Investigating the Impact of Group Size on the Treatment Intensity of a Tier 2 Mathematics Intervention

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NSF's STEM Education, Learning Disabilities, and the Science of Dyslexia Conference, Arlington, VA (September 26-27, 2017)

Project ROOTS: Efficacy Study 2012-2016

ABSTRACT

We present a Tier 2 kindergarten math intervention for at-risk students to researchers interested in math RTI. Results from a randomized control trial in which group size was systematically manipulated results are shared and implications for practice are discussed.

BACKGROUND

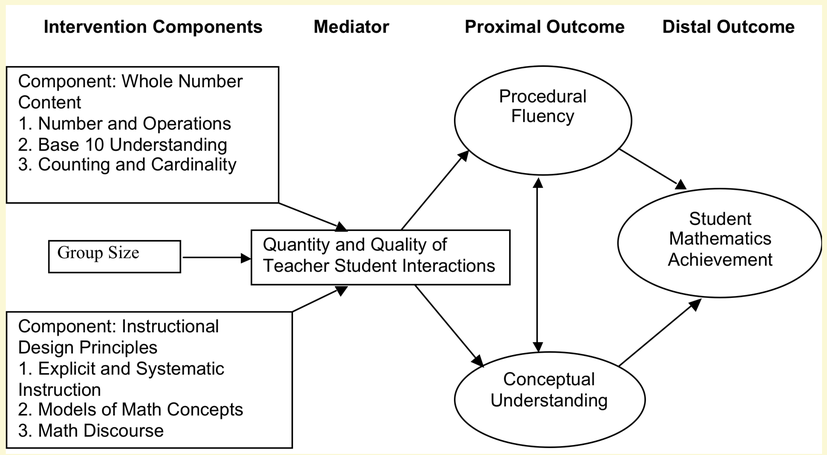
The importance of a successful early start in mathematics is garnering increased attention as evidence mounts that early math difficulties are persistent and difficult to remediate (Morgan et al., 2009). One mechanism to support student achievement is a Response to Intervention service delivery model (Fuchs & Vaughn, 2012). However, there are significant challenges to implementing RtI models in mathematics including limited resources in the early elementary grades (Clarke et al., 2014) and there is a considerable need to investigate intervention delivery parameters.

An initial study of Roots conducted by Clarke, Doabler et al. (2014) randomly assigned 29 kindergarten classrooms to treatment (ELM + ROOTS) and control (ELM only). In each classroom, teachers nominated 5 at-risk students with a final sample of 67 ROOTS students and 73 control students. Results from the Clarke et al. study suggest that ROOTS students made educationally meaningful gains on TEMA-3 (g = .38*) and EN-CBM (g = .30) compared to control peers.

PURPOSE

The purpose of the research study was to investigate the efficacy of ROOTS and whether or not that efficacy varied by group size (as a proxy for treatment intensity).

Treatment Intensity: Treatment intensity is a common frame for other fields (e.g. medicine) to prescribe interventions with high degrees of specificity. TI varies widely in how it is operationalized (e.g. number of sessions, length of sessions, teaching episodes/doses) but can be used to document the cumulative intensity of an intervention (Warren et al., 2007) and is linked to critical issues related to the allocation of resources and decision making models that rest upon the assumption of intensity (i.e. MTSS/RTI; Codding & Lane, 2014)



METHOD

Setting: Recruited 69 kindergarten classrooms from 14 schools (Title 1) in 4 Oregon school districts (rural & urban)

Participants: In each classroom, we screened all students and identified the 10 lowest-performing students who scored below 20 on the NSB (Jordan et al., 2009) and had an ASPENS composite score in *Strategic* or *Intensive* categories (Clarke et al., 2011). Students were then randomized to a ROOTS low intensity group (n = 295), a ROOTS high intensity group (n = 120), and a control group (n = 177).

Intervention: ROOTS is a 50 lesson Tier 2 kindergarten intervention curricula. The goal of ROOTS is to support students' conceptual understanding of and procedural fluency with critical whole number concepts. ROOTS is fully aligned to the kindergarten CCSS in the area of number and number and operations (CCSS, 2010). Each lesson is approximately 20 minutes in duration and consists of 4 to 5 brief math activities. A central instructional design feature of the ROOTS program is its *explicit* and *systematic* approach to instruction (Gersten et al., 2009).

