


Early Mathematics Intervention for Tier II Support: Design, Findings, & Data

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Agenda

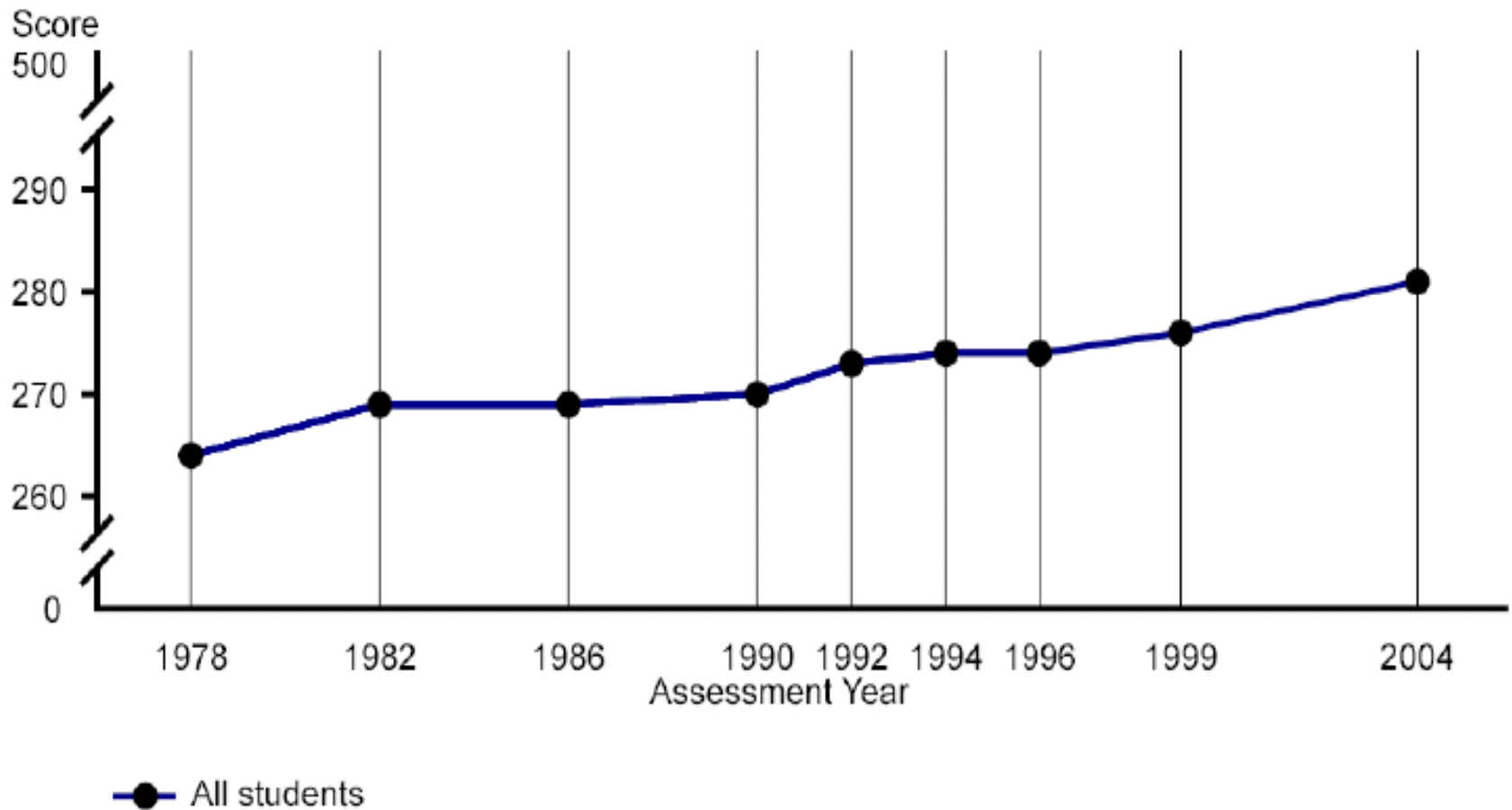
- **Introduction**
- **Method**
- **Results**
 - PNRT data
 - CBM data
 - Teacher ratings of program
- **Discussion & Limitations**



