Title:
Examining the Student and Teacher Correlates of Math Achievement and Moderators of Treatment Impact for a Kindergarten Mathematics Curriculum Implemented in Whole Classroom Settings

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Background/context:

Recently, the National Math Advisory Panel (NMAP, 2008) noted the need for serious reform in the mathematics instruction provided in American schools. In part, the work of the NMAP was a response to repeated findings in both international comparisons and national longitudinal comparisons that American students lack a sufficient understanding of mathematics (NMAP, 2008). Persistent problems in mathematics achievement are particularly troubling given that the achievement gap faced by students from low income and minority backgrounds, as well as students with disabilities, is wide and represents a growing number of students in public schools across the United States (NAEP, 2009). Central to the call of the NMAP report, and the Curriculum Focal Points released by the National Council for Teachers of Mathematics (NCTM, 2007) for reforming mathematics education, is the need to address the unfocused nature of current curriculum programs. That is, mathematics programs cover a vast array of topics and mathematical concepts but with limited depth. The lack of depth prevents students from developing deep proficiency and understanding of critical mathematical concepts at their grade level. This is particularly troublesome for students with or at risk for MD. One potential approach to improving kindergarten and later math achievement is the delivery of effective instructional programs to all students as they enter school to bridge the emerging achievement gap and promote early mathematics learning.

The primary purpose of our Goal 3 project funded by the Institute for Education Sciences, Mathematics and Science Education, was to study the efficacy of an intervention curriculum, Early Learning in Mathematics (ELM), when implemented under rigorous experimental conditions. Sixty-six kindergarten classrooms were randomly assigned within schools to treatment and control conditions. Treatment classrooms implemented ELM with the full range of students in general education. Preliminary evidence supports the efficacy of ELM. Students in the treatment condition outperformed their control classroom controls on TEMA ($t = 2.41, p = .02$) and Early Numeracy CBM ($t = 1.99, p = .05$). Hedges’ $g$ effect sizes were .13 on TEMA and .14 on EN CBM (Baker, Clarke, Smolkowski, Fien, & Chard, 2011). In a condition by risk status analysis, at-risk students significantly outperformed their at risk counterparts on both TEMA ($t = 3.29, p = .0017$) and EN CBM ($t = 2.54, p = .0138$). Hedges’ $g$ effect sizes were .24 on the TEMA and .22 on EN CBM.

A secondary purpose of our Goal 3 project, and the purpose of this poster presentation proposal, was to examine hypothesized student and teacher level correlates of math achievement and moderators of treatment impact. It is critical to examine not just intervention efficacy, but for whom and under what circumstances those effects occur. In fact, IES “expects efficacy studies to examine relevant moderating factors” (p. italics added). Moderation analysis is a tool to address these kinds of for whom and under what context type questions. A treatment moderator is a variable that alters either the magnitude or the direction of the relation between the treatment condition and the dependent variable (Baron & Kenny, 1986). Identifying factors that help explain the conditions under which interventions are most effective is central to education research (Cohen et al. 2003).

Purpose / objective / research question / focus of study:

The purpose of this presentation is to examine the student and teacher correlates of math achievement and moderators of treatment impact findings from Year 1 of our study. In particular, we will examine the extent to which these student and teacher covariates moderate treatment impact for the at risk sample of the study. We will address two research questions.
**Research Question 1.** Is treatment impact moderated by student level variables, SPED status, EL status, attention rating, and attendance?

**Research Question 2.** Is treatment impact moderated by teacher or classroom level variables, years of teaching, teacher certification level, fall content and pedagogical knowledge of math instruction of risk for mathematics difficulties?

**Setting:**
This study was conducted in Oregon during the 2008-2009 school year. All kindergarten classrooms in three school districts (urban and suburban) were recruited to participate. A total of 66 classrooms were randomly assigned to treatment and comparison conditions. A total of 64 classrooms were included in data analysis. Classrooms in the treatment condition implemented the ELM curriculum for the entire school year. Classrooms in the comparison condition implemented standard district mathematics instruction for the entire school year. The amount of time mathematics instruction was provided each day was the same in treatment and comparison classrooms.

**Population / Participants / Subjects:**
The study sample included two participant groups: kindergarten classroom teachers and students in the participating kindergarten classrooms. The teacher sample includes 65 different teachers (i.e., one classroom included two teachers who shared one job). The student sample included 1,124 students. In the student sample, 56.3% were eligible for free or reduced lunch rate meals, 38.4% were English learners, and 8.4% were receiving special education services. The breakdown by ethnicity was 49.5% White, 36.4% Hispanic, 4.8% Asian American / Pacific Islander, 2.3% African American, and 6.9% Other.

