Understanding the Practical Significance of Explicit Mathematics Instruction for At-Risk English Learners

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Abstract
There is an urgent need to establish "what works" for teaching English learners (ELs) who face long-term mathematics difficulties (MD). This presentation shares results from two IES-funded, mathematics efficacy studies involving 851 ELs with MD. The first study involved a whole-class program and the second a small-group intervention. Results from both studies revealed overall treatment effects. Implications for extending the literature on effectively teaching at-risk ELs will be discussed.

INTRODUCTION

A deep and robust understanding of early number sense is a gateway for subsequent learning in school mathematics (Berch, 2005; Geary et al., 2018). Given its practical significance, there is an urgent need to promote early number sense among English learners (ELs). ELs represent a rapidly growing subgroup in US schools and projections suggest that they will comprise 40% of the school-age population by 2030 (National Academies of Sciences, Engineering, and Medicine, 2018). Unfortunately, however, widespread concern has been expressed for some time about the persistent low mathematics achievement of ELs (National Center for Education Statistics [NCES], 2017). Results from the most recent National Assessment for Educational Progress (NAEP), for instance, indicate that 86% of fourth grade ELs scored below Proficient (NCES, 2017). The NAEP mathematics data also suggest that ELs do not achieve commensurate with their English proficient peers and that a mathematics achievement gap between these student subgroups begins early and widens over time.

Given the likelihood that many ELs will struggle to acquire mathematics proficiency, a priority of the field should be to establish effective interventions for ELs who face long-term mathematics difficulties (MD). Yet to date, few methodologically rigorous studies have been conducted involving ELs with MD. Over the past decade, we have sought to address this blank spot in the empirical literature by establishing a development-efficacy research program focused on kindergarten mathematics instruction (Doabler et al., 2015; Clarke et al., 2017). We target the kindergarten year because it represents a critical tipping point in getting at-risk students "on track" for developing number sense.

While the empirical literature base on mathematics instruction for ELs in the elementary grades remains woefully thin (Richards-Tutor et al., 2017), recent intervention research has begun to offer potential avenues for improving mathematics outcomes among ELs with MD. At the forefront of this literature base is explicit mathematics instruction (Gersten et al., 2009). Explicit instruction is a systematic approach that utilizes empirically-validated instructional

design and delivery principles to unambiguously teach fundamental concepts and skills that students would not otherwise acquire on their own (Hughes, Morris, Therrien, & Benson, 2017). Explicit mathematics interventions may hold promise for ELs with MD because they offer scaffold-rich mathematics instruction. For example, high quality, explicit mathematics interventions have the capacity to assist teachers in providing ELs with overt demonstrations and clear explanations of mathematical concepts, skills and vocabulary. These interventions also facilitate frequent practice opportunities for students to demonstrate their mathematical thinking and understanding. Particularly important for ELs with MD are practice opportunities that involve verbal interactions with their teachers and peers. Research indicates that verbalization opportunities permit ELs and other at-risk students to build critical language skills in English and mathematics (Baker et al., 2014).

PURPOSE

The purpose of this presentation is to describe results from two randomized controlled trials (RCTs) involving a collective sample of 851 kindergarten ELs (Doabler et al., 2016; Doabler et al., 2019). Each study was conducted within separate, larger IES-funded, efficacy projects. The first study investigated the efficacy of the *Early Learning in Mathematics* program on the mathematics achievement of kindergarten ELs. Early Learning in Mathematics is a 120-lesson, whole-class (Tier 1) mathematics program designed to promote mathematical proficiency among the full range of learners. The second RCT involved the *ROOTS* intervention, a 50-lesson, small-group (Tier 2) mathematics program aimed at building number sense among kindergarteners with MD. Both programs were purposefully designed to incorporate design and delivery principles of explicit mathematics instruction.

RESEARCH DESIGN

Both of the larger efficacy projects employed RCTs. However, the Early Learning in Mathematics project was a cluster-RCT, randomly assigning kindergarten classrooms to either treatment (Early Learning in Mathematics) or control (BAU) conditions. Random assignment in the ROOTS project occurred at the student level, with the treatment condition consisting of ROOTS and control consisting of Tier 1 instruction in kindergarten classrooms. The analytic sample for the Early Learning in Mathematics study included 556 ELs from 66 kindergarten classrooms, whereas the ROOTS study had 295 ELs from 138 kindergarten classrooms. Student mathematics outcome measures employed in the RCTs included the Number Sense Brief (Jordan et al., 2008; Assessing Student Proficiency in Early Number Sense (Clarke et al., 2011), Test of Early Mathematics Ability – 3rd Edition (Ginsburg & Baroody, 2003), and the Stanford Early School Achievement Test (Harcourt Educational Measurement, 2003). All measures demonstrated acceptable technical properties, with reported concurrent validity coefficients (r) for the outcome measures ranging from .54 to .91.

DATA ANALYSIS

Overall effects of the Early Learning in Mathematics and ROOTS programs on the mathematics achievement of ELs were examined using mixed-model (multilevel) Time x Condition analyses (Murray, 1998). These analyses tested for net differences between conditions on gains in outcomes from the fall to spring of kindergarten. Hedges' g effect sizes were calculated for each fixed effect of condition. Student-level predictors of differential response

(moderators) to Early Learning in Mathematics and ROOTS, including English proficiency and initial mathematics achievement, were also explored.

RESULTS

Analyses from both studies revealed overall positive treatment effects. ELs in the Early Learning in Mathematics and ROOTS conditions made greater gains than their control EL peers on targeted mathematics outcome measures, with effect sizes (*g*) ranging from .12 to .94. Evidence of differential response to the Early Learning in Mathematics program was not found. However, results suggested that the ROOTS intervention worked equally well across a diverse sample of at-risk ELs with varying mathematics skills and English proficiency levels.

CONCLUSION

In summary, convincing evidence suggests that many ELs experience early and persistent MD. Our results indicate that getting ELs on track for mathematical success entails establishing a prevention-oriented framework of instruction and implementing purposefully-designed Tier 1 and Tier 2 mathematics programs. While these findings are encouraging, we were left with the question: How does the field continue to advance the empirical literature base on effective mathematics instruction for at-risk ELs? Implications in terms of the practical significance of using empirically-validated principles of explicit instruction to improve the design and delivery of mathematics interventions for ELs with MD will be discussed.

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