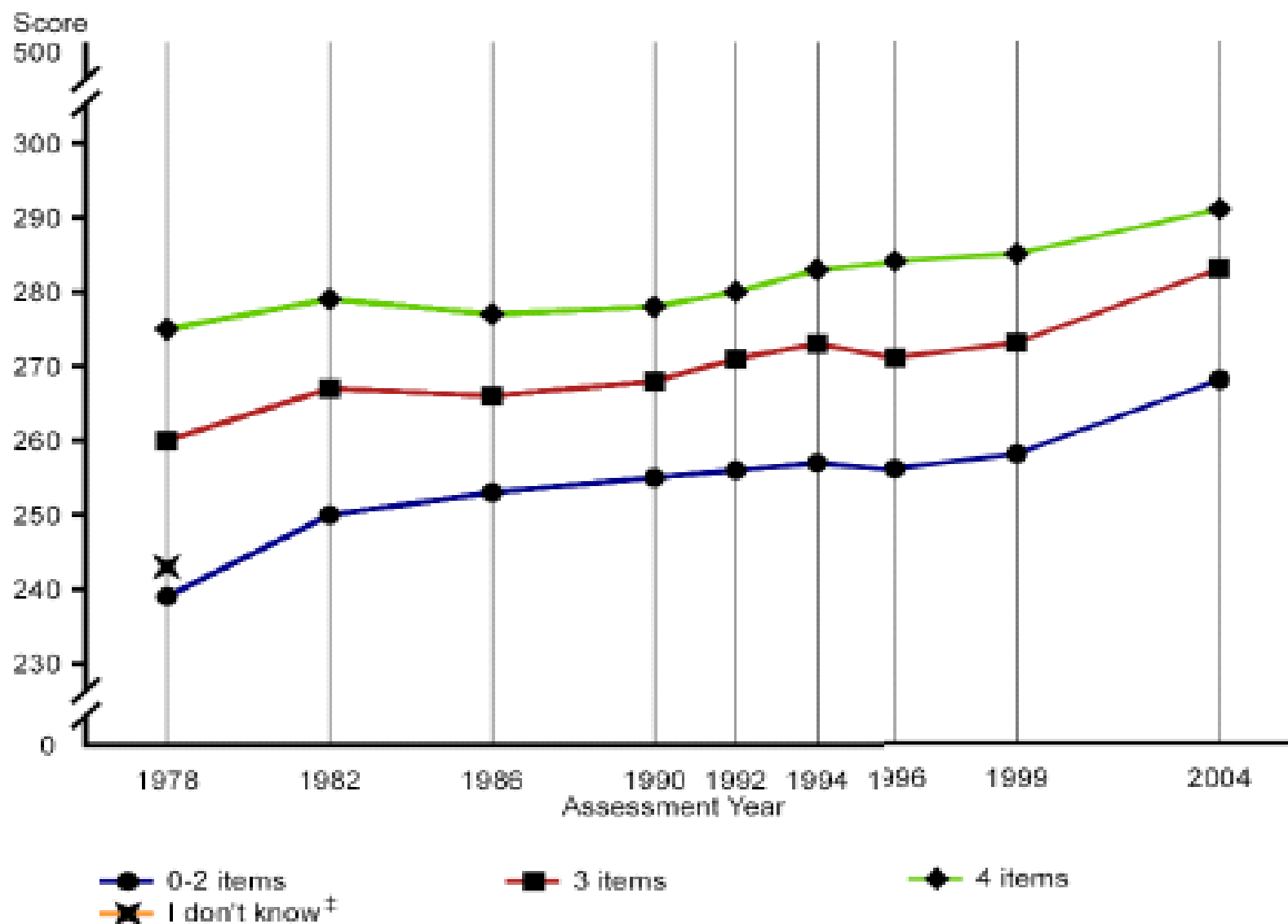
The Effect of Schooling on Numeracy Development for Children “At-Need”

- **Big news: math scores improving! (next slide)**
- **However, schools appear to uphold a social and economic status quo (next two slides)**
- **Leading to an erroneous conclusion that society cannot rely on schooling to enhance outcomes for at-risk groups in mathematics**
- **School psychologists implementing evidence-based tier II intervention can help!**

Average scale scores for long-term trend mathematics, age 13
All students [TOTAL]
National (LTT), 1978, 1982, 1986, 1990, 1992, 1994, 1996, 1999 and 2004



Average scale scores for long-term trend mathematics, age 13
Reading materials in the home [HOMEEN4]
National (LTT), 1978, 1982, 1986, 1990, 1992, 1994, 1996, 1999 and 2004





What is Numeracy?

- **An “ability and inclination” to use numbers and number principles to solve problems (Clarke & Shinn, 2004)**
 - Literacy uses an alphabetic code
 - Numeracy uses a numeric code
- **We are a data-drenched and data-driven society**



More About Numeracy

- Also known as “numeric literacy”
- Early origins of numeracy known as a “number sense,” which is an awareness that numerals are representative of underlying concepts of quantity.
- What are these concepts? Think of the Mesopotamian Shepherd (Gazale, 2000) and the convenience store clerk.
 - Shepherd counts and tracks sheep using clay pots – foundation for “early numeracy”
 - Convenience store clerks group lottery scratch tickets by 5s for large orders of scratch tickets.



More About Numeracy

- **Concepts (Clements, Sarama, & DiBiase, 2004; Clements, 2004; Methe & Riley-Tillman, 2008):**
 - **Counting**
 - **Comparing and Ordering**
 - **Equal Partitioning**
 - **Composing and Decomposing**
 - **Grouping (also known as unitizing; see Twomey & Fosnot, 2001)**
 - **Adding to and Taking Away**
- **Across all levels of these concepts, children use “subitizing” ability to automatically recognize numbers of sets (Clements, 2006)**

Key Outcomes

- **School- and Work-Related Outcomes:**
 - **Bynner (2004) indicated that out of all students in their sample who dropped out of school, 80% had math skills in upwards of 5 grade levels lower than peers who did not drop out**
 - **Students with low numeracy less likely to attend a University (Idris, 2006)**
 - **Relegated to marginal, part-time work with low levels of self-rated job satisfaction (Bynner, 2004)**

Key Outcomes

- **Health Related Outcomes:**
 - **Patients, especially those with chronic illnesses, are often responsible for self-managing their health, and numeracy plays an important role in their ability to “safely and efficaciously self-administer treatments.” (Rothman, Cherrington, Montori & Pignone, 2008, p. 585).**
 - **According to Ginde, Clark, Goldstein & Camargo (2008), “Compared to general health literacy, numeracy may be an equal or better predictor of unfavorable outcomes in self-managed chronic conditions, such as asthma and anticoagulation control”**
 - **There is a negative correlation between numeracy and BMI. (Huizinga, Beech, Cavanaugh, Elasy & Rothman, 2008, p. 1967).**



