

# What Works Clearinghouse



## Pre-K Mathematics

### Program description<sup>1</sup>

*Pre-K Mathematics* is a supplemental curriculum designed to develop informal mathematical knowledge and skills in preschool children. Mathematical content is organized into seven units. Specific mathematical concepts and skills from each unit are taught

in the classroom through teacher-guided, small-group activities with concrete manipulatives. Take-home activities with materials that parallel the small-group classroom activities are designed to help parents support their children’s mathematical development at home.

### Research

One study of *Pre-K Mathematics* met the What Works Clearinghouse (WWC) evidence standards and one study met the WWC evidence standards with reservations.<sup>2</sup> The studies included 430 preschool children at 39 Head Start and state-funded preschools in New York and California and examined intervention effects on children’s math outcomes. This report focuses on immediate

posttest findings to determine the effectiveness of the intervention.<sup>3</sup> The WWC considers the extent of evidence for *Pre-K Mathematics* to be moderate to large for mathematics achievement. No studies that met WWC evidence standards with or without reservations addressed oral language, print knowledge, phonological processing, early reading/writing, or cognition.

### Effectiveness

*Pre-K Mathematics* combined with *DLM Early Childhood Express* software (hereafter referred to as *DLM Express*) was found to have positive effects on mathematics achievement.

	Oral language	Print knowledge	Phonological processing	Early reading/writing	Cognition	Math
Rating of effectiveness	na	na	na	na	na	Positive effects
Improvement index <sup>4</sup>	na	na	na	na	na	Average: +22 percentile points Range: +22 to +23 percentile points

na = not applicable

- The descriptive information for this program was obtained from publicly available sources: the program’s web site ([http://www.pearsonearlylearning.com/products/curriculum/pre\\_k/index.html](http://www.pearsonearlylearning.com/products/curriculum/pre_k/index.html), downloaded March 15, 2007), the research literature (Clements & Sarama, 2006, June; Starkey & Klein, 2005; Starkey, Klein, & Wakeley, 2004), and the program description provided by the author upon the WWC request. The WWC requests developers to review the program description sections for accuracy from their perspective. Further verification of the accuracy of the descriptive information for this program is beyond the scope of this review.
- Both studies included an additional component with the *Pre-K Mathematics* intervention. The impact of the additional component—*DLM Early Childhood Express* software—cannot be separated from the impact of the *Pre-K Mathematics* curriculum. However, because *DLM Early Childhood Express* software can be used with *Pre-K Mathematics*, the WWC considers the information in this report to be useful for practitioners in search of a preschool mathematics curriculum. To be eligible for the WWC’s review, the Early Childhood Education (ECE) intervention had to be implemented in English in center-based settings with children aged three to five or in preschool.

## Absence of conflict of interest

*Pre-K Mathematics* was developed in part by Dr. Alice Klein, the Principal Investigator for the WWC elementary school math topic review, and she receives royalties from sales of *Pre-K Mathematics*. In addition, Dr. Klein co-authored two of the

studies reviewed for this WWC intervention report. Dr. Klein was not involved in the coding, reconciliation, or discussions of the included studies. Additionally, she was not involved in writing or reviewing the ECE intervention report on *Pre-K Mathematics*.

## Additional program information<sup>1</sup>

### Developer and contact

Developed by Alice Klein and Prentice Starkey with Alma Ramirez, *Pre-K Mathematics* is distributed by Pearson Scott Foresman division of Pearson Education as part of the Scott Foresman-Addison Wesley Mathematics (2004) series for grades Pre-K–6. Address: 1900 E. Lake Avenue, Glenview, Illinois 60025. Web: [www.scottforesman.com/support/index.cfm](http://www.scottforesman.com/support/index.cfm). Telephone: (800) 552-2259.

### Scope of use

Information is not available on the number or demographics of children or centers using *Pre-K Mathematics* with or without *DLM Express*.

### Teaching

The *Pre-K Mathematics* curriculum includes activities organized in seven units containing closely related mathematical content: (1) Counting and Number, (2) Understanding Arithmetic Operations (Fall Activities), (3) Spatial Sense and Geometry, (4) Patterns, (5) Understanding Arithmetic Operations (Spring Activities), (6) Measurement and Data, and (7) Logical Reasoning. The program has both classroom activities with manipulatives and home activities with picture strips in English or Spanish. In the classroom, mathematical concepts and skills are taught through teacher-guided, small-group activities over the course of the school year. A new mathematics activity is introduced each week and presented to pre-Kindergarten children twice. Each small group contains four to six children and the small-group lessons

last approximately 20 minutes. Home activities are sent home with the child every one to two weeks. Parents are encouraged to help their children engage in mathematical activities that are related to the concepts and skills they are learning at school. Materials for the classroom and home are provided in a core program package that includes a teacher's curriculum book, activity aid masters, home activity masters, and assessment record sheets. The research evidence reviewed in this report addresses *Pre-K Mathematics* combined with *DLM Express*, which is supplemental *DLM Early Childhood Express* math software. The software reinforced classroom support in two mathematical domains: (1) geometric and spatial concepts and skills and (2) numerical concepts and skills. It can be purchased only as part of a bundle called the *DLM Express Math Resource Package*, which includes the DLM math software CD and the math resources guide booklet. The studies reviewed for this report used only the math software, and in the case of Starkey and Klein (2005) only a subset of the math software activities included on the CD were used.