Research Design: The study used a randomized control trial (RCT) design (blocking on classrooms) to investigate the ROOTS intervention in 69 kindergarten classrooms with approximately 10 eligible students per classroom. The research team randomly assigned these 10 students to one of three conditions: (1) a ROOTS-large group (5:1 student-teacher ratio), (2) a ROOTS-small group (2:1 student-teacher ratio), and (3) a no-treatment control group.

Research Questions: Three research questions were investigated:
(1) What was the overall impact of the treatment (ROOTS intervention) compared to a no-treatment control (business as usual)?
(2) Was there a differential impact on treatment intensity between the two treatment conditions (i.e., ROOTS large group versus ROOTS small group)?
(3) Was there a differential impact on student outcomes between the two treatment conditions (i.e. ROOTS large group versus ROOTS small group)?

Student Outcome Measures:
-Number Sense Brief Screener* (Jordan et al., 2009)
-Assessing Student Proficiency in Early Number Sense*(Clarke et al., 2012)
-Test of Early Mathematics Ability 3rd Ed. (Pro-ED, 2003)
-ROOTS Assessment of Early Number Sense (Doabler et al, 2013)

Observations: Conducted direct observations of ROOTS instruction to capture metrics of treatment intensity using the Classroom Observation of Student Teacher Interactions – Math (COSTI-M; Doabler et al., 2015). The COSTI is a frequency-based, low inference observation instrument that captures five types of instructional interactions related to treatment intensity. Each ROOTS group was observed 3 times across the intervention time period.

STUDENT BEHAVIORS	TEACHER BEHAVIORS
Guided practice*	Teacher models
Independent practice*	Academic feedback
Errors	

Analysis: Conducted nested time by condition impact analyses using gain scores from pre to post nesting repeated measures within students within groups. Independent-samples t tests were used to compare rates of instructional interactions (i.e., metrics of treatment intensity) by ROOTS group size.

RESULTS

Tables 1, 2 and 3 present results from the study. Table 1 shows an overall impact of the ROOTS curriculum on student outcomes compared to BAU. Table 2 summarizes differences between Roots high and Roots low conditions on key treatment intensity variables related to group versus individual practice opportunities. Table 3 indicates no differences between Roots high and low conditions on student outcomes.

Table 1. Impact Data Treatment vs. Control

Fixed Effect / Effect Size	NSB	ASPENS	TEMA	RAENS
ROOTS x Time	0.43 (0.41)	18.30* (2.85)	1.97* (0.52)	1.52* (0.72)
Hedges' g	0.09	0.52	0.25	0.76

Table 2. Treatment Intensity Data (t-tests): COSTI-M Interactions x Group Size

COSTI-M Instructional Interactions	ROOTS – High (2:1) M (SD)	ROOTS – Low (5:1) M (SD)			
	Rates per minute		t	p	Hedges' g
Guided Practice	0.6 (0.4)	0.7 (0.3)	-0.63	.529	-0.14
Independent Practice	3.5 (0.7)	3.3 (0.7)	1.52	.131	0.27
Individual Practice*	**2.6 (0.8)**	2.1 (0.6)	4.25	**<.001**	0.78
Group Practice*	1.4 (0.7)	**1.8 (0.7)**	-3.18	**.002**	-0.58
All Practice	4.1 (0.9)	3.9 (0.8)	1.02	.309	0.18

Table 3. Impact Data Roots high vs. Roots low

Fixed Effect / Effect Size	NSB	ASPENS	TEMA	RAENS
ROOTS High x ROOTS Low	0.00 (0.49)	-4.81 (3.31)	-0.09 (0.65)	.15 (0.62)
Hedges' g	0.00	-0.14	-0.01	0.02

DISCUSSION

Results show an overall treatment effect on important outcome measures. Observation data indicate that ROOTS students are receiving highly intensive Tier 2 math instruction yet group size/intensity does not appear to impact student outcomes. Why?

- Are the results linked to the type of intervention?
- Is there a threshold effect for practice? Do individual and group practice yield similar benefit for learners?
- What does "intensity" mean?
- Results replicated across sites (Doabler et al., 2017)
- What are the current implications for schools and multi-tiered service delivery models?
- Conducting a study of a first grade math intervention with additional measurement net and fMRI data to gain further insight.

Note. This project is funded by an IES grant R324A12034 to Drs. Ben Clarke Chris Doabler, and Hank Fien at the University of Oregon. **Questions?** For further information about our research, please contact Ben Clarke (clarkebr@uoregon.edu)