b) 35, 39, 43, 47, add _____

c) 43, 54, 65, 76, add _____

d) 119, 116, 113, subtract _____

e) 25, 32, 39, 46, add _____

f) 98, 86, 74, subtract _____

Tell another story about pattern fans Bonnie and Leonie: The teacher asked them to write a sequence that is given by the rule "add 2". Bonnie has written the sequence: "3, 5, 7, 9…". Leonie has written the sequence: "2, 4, 6, 8…". They quarrel—whose sequence is the right one?

Ask your students: how can you ensure that the sequence given by a rule is the one that you want? What do you have to add to the rule? Students should see that you need a single number as a starting point. Write several sequences on the board and ask your students to make rules for them.

Explain to your students that mathematicians need a word for the members of the sequences. If your sequence is made of numbers, you might say "number". But what if the members of the sequence are figures? Show an example of a pattern made of blocks or other figures.

Tell the students that the general word for a member of a sequence is "term".

Form a line of volunteers. Ask them to be a sequence. Ask each student in the sequence to say in order: "I am the first/second/third… term." Ask each term in the sequence to do some task, such as: "Term 5, hop 3 times", or "All even terms, hold up your right arm!" Ask your sequence to decide what simple task each of them will be do, and ask the rest of the class to identify which term has done what. Thank and release your sequence.

MORE PRACTICE:

a) What is the third term of the sequence 2, 4, 6, 8?
b) What is the fourth term of the sequence 17, 14, 11, 8?
c) Extend each sequence and find the sixth term:

i) 5, 10, 15, 20 ii) 8, 12, 16, 20 iii) 131, 125, 119, 113, 107

WORKBOOK 5:1 PAGE 7

Bonus

What operation was performed on each term in the sequence to make the next term: 2, 4, 8, 16… (**HINT:** neither "add", nor "subtract". **ANSWER:** Multiply the term by 2.)

ACTIVITY

Divide your students into groups or pairs and ask them to play a game: One player or group writes a sequence, the other has to guess what the rule is. Each correctly solved problem gives 5 points. Warn them that the rules have to be simple—otherwise they will have to give clues. Each clue lowers the score by 1 point for both players or groups.

Extensions

1. Find the mistake in each pattern and correct it.

   a) 2, 5, 7, 11 add 3
   b) 7, 12, 17, 21 add 5
   c) 6, 8, 14, 18 add 4
   d) 29, 27, 26, 23 subtract 2
   e) 40, 34, 30, 22 subtract 6

2. Divide the students into groups or pairs. One player writes a rule, the other has to write a sequence according to the rule, but that sequence must have one mistake in it. The first player has to find the mistake in the sequence. Warn the students that making mistakes on purpose is harder than simply writing a correct answer, because you have to solve the problem correctly first! The easiest version is to make the last term wrong. More challenging is to create a mistake in any other term.

3. Find the missing number in each pattern. Explain the strategy you used to find the number.

   a) 2, 4, _____, 8 b) 9, 7, _____, 3
   c) 7, 10, _____, 16 d) 16, _____, 8, 4
   e) 3, _____, 11, 15 f) 15, 18, _____, 24, _____, 30
   g) 14, _____, _____, 20 h) 57, _____, _____, 45

4. One of these sequences was not made by a rule. Find the sequence and state the rules for the other two sequences. (Identify the starting number and the number added or subtracted.)

   a) 25, 20, 15, 10 b) 6, 8, 10, 11 c) 9, 12, 15, 18

5. Students should know the meaning of "term" and should be able to connect each term in a sequence with its term number. (For instance, in the sequence 4, 10, 16, 22, the first term is 4, the second term is 10, and so on.)

   Here are some questions that will give students practice with this skill:

   a) What it the third term of the sequence 2, 4, 6, 8?

   b) What is the fourth term of the sequence 17, 14, 11, 8?

   c) Extend each sequence and find the sixth term.