

# The Impact of Early Mathematics Intervention on First-Grade Achievement Outcomes

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## Abstract

This study investigates the relationship between specialized mathematics interventions in kindergarten and subsequent mathematics achievement in first grade. Utilizing restricted-use data from a nationally representative longitudinal study, we analyzed child-level assessment scores, teacher surveys, and demographic covariates to determine if early targeted pull-out instruction mitigates early skill gaps. Results indicate a significant positive effect for children receiving high-intensity interventions.

## 1. Introduction

Early mathematics skills are a strong predictor of later academic success. While public-use data provides broad trends in early childhood education, answering nuanced questions about specific intervention strategies requires access to detailed, restricted-level variables regarding teacher qualifications and precise pull-out intervention timing. This paper leverages longitudinal tracking to isolate these effects.

## 2. Methodology

### 2.1 Data Source

Data for this study were drawn from the restricted-use files of the Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011). The ECLS-K:2011 follows a nationally representative sample of children from their kindergarten year through fifth grade. We restricted our analytic sample to children who had complete data for both the fall kindergarten and spring first-grade direct cognitive mathematics assessments.

### 2.2 Sample Size

After applying survey weights and removing cases with missing data on key variables (primarily teacher intervention logs), our final analytic sample consisted of 14,320 students nested within 1,210 schools. Numbers are unweighted and rounded to nearest tens according to the IES reporting policy.

## 2.3 Measures

*Mathematics Achievement:* The primary outcome variable is the spring first-grade mathematics Item Response Theory (IRT) scale score. The IRT scores in our sample ranged from a minimum of 12.4 to a maximum of 145.8.

*Intervention Status:* Students were categorized into three groups based on teacher reports: No Intervention, Low-Intensity Pull-Out (1-2 times per week), and High-Intensity Pull-Out (3 or more times per week).

## 3. Results

### 3.1 Descriptive Statistics

Table 1 presents the demographic breakdown of the analytic sample across the three intervention conditions.

Characteristic	No Intervention	Low-Intensity	High-Intensity
<i>Gender</i>			
- Male	5,120	1,420	580
- Female	5,080	1,400	720
<i>Race/Ethnicity</i>			
- White, Non-Hispanic	5200	1200	500
- Black, Non-Hispanic	2110	800	400
- Hispanic	2300	600	380
- Asian	590	210	20
- Other/Multiracial	0	10	0

NOTE: Numbers for sample sizes are unweighted and rounded to the nearest ten. Values may not sum to a total due to rounding.

SOURCE: U.S. Department of Education, National Center on Educational Statistics (NCES), 2017 NAEP Grade 8 Mathematics Process Data, Student Features Data File Partial Form and Response Data File.

### 3.2 Regression Models

We utilized an Ordinary Least Squares (OLS) regression model to predict spring first-grade mathematics IRT scores. The model controlled for fall kindergarten baseline scores, socioeconomic status (SES), and school locale.

The baseline model (without intervention variables) yielded an  $R^2$  of 0.45. Adding the intervention indicators significantly improved model fit ( $F(2, 14318) = 45.2, p < .001$ ). High-intensity intervention was associated with a 4.2 point increase in the spring IRT scale score ( $SE = 1.1, p < .01$ ) compared to the no-intervention control group.

#### **4. Discussion**

The findings underscore the importance of targeted, high-intensity interventions in early elementary grades. The data suggest that infrequent pull-out sessions (1-2 times per week) do not yield the same statistically significant benefits as more frequent instructional support.

Future research should investigate the specific curricula used during these pull-out sessions, which was a limitation of the current dataset.