### Cost

The *Pre-K Mathematics* Core Program Package (Pre-K Teacher's Edition, Activity Aid Masters, Home Activity Masters, and Assessment Record Sheets) costs \$145 and the Spanish Home Activity Masters cost \$16. Information on the cost of professional development is not available. The *DLM Express Math Resource Package* that includes the computer software costs \$185.<sup>5</sup>

3. The evidence presented in this report is based on available research. Findings and conclusions may change as new research becomes available. *Pre-K Mathematics* is a part of the Preschool Curriculum Evaluation Research (PCER) Grants administered through the U.S. Department of Education's Institute of Education Sciences. The final PCER reports were not released in time to be reviewed for this report.
4. These numbers show the average and range of student-level improvement indices for all findings across the study.
5. The manipulatives noted in the teaching section are not available for purchase from Pearson Scott Foresman.

**Research** Three studies reviewed by the WWC examined the effects of *Pre-K Mathematics* in center-based settings. One study (Starkey & Klein, 2005) was a randomized controlled trial that met WWC evidence standards. Another study (Clements & Sarama, 2006) was a randomized controlled trial that met WWC evidence standards with reservations due to within-cluster differential attrition between the intervention and comparison groups. The remaining study did not meet WWC evidence screens.

#### **Met WWC evidence standards**

Starkey and Klein (2005) included two cohorts of 564 three- and four-year-old children from low-income families attending Head Start and state-funded preschool programs in New York and California, but the WWC includes the data from the 278 children in cohort one only.<sup>6</sup> More than half of the children were African-American. The authors compared math outcomes for children who participated in a *Pre-K Mathematics* combined with *DLM Express* intervention group to children who participated in a business-as-usual comparison group.

#### **Met WWC evidence standards with reservations**

Clements and Sarama (2006) included 21 preschool teachers (152 children) from low-income families in New York State and compared math outcomes for children participating in a *Pre-K Mathematics* combined with *DLM Express* intervention group to a business-as-usual comparison group.<sup>7</sup>

#### **Extent of Evidence**

The WWC categorizes the extent of evidence in each domain as small or moderate to large (see the [What Works Clearinghouse Extent of Evidence Categorization Scheme](#)). The extent of evidence takes into account the number of studies and the total sample size across the studies that met WWC evidence standards with or without reservations.<sup>8</sup>

The WWC considers the extent of evidence for *Pre-K Mathematics* to be moderate to large for mathematics achievement. No studies that met WWC evidence standards with or without reservations addressed oral language, print knowledge, phonological processing, early reading/writing, or cognition.

### **Effectiveness Findings**

The WWC review of interventions for early childhood education addresses children's outcomes in six domains: oral language, print knowledge, phonological processing, early reading/writing, cognition, and math.<sup>9</sup> Both studies addressed a single outcome

(but used a different measure) in the math domain. The findings below present the authors' and the WWC-calculated estimates of the size and statistical significance of the effects of *Pre-K Mathematics* on children's mathematics performance.

6. The study authors implemented a pure randomized controlled trial for cohort one (meets WWC evidence standards), whereas in cohort two the study authors replaced classrooms lost to attrition via random selection (meets WWC evidence standards with reservations). Therefore, the WWC bases the rating of effectiveness on the data from cohort one only because it has the strongest research design. The data from cohort two are provided in Appendix A4.
7. The study also included a *Building Blocks for Math* intervention group. The study authors labeled the *Building Blocks for Math* group as the "intervention group" and the *Pre-K Mathematics* group as the "comparison group;" however, the WWC considers *Building Blocks for Math* as a separate intervention (see the separate [WWC Building Blocks for Math intervention report](#)). For the rating of effectiveness in this WWC intervention report, the WWC includes only the results comparing the *Pre-K Mathematics* group to the business-as-usual comparison group; however, results for the comparison between the curricula are included in a separate section of this report and Appendix A5.
8. The Extent of Evidence Categorization was developed to tell readers how much evidence was used to determine the intervention rating, focusing on the number and sizes of studies. Additional factors associated with a related concept, external validity, such as the students' demographics and the types of settings in which studies took place, are not taken into account for the categorization.
9. The level of statistical significance was reported by the study authors or, where necessary, calculated by the WWC to correct for clustering within classrooms or schools and for multiple comparisons. For an explanation about the clustering correction, see the [WWC Tutorial on Mismatch](#). See [Technical Details of WWC-Conducted Computations](#) for the formulas the WWC used to calculate the statistical significance. In the case of *Pre-K Mathematics*, no corrections for clustering or multiple comparisons were needed.

