What Works Clearinghouse

Pre-K Mathematics

Program description[1]

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.[2] 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.[3] 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[4]	na	na	na	na	na	Average: +22 percentile points Range: +22 to +23 percentile points

na = not applicable

1. 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, 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.
2. 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[1]

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. 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.[5]

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.[6] 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.[7]

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.[8]

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.[9] 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.

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,[9] 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).

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'* 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.[10]

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.

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.

Appendix

Appendix A1.1 Study characteristics: Starkey & Klein, 2005 (randomized controlled trial)

Characteristic	Description
Study citation[1]	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.
Participants	The study was implemented with two cohorts of children from two states across a two-year time period. This WWC review focuses on cohort one combined across states.[2] During the first year of implementation, 20 Head Start and 20 state-funded preschool classrooms were randomly assigned to the *Pre-K Mathematics* intervention or business-as-usual comparison groups within program type. The classroom assignment to conditions was maintained for the second year of implementation. Four intervention and two comparison classrooms from the first year of implementation were unable to participate and were replaced by randomly selecting classrooms from a list of volunteers in the second year.[2] The study began with 316 low-income children in cohort one combined across states. During year one of the study, 38 children left resulting in a final cohort one sample of 278 children. The mean age of the children in cohort one was 4.4 years. Fifty-three percent of the children in cohort one were African-American; 22% were Hispanic; 22% were Caucasian; 4% were Asian-American; and 4% were interracial or another ethnicity. Forty-eight percent of the children were female.
Setting	The study took place in New York and California in 40 Head Start and state-funded classrooms from 37 schools in cohort one and 40 Head Start and state-funded classrooms from 36 schools in cohort two.
Intervention[3]	Teachers implemented the *Pre-K Mathematics* curriculum with small groups of 4–6 children in twice weekly 20-minute sessions for one school year. Each week involved the introduction of a new math activity. The sessions included activities in seven units: counting and number; understanding arithmetic operations (fall and spring units); spatial sense and geometry; patterns; measurement and data; and, logical reasoning. In addition, teachers used two other instructional activities: computer activities (*DLM Express* software) and mathematics learning centers, which included materials from the small-group activities and additional mathematics materials from the classroom. Home activity materials parallel to the classroom activities were sent home every one to two weeks for parents to use with their children. Teachers tracked children's progress using a Math Mastery Form, and treatment fidelity data were collected using the Fidelity of Implementation Record Sheet.
Comparison	Children in the business-as-usual comparison group participated in the curriculum used in their schools (*Creative Curriculum, High/Scope,* Montessori, or specialized literacy curricula and curricula developed by local teachers and school districts).
Primary outcomes and measurement	The primary outcome domain assessed was math and it was measured with the researcher-developed Child Math Assessment (see Appendix A2 for a more detailed description of the outcome measure).
Teacher training	During the first year of implementation teachers received one four-day workshop at the beginning of the school year to learn how to implement units one to three of the curriculum and another four-day workshop at mid-year to learn how to implement units four to seven of the curriculum. In addition, teachers were provided on-site training and implementation fidelity checks twice each month. In the second year of implementation, teachers received two-day refresher workshops at the beginning of the school year and at mid-year, and received on-site training and fidelity checks twice a month.

1. The study authors submitted an executive summary to the WWC and provided additional details about participants, sample sizes, study design, intervention implementation, and the data necessary to calculate effect sizes upon WWC request.
2. 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.
3. The impact of the *DLM Express* software cannot be separated from the impact of the *Pre-K Mathematics* curriculum.

Appendix A1.2 Study characteristics: Clements & Sarama, 2006 (randomized controlled trial with attrition problems)[1]

Characteristic	Description
Study citation	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.
Participants	Teachers were randomly assigned to conditions in two separate steps. Twenty-four teachers from preschool programs serving low-income children were randomly assigned to two intervention groups (*Pre-K Mathematics* or *Building Blocks for Math*)[2] or a business-as-usual comparison group. Twelve teachers from preschool programs serving mixed-income children were randomly assigned to the *Building Blocks for Math* group or the business-as-usual comparison group. Consequently there were a total of eight teachers in the *Pre-K Mathematics* group and 14 teachers in the business-as-usual comparison group. Eight preschool-age children were randomly selected from each classroom for assessment (N=176).[3] After attrition, the final sample included 21 teachers and 152 children (seven teachers and 51 children in the *Pre-K Mathematics* group; 14 teachers and 101 children in the business-as-usual comparison group).
Setting	The study was conducted in Head Start and state-funded preschool programs in New York State.
Intervention	Children in the intervention condition used the *Pre-K Mathematics* curriculum, which was designed to develop informal mathematical knowledge and skills. The curriculum was implemented primarily during 15- to 20-minute small-group activities at least twice a week and 10- to 15-minute whole-class math activities once a week. In addition, these classrooms used *DLM Express* software for 5 to 10 minutes twice a week. Weekly letters were sent to parents that included math activities similar to those children were learning at school. The intervention lasted for 26 weeks and the teachers maintained their daily activities and schedule while inserting mathematics activities at appropriate times during the day.[4]
Comparison	Children in the business-as-usual comparison group participated in their regular daily activities and schedule, with emphasis on small groups and computer activities. These included city-wide math activities, *Creative Curriculum,* Montessori math activities, or "home-grown" math materials based on state standards.
Primary outcomes and measurement	The primary outcome domain assessed was math and it was measured with the Early Mathematics Assessment (see Appendix A2 for a more detailed description of the outcome measure). The study authors also assessed implementation fidelity with the Fidelity of Implementation measure and the quality of the mathematics environment using the Classroom Observation of Early Mathematics Environment and Teaching. This WWC review does not include the results from these observations.[5]
Teacher training	Professional development activities for teachers in the *Pre-K Mathematics* group consisted of four days of training, a monthly two-hour class, and monthly in-class coaching by project staff. Teacher training covered a number of topics such as supporting mathematical development in the classroom, recognizing and supporting mathematics throughout the day, setting up mathematics learning centers, teaching with computers, small-group activities, and supporting mathematical development in the home.