Setting the Direction

- **Primary research question:**
 - What is the effect of an 8-week intervention program designed to teach number sense?
- **Research hypothesis:**
 - The intervention will produce *clinically significant* group and individual gains *not due to chance*
- **Proposed contribution**
 - Support successful implementation of RTI with effective Tier II intervention (Burns, 2007)

Additional Objectives

- 1. Examine the instructional utility of the Ordinal Position Fluency (OPF-5) early numeracy CBM measure (Methe, Hintze, & Floyd 2008)**
 - Hypothesis #2: The OPF measure, as demonstrated on a larger sample, will again model growth reliably with the TEMA-3**
- 2. Examine the impact (i.e., social validity) of the full 8-week program (intervention, assessment, & impact on the host environment).**
 - Hypothesis #3: Teachers will rate the program favorably in numerous areas of program development**

Design

- **Pre-experimental, one group pre- & post-test design**
 - **O x O (Cook & Campbell, 1979)**
- **Comparison group matched on age, sex, TEMA-3, and OPF-5 scores**
 - **MA and NC curricula in K are similar – aligned with NCTM PSSM (2000), NC did not upgrade to 2006 recommendations.**
 - **Used to answer the question: “What might be more typical growth for students over the course of a school year”**

Method

- **Participants**

- 9 Kindergarten children began the study, 1 student moved just prior to post-testing (5 girls, 3 boys)
- Age range 5.1 – 6.0*

- **Selection**

- Teachers nominated students at the beginning of each month starting in October who were “at risk”
- Consisted of students considered at supplemental and intensive need

- **Setting**

- Rural NC K-2, 200 students per grade

Method, continued

- **Materials**

- Number Worlds Level A (www.sranumberworlds.com)
- Test of Early Mathematics Abilities, 3rd Ed. (TEMA-3)
- Ordinal Position Fluency (Methe, Hintze, & Floyd, 2008)

- **Personnel**

- Non-traditional aged undergraduate with 10 years of experience as a paraprofessional in K

- **Procedure**

- 3 students, 3 times per week, 30 minutes
- Instruction was consistent for weeks 2-7
 - Week 1 – warm ups & assessment

Ordinal Position Fluency

Stimulus Sheet

The image displays two rows of five objects each, used for an ordinal position fluency task. The first row contains a brown dog, a bowl of cookies, a soccer ball, a toaster, and a red tomato. The second row contains a black cat, a black electric fan, a yellow and pink ice cream cone, a wooden rocking chair, and a yellow banana. Below each row is a horizontal white bar with five black diamond markers, one centered under each object, indicating the positions for identification.

Task Measures: Rapid, automatic recognition and production of ordinal sequence

Assumes: Development of counting schema (cardinality, ordinality)

East Carolina University & The Department of Psychology – Number Sense Unit Overview – Kindergarten Intervention Program

Session	Objectives*	Warm-Up**	Activity** (Discussion of activity w/students follows)	Skill Area***
#1-#14	1.01 Develop number sense for whole numbers through 30 (a-g)	-----	-----	-----
#1	a. Connect model, number word (orally), and number using a variety of representations	Object Land 1 - Count Up Purpose: helps students learn order of numbers	Object Land 1 – Watch Listen and Count Purpose: helps students learn that each number is associated with an object; last number said identifies a set	Counting
#2	a. Connect model, number word (orally), and number using a variety of representations	Object Land 2 – Blastoff! Purpose: give opportunities to practice counting backward; lays foundation for subtractions	Object Land 4 – Matching Colors and Quantities Purpose: helps extend students’ knowledge of number concepts from concrete objects to 2-D images (dot – sets)	Counting
#3	b. Count objects in a set	Line Land 6 – Count Up Purpose: helps students learn order of numbers/associate with moving forward	Object Land 14 – Tapping and Clapping Purpose: gives concrete example of set size by performing and action sequence that corresponds to the size of the set/explore dot-set patterns and set size	Counting
#4	b. Count objects in a set	Picture Land 4 – Blastoff! Purpose: teaches that counting backward by one unit and subtraction one object from a set yield equivalent results	Picture Land 16 – Dog and Bone Purpose: helps children make transition from counting objects to counting set representations of familiar objects	Counting
#5	c. Read and write numerals	Picture Land 5 – Name That Numeral Purpose: builds numeral recognition skills	Picture Land 19 – Bravo Purpose: helps students to compare numerals	Counting

East Carolina University & The Department of Psychology – Number Sense Unit Overview – Kindergarten Intervention Program