**Intervention / Program / Practice:**
The treatment condition consisted of the ELM curriculum. In these classrooms, the ELM program functions as the core (or Tier 1) mathematics program. The comparison condition consisted of standard district mathematics instruction. ELM is a full-year kindergarten mathematics curriculum designed for use in whole classroom settings. ELM includes 120 core daily lessons, approximately 45 minutes in duration. Lessons incorporate 4-5 activities across four content strands: (a) whole number and operations; (b) measurement; (c) geometry; and (d) precise mathematics vocabulary. Mathematics content is explicitly introduced in each lesson, and systematically reviewed and extended across lessons.

Practicing ELM teachers implement all aspects of the program, using resources typically available for classroom instruction purposes. Teachers receive four days of professional development training related to program implementation: 2 days at the beginning of the intervention and 2 days during the school year once implementation has begun. A central feature of the program, established through the design of the curriculum and the professional development that teachers receive to implement the program as intended, is high rates of teacher-student interactions during mathematics instruction. Instructional interactions through explicit instruction and student practice opportunities have been shown to be important for students with and without math difficulties (Gersten et al., 2009). Teachers are expected to model and demonstrate what they want students to learn, and provide specific and frequent feedback to students as they engage in learning activities. Teachers are also expected to provide students with many opportunities to practice learning key mathematics concepts and content.

**Research Design:**
A randomized controlled trial was the research design used. Math achievement data were collected from individual students, and random assignment and instructional delivery took place at the classroom level. Thus, our primary analysis framework is a group-randomized trial (Murray, 1998, 2001) with students nested within classrooms and classrooms nested within condition.

**Data Collection and Analysis**

**Student outcomes.** Student mathematics performance measures included the Test of Early Mathematics Ability (TEMA) and Early Numeracy – Curriculum Based Measurement (Oral Counting, Number Identification, Missing Number, and Quantity Discrimination). These measures demonstrate strong psychometric properties. All student data and classroom observation data were collected by trained staff members. Reliability information was collected on all data included in the analysis.

For analyses of student measures, we will conduct a mixed-model analysis of covariance (ANCOVA) with adjustment for pretest (Murray, 1998, p. 187, 2001, p. 1380). The mixed-model ANCOVA partitions variance into within- and between-classroom components and compares treatment and control conditions while accounting for student nonindependence. The proposed model treats classrooms as random.

**Moderation Analysis.** We will extend this model to include a modest number of additional covariates and their interactions with condition to test moderation hypotheses (Jaccard & Turrisi, 2003). We expect, for example, that age, English learner (EL), and Special Education status, attendance rates, and attention ratings may moderate the effect of ELM. At the teacher level we expect teacher content and pedagogical knowledge of mathematics, teacher certification level, years of experience, and aggregate student factors (average math scores) may moderate the effect of ELM.

**Findings / Results:**

There was a statistically significant main effect on CBM gains for sped status ($B=-15.917$, $t(61)=-2.61$, $p=.034$), ELL status ($B=-26.450$, $t(61)=-5.737$, $p<.0001$), attention rating ($B=21.664$, $t(61)=4.043$, $p=.0002$) on early math gains. There was no significant main effect on CBM math gains for age ($B=6.670$, $t(61)=1.57$, $p=.122$) and attendance ($B=13.184$, $t(61)=1.425$, $p=.159$). Additionally, there were no statistically significant moderation effects on treatment for any of the student level covariates, for sped status ($B=-1.023$, $t(61)=-1.01$, $p=.919$), ELL status ($B=8.925$, $t(61)=1.394$, $p=.1685$), attention rating ($B=0.341$, $t(61)=0.048$, $p=.961$) and attendance ($B=7.821$, $t(61)=6.22$, $p=.536$). Analyses are currently ongoing for teacher level covariates and will be ready for dissemination by the time of the fall SREE conference.

**Conclusions:**

This study represents our first examination of the potential student and teacher level moderators of ELM treatment impact. Even in this at risk sample, special education status, English Learner status, and student’s ability to maintain attention during academic instruction were all negatively related to math gains across kindergarten, independent of condition. Although none of the student level variables moderated treatment impact, trends indicate that the negative relation between EL status and math gains may have been somewhat mitigated in the treatment group. In the context of a universal, or Tier 1 math program, impacts seem to be constant across these student level risk factors. In other words, our previous findings that demonstrate a positive ELM treatment effect estimate for at risk students (Clarke et. al., 2011) does not vary by student risk factors.
Appendix A. References