1. The study was downgraded by the WWC due to within-cluster differential attrition of 11% between the *Pre-K Mathematics* group and the business-as-usual comparison group. Additionally, the two groups differed at pretest by more than half of a standard deviation.
2. 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.
3. The remaining 14 teachers were assigned to the *Building Blocks for Math* group, which is not the main focus of this WWC intervention report.
4. The impact of the *DLM Express* software cannot be separated from the impact of the *Pre-K Mathematics* curriculum. Children in the *Building Blocks for Math* intervention group participated in 10- to 15-minute small-group (4–6 children) math activities weekly. These children also participated in 5- to 15-minute whole-group math activities four times a week and 5- to 10-minute computer activities twice a week. Related family activities were sent home weekly. The intervention lasted for 26 weeks, and intervention teachers maintained their daily activities and schedule while inserting mathematics activities at appropriate times during the day.
5. For further details about the outcomes included in the early childhood education topic review, please see the Early Childhood Education Protocol.

Appendix A2 Outcome measures in the math domain

Outcome measure	Description
Child Math Assessment	A researcher-developed measure designed to assess young children's early mathematical knowledge in the areas of number, arithmetic, space and geometry, measurement and pattern knowledge (as cited in Starkey & Klein, 2005).[1]
Early Mathematics Assessment	A researcher-developed measure that uses two individual child interviews to assess young children's mathematical knowledge and skills in the areas of number, geometry, measurement, and patterning (as cited in Clements & Sarama, 2006).

1. The Child Math Assessment was developed by the researchers, who are also the program developers, and this measure was developed for the purposes of this research project. The measure was confirmed to have sufficient face validity by the WWC ECE Principal Investigators and a psychometric study to establish its measurement properties by the study authors as a part of the Institute of Education Sciences funded Interagency Education Research Initiative (IERI) Scale-Up project.

Appendix A3 Summary of study findings included in the rating for the math domain[1]

Outcome measure	Study sample	Sample size (classrooms/children)[3]	Authors' findings from the study: Mean outcome (standard deviation[2]) *Pre-K Math* group[4]	Comparison group[4]	WWC calculations: Mean difference[5] (*Pre-K Math* – comparison)	Effect size[6]	Statistical significance[7] (at $\alpha = 0.05$)	Improvement index[8]
Starkey & Klein, 2005 (randomized controlled trial)[9]								
Child Math Assessment	3–4 year olds	40/278	0.55 (0.13)	0.47 (0.14)	0.08	0.58	Statistically significant	+22
Average[10] for math (Starkey & Klein, 2005)						0.58	Statistically significant	+22
Clements & Sarama, 2006 (randomized controlled trial with attrition problems)[11]								
Early Mathematics Assessment	Preschool children	21/152	58.01 (6.53)	53.22 (8.38)	4.79	0.61	Statistically significant	+23
Average[10] for math (Clements & Sarama, 2006)						0.61	Statistically significant	+23
Domain average[10] for math across all studies						0.60	na	+22

na = not applicable

1. This appendix reports findings considered for the effectiveness rating and the average improvement indices. For Starkey and Klein (2005), the findings for cohort one are combined across state; findings for cohort two are reported in Appendix A4. For Clements & Sarama (2006), findings from the head-to-head comparison of *Pre-K Mathematics* to *Building Blocks for Math* are not included in these ratings, but are reported in Appendix A5.
2. The standard deviation across all students in each group shows how dispersed the participants' outcomes are: a smaller standard deviation on a given measure would indicate that participants had more similar outcomes. For Starkey and Klein (2005), the standard deviations were provided by the study authors upon WWC request.
3. For Clements and Sarama (2006), the cluster-unit is the teacher and the child-level sample size was provided by the study authors upon WWC request. For Starkey and Klein (2005), the classroom and child-level sample sizes were provided by the study authors upon WWC request.
4. For Clements and Sarama (2006), the intervention group mean (58.01) equals the comparison group mean (53.22) plus the program coefficient from the author-conducted HLM analysis (4.79). For Starkey and Klein (2005), the posttest means are covariate-adjusted means provided by the study authors upon WWC request.
5. Positive differences and effect sizes favor the intervention group; negative differences and effect sizes favor the comparison group. For Clements and Sarama (2006), the mean difference was the program coefficient from the author-conducted HLM analysis.
6. For an explanation of the effect size calculation, see Technical Details of WWC-Conducted Computations.
7. Statistical significance is the probability that the difference between groups is a result of chance rather than a real difference between the groups.
8. 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. The improvement index can take on values between –50 and +50, with positive numbers denoting results favorable to the intervention group.
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 statistical significance. In the case of Starkey and Klein (2005), no corrections for clustering or multiple comparisons were needed because the study authors used HLM to analyze their data and accounted for clustering of children in classrooms.
10. The WWC-computed domain average effect sizes for each study and for the domain across studies are simple averages rounded to two decimal places. The average improvement indices are calculated from the average effect sizes.
11. In the case of Clements and Sarama (2006), no corrections for clustering or multiple comparisons were needed because the study authors used HLM to analyze their data and accounted for clustering of children in classrooms.

Appendix A4 Summary of findings from cohort two for the math domain[1]

			Authors' findings from the study		WWC calculations			
			Mean outcome (standard deviation[2])					
Outcome measure	Study sample	Sample size (classrooms/ children)[3]	*Pre-K Math* group[4]	Comparison group[4]	Mean difference[