#6	c. Read and write numerals	Picture Land 5 – Name That Numeral Purpose: helps children learn to recognize numbers	Picture Land 17 – Concentration Purpose: helps students connect their knowledge of counting and patterns with numerals	Counting
#7	d. Compare and order sets and numbers	Circle Land 11 – Count Up Purpose: shows children that numbers can be used for measurement and counting	Object Land 3 – Using the Sorting Mats Purpose: helps students practice comparing sets of object to identify which sets have more, less, or the same amount	Comparing and Ordering
#8	d. Compare and order sets and numbers	Sky Land 10 – Blast Off Purpose: helps children develop a foundation for subtraction	Object Land 13 – 2 – D Count and Compare Purpose: allows students to understand how to make comparisons between sets of different sizes	Comparing and Ordering
#9	e. Use ordinals (1 st – 10 th)	Line Land 6 – Count Up Purpose: reinforces association between moving forward on a number line and counting up	Picture Land 20 – Sequencing Purpose: helps students build an understanding of the position of each numeral in the number sequence	Comparing and Ordering
#10	e. Use ordinals (1 st – 10 th)	Sky Land 10 – Blastoff! Purpose: helps students learn applications for the reverse counting sequence	Line Land 23 – Position on the Number Line Purpose: helps children learn the position of each number	Comparing and Ordering
#11	f. Estimate quantities fewer than or equal to 10	Line Land 8 – Line Up Purpose: helps students identify or compute set size	Object Land 12 – Mouse in the Cookie Jar Purpose: helps children to strengthen ability to count a set of objects and compare amounts	Comparing and Ordering
#12	f. Estimate quantities fewer than or equal to 10	Line Land 9 – Count Up Purpose: reinforce students' knowledge of the counting sequence	Object Land 10 – Count and Compare Purpose: challenges students to identify the number of objects in a set	Comparing and Ordering

Results

Table 2. Gain Scores and Effect Sizes (n = 8)

Student	TEMA-3 Pretest	TEMA-3 post-test	gain	gain/hour	effect size (RCI)
1	70	94	24	4.53	5.54
2	89	107	18	3.40	4.16
3	67	83	16	3.02	3.70
4	87	100	13	2.45	3.00
5	66	76	10	1.89	2.31
6	78	87	9	1.70	2.08
7	89	95	6	1.13	1.39
8	80	85	5	0.94	1.16