## Effectiveness *(continued)*

*Math.* Starkey and Klein (2005) reported a statistically significant positive effect for *Pre-K Mathematics* combined with *DLM Express* for cohort one combined across states using the Child Math Assessment as an outcome measure.

Clements and Sarama (2006) reported a statistically significant positive effect for *Pre-K Mathematics* combined with *DLM Express* using the Early Mathematics Assessment as an outcome measure.

## The WWC found *Pre-K Mathematics* to have positive effects on math

### Improvement index

The WWC computes an improvement index for each individual finding. In addition, within each outcome domain, the WWC computes an average improvement index for each study and an average improvement index across studies (see [Technical Details of WWC-Conducted Computations](#)). The improvement index represents the difference between the percentile rank of the average student in the intervention condition versus the percentile rank of the average student in the comparison condition. Unlike the rating of effectiveness, the improvement index is based entirely on the size of the effect, regardless of the statistical significance of the effect, the study design, or the analyses. The improvement index can take on values between -50 and +50, with positive numbers denoting results favorable to the intervention group.

The improvement index for math is +22 percentile points across the two studies, with a range of +22 to +23 percentile points across findings.

### Findings for comparisons between *Pre-K Mathematics* and *Building Blocks for Math*

The analysis for the comparison described below was included in the Clements and Sarama (2006) study, but the findings do not contribute to the overall rating of effectiveness because the WWC included the comparison of *Pre-K Mathematics* to the business-as-usual comparison group in the rating for the same study, which provides a clearer sense of *Pre-K Mathematics'*

## Rating of effectiveness

The WWC rates the effects of an intervention in a given outcome domain as positive, potentially positive, mixed, no discernible effects, potentially negative, or negative. The rating of effectiveness takes into account four factors: the quality of the research design, the statistical significance of the findings,<sup>9</sup> the size of the difference between participants in the intervention and the comparison conditions, and the consistency in findings across studies (see the [WWC Intervention Rating Scheme](#)).

effects. However, the WWC believes that the findings from this comparison provide useful information to practitioners who may be interested in comparing the effects of different curricula. The WWC reports the findings for comparisons of *Pre-K Mathematics* and *Building Blocks for Math* here and in Appendix A5.

*Math.* Clements and Sarama (2006) analyzed group differences between the *Pre-K Mathematics* combined with *DLM Express* group and the *Building Blocks for Math* group for one math outcome measure (Early Mathematics Assessment). The difference between groups was statistically significant and favored children in the *Building Blocks for Math* group. The improvement index for math is -19 percentile points (*Pre-K Mathematics* is the intervention group and *Building Blocks for Math* is the comparison group) for the single finding in the study.

## Summary

The WWC reviewed three studies on *Pre-K Mathematics*. One study met WWC evidence standards and another study met WWC evidence standards with reservations; the remaining study did not meet WWC evidence screens. Based on these two studies, the WWC found positive effects on math. Additional findings that were not considered for the rating of effectiveness indicated that *Pre-K Mathematics* may not have as large an impact on children's math outcomes as another skills-focused preschool mathematics intervention. The evidence presented in this report may change as new research emerges.

## References **Met WWC evidence standards**

Starkey, P., & Klein, A. (2005). *A longitudinal study of the effects of a pre-kindergarten mathematics curriculum on low-income children's mathematical knowledge* (From PCER 2002: Grantee Annual Progress Report (2005), IES Grant No. R305J020026). Berkeley: University of California.

### **Met WWC evidence standards with reservations**

Clements, D. H., & Sarama, J. (2006, June). *Scaling up the implementation of a pre-kindergarten mathematics curriculum: The Building Blocks curriculum*. Paper presented at the Institute of Education Sciences Research Conference, Washington, D.C.

## **Did not meet WWC evidence screens**

Starkey, P., Klein, A., & Wakeley, A. (2004). Enhancing young children's mathematical knowledge through a pre-kindergarten mathematics intervention. *Early Childhood Research Quarterly*, 19(1), 99–120.<sup>10</sup>

### **Additional source:**

Klein, A., & Starkey, P. (2004). Fostering preschool children's mathematical knowledge: Findings from the Berkeley Math Readiness Project. In D. H. Clements, J. Sarama & A.-M. DiBiase (Eds.), *Engaging young children in mathematics: Standards for early childhood mathematics education* (pp. 343–360). Mahwah, NJ: Lawrence Erlbaum Associates.

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**For more information about specific studies and WWC calculations, please see the [WWC Pre-K Mathematics Technical Appendices](#).**

10. Lack of evidence for baseline equivalence: the study, which used a quasi-experimental design, did not establish that the comparison group was equivalent to the intervention group at baseline.