Chart Title

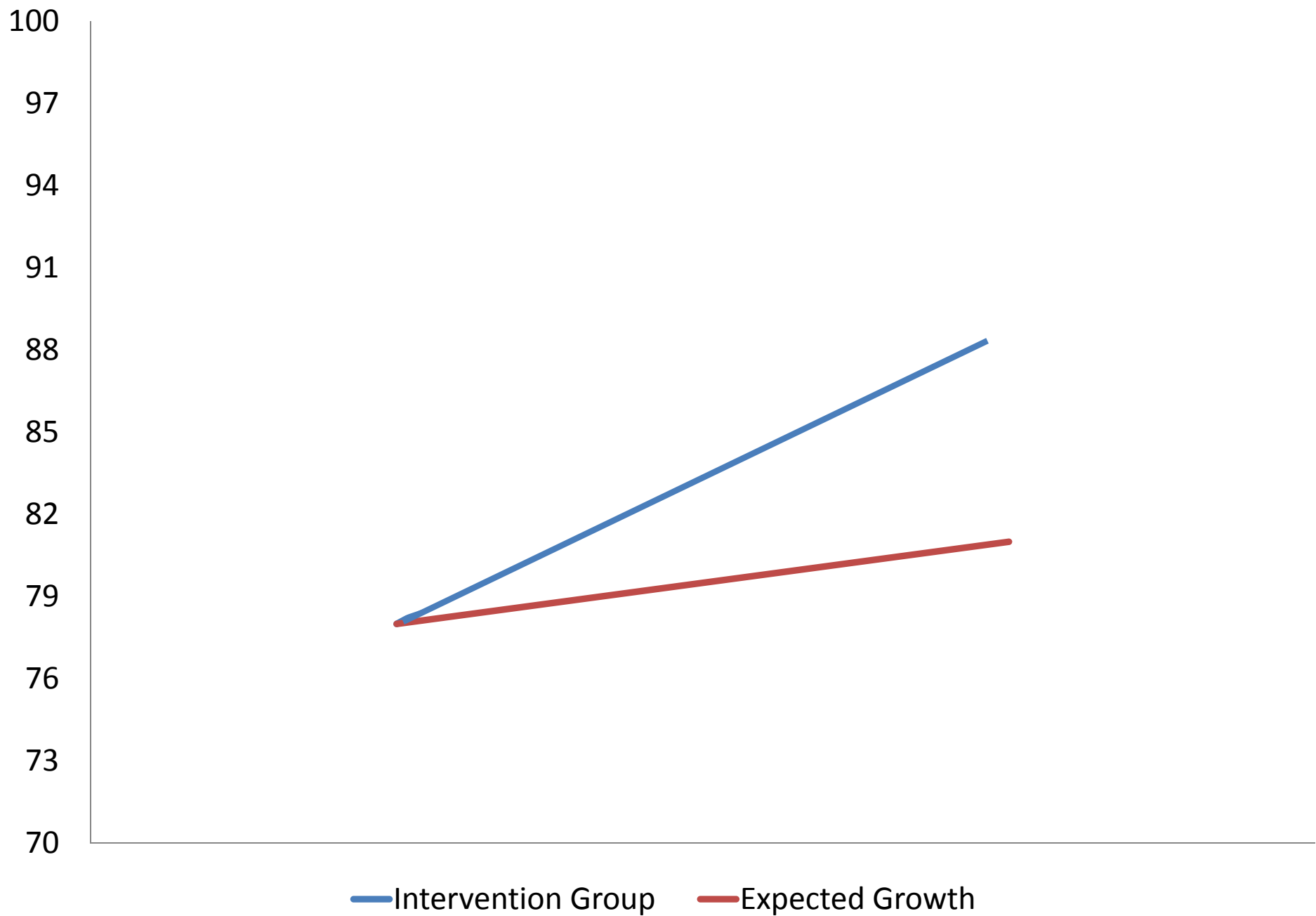
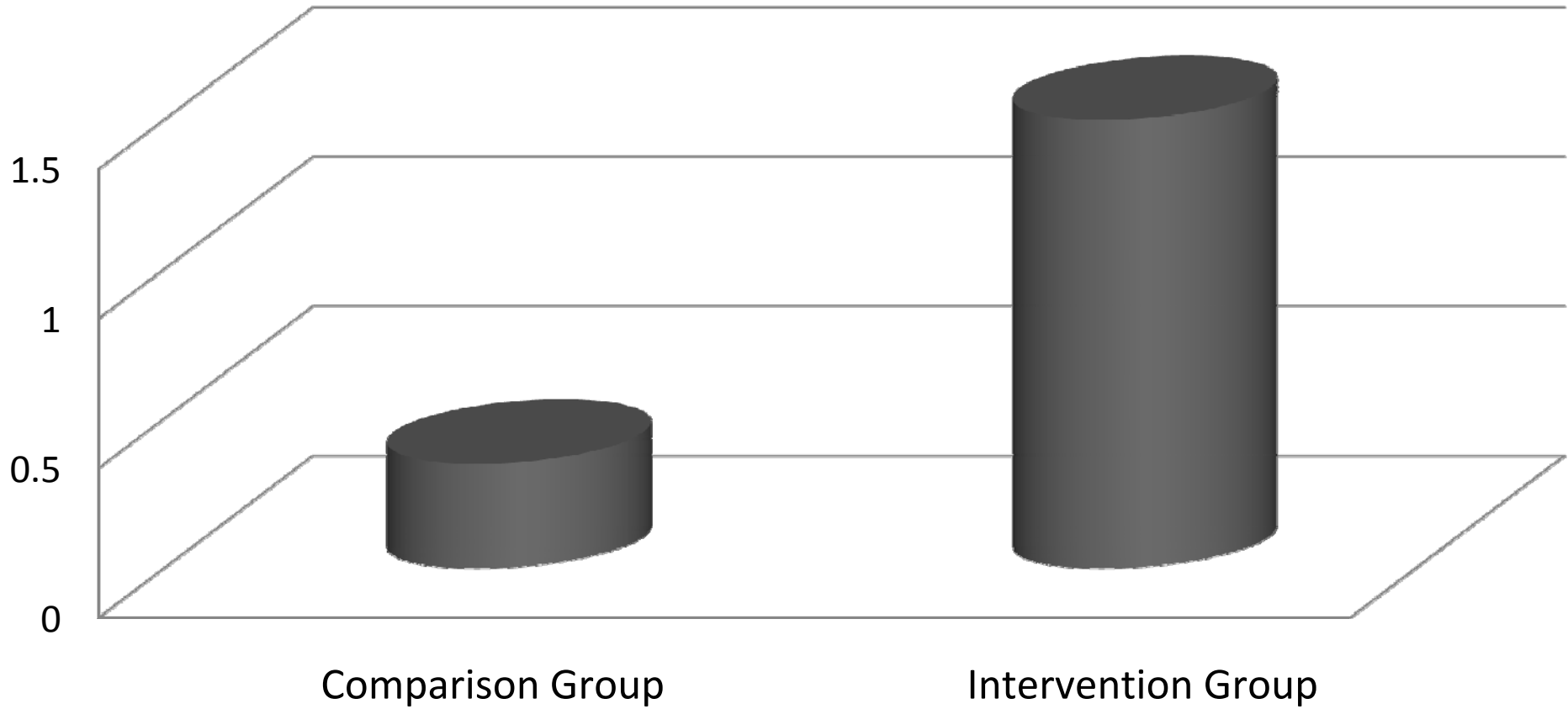
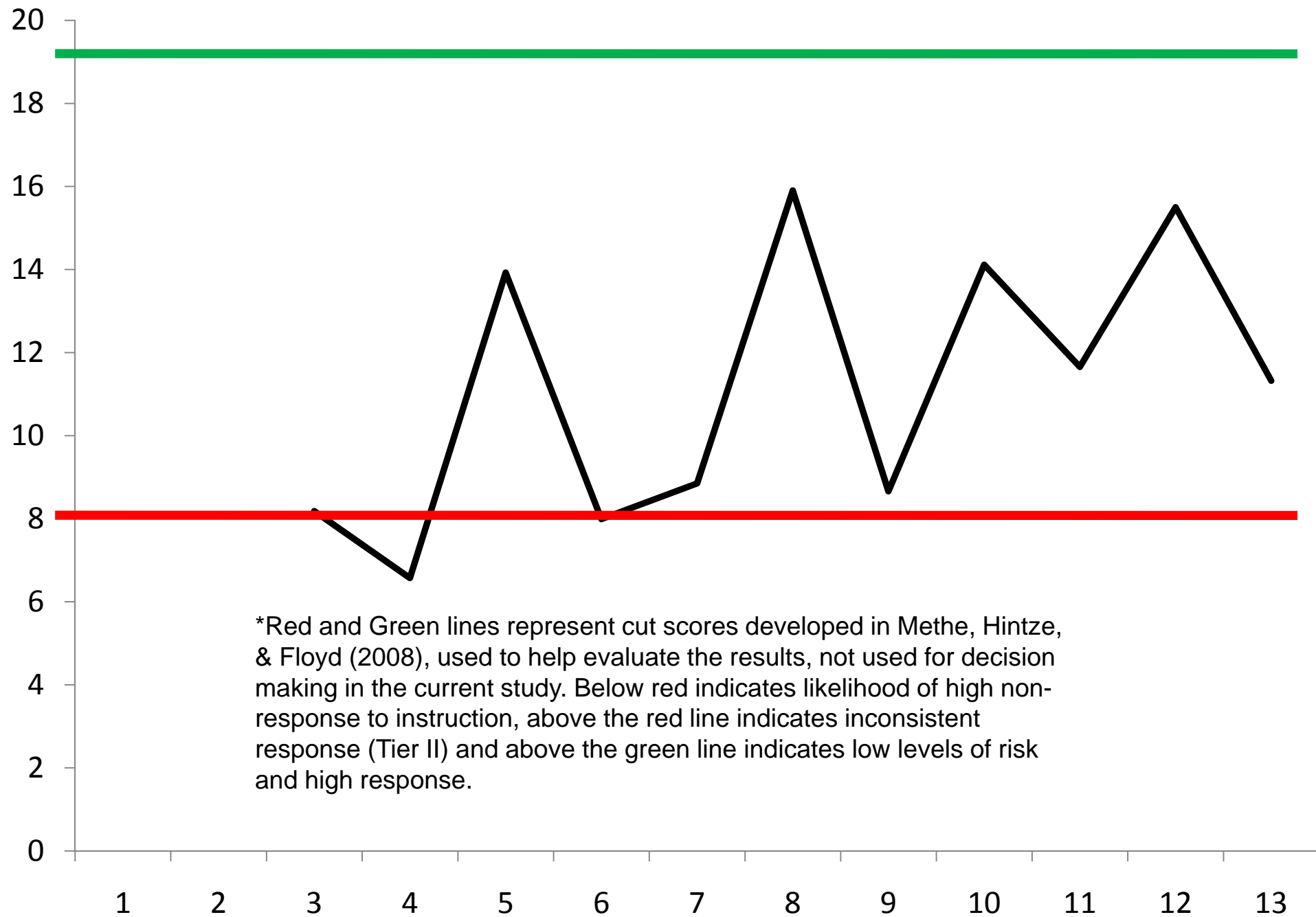
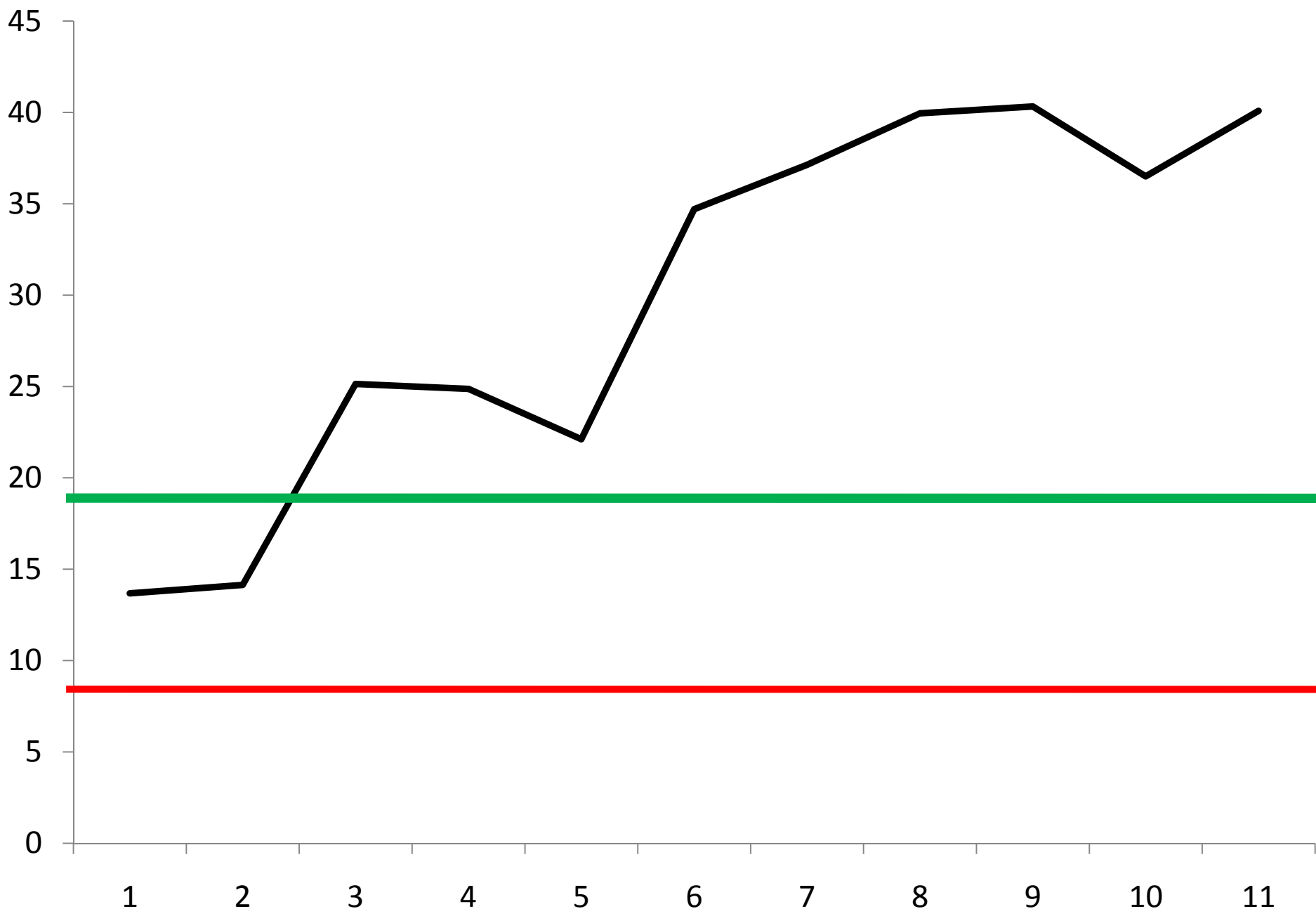


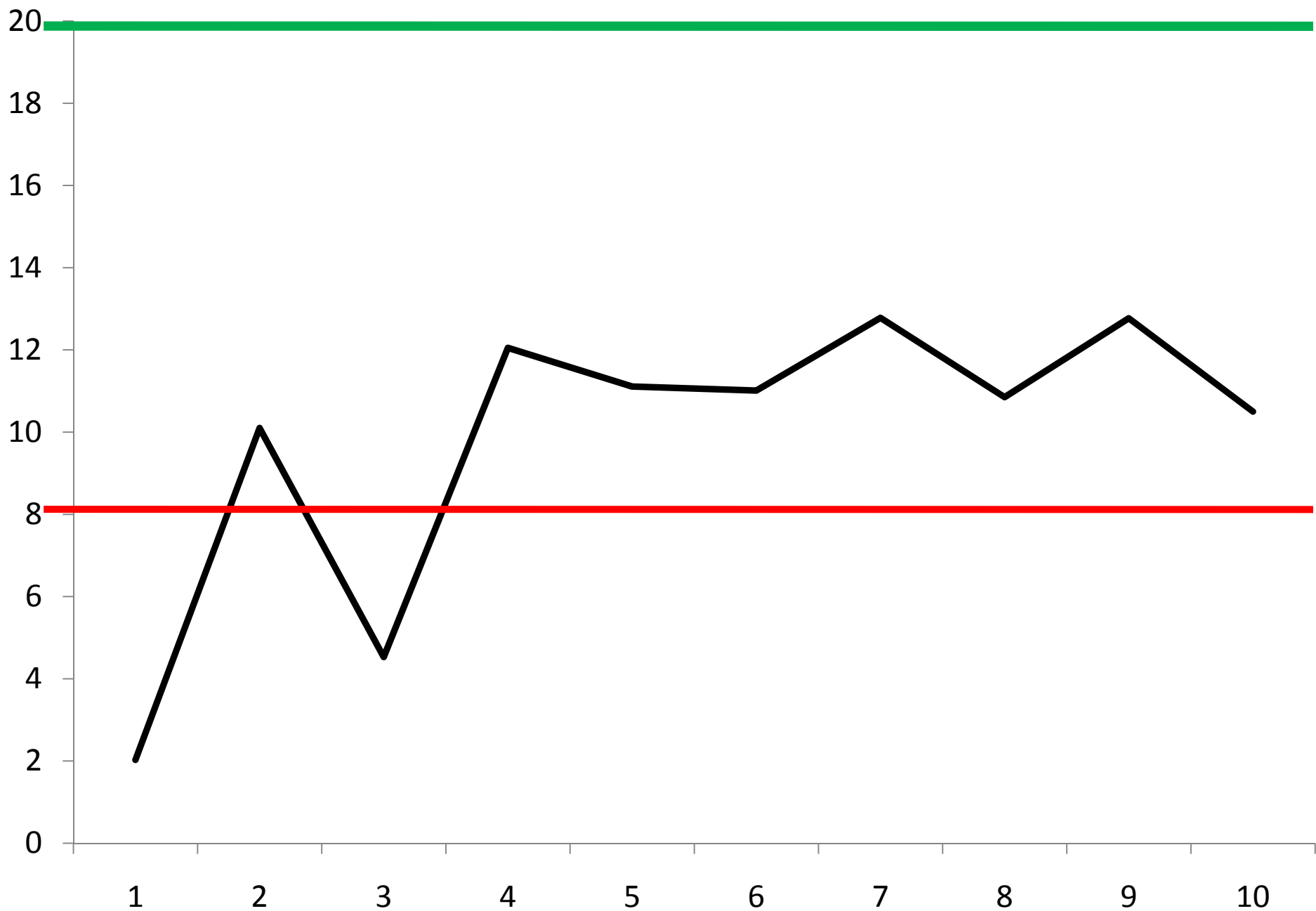
Chart Title

Gain in Standard Score Units Per Week





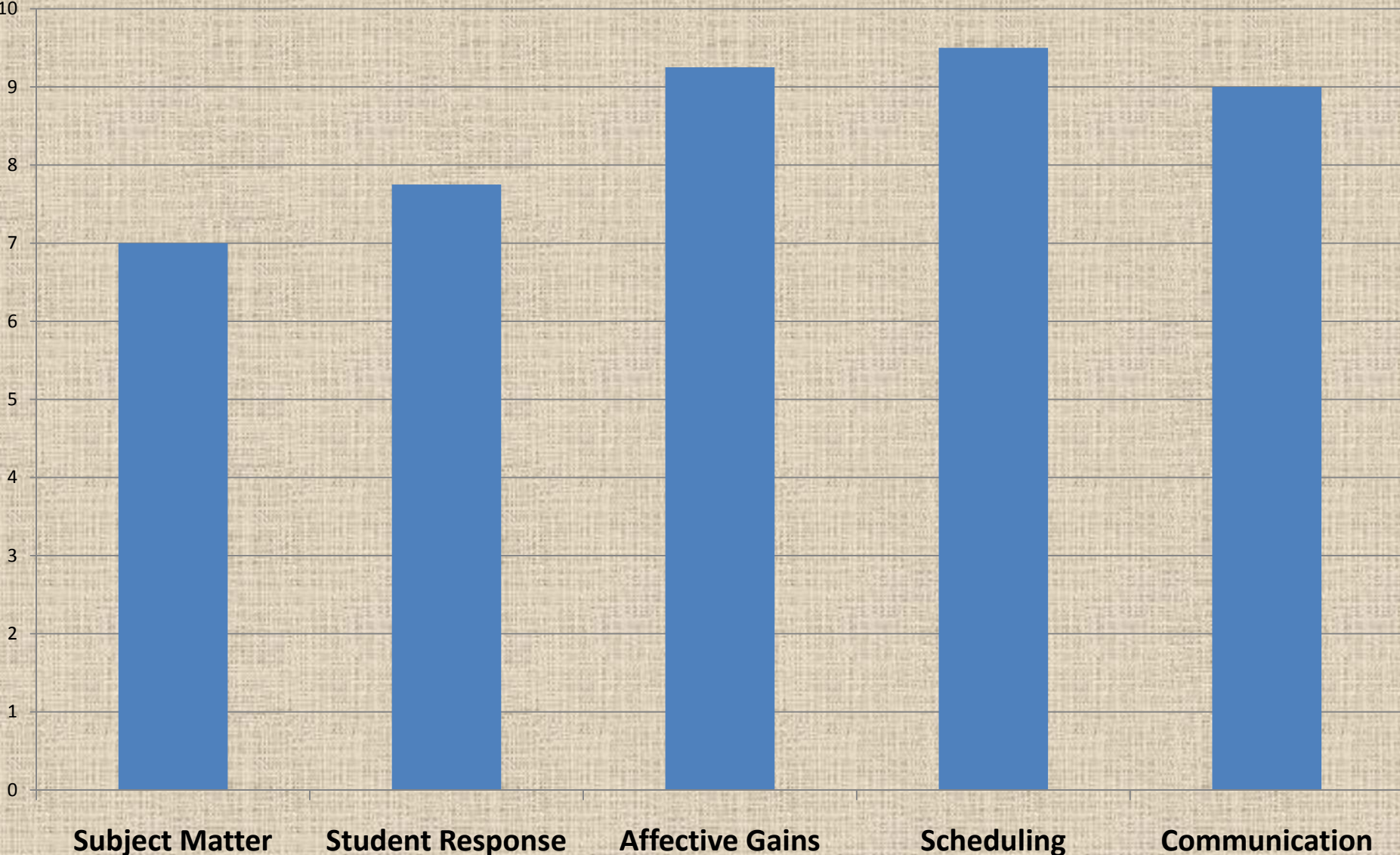




Results

- **Hypothesis #1**: The intervention will produce *clinically significant* group and individual gains *not due to chance*
 - 6 of 8 students found to have RCI indices of greater than 2.00 (Jacobson, Folette, & Revenstorf, 1984; Christensen & Mendoza, 1986; Jacobson & Truax, 1991)
 - Group RCI was also greater than 2.00
 - Paired samples t was significant ($p < .001$)
 - Estimated regression toward mean was approximately 4 standard score units (adjusted mean growth was 9 standard units)
- **Hypothesis #2**: The OPF measure will reliably model growth
 - All gain scores were positive
 - Spearman's $r = .89$ between gain scores on TEMA-3 and OPF-5
- **Hypothesis #3**: Consumers will rate the program favorably.

Teacher Rating Data (N=5; 10 – strongly agree; 1 – Strongly Disagree)



Program Highlights

- **Highest Rated Content Items:**
 - Improved counting skills
 - Improved automatic naming of small sets
 - Improved knowledge of order and relative size
 - Improved ability to compare quantities
 - Improved numeral recognition

- **Highest Rated RTI and Program Effectiveness Items**
 - Student was clearly better at math
 - Effective use of student's time
 - Improved accuracy in select skill areas
 - Clearly effective for the student

Highlights

- **Three students gained over 3 standard score units per hour of intervention**
- **One student gained 4.5 standard score units per hour (pre=70, post=94)**
- **Median gain per hour = 2.17 standard score units**
- **Preliminary data to develop a schoolwide program evaluation tool**

Discussion

- **Change was not likely due to chance**
 - **However, change cannot be attributed to the treatment**
- **Two reliable measures of EM ability indexed change**
- **Students with supplementary and intensive needs showed improvement**
 - **Consistent with intentions of RtI, Tier II (Burns, 2007)**
- **Demonstrated positive impact on host environment**

Limitations and Future Directions

- **By IES & WWC standards, this research would provide low to moderate evidence of support for this program**
 - **However, a “preponderance” of evidence from numerous studies are necessary for policy-based adoption**
- **Classic threats to the validity of the results limit ability to attribute gains to the intervention alone**
- **Use a wait-list control and ensure treatment equalization.**
- **Control for age – small age differences in K are substantial in terms of early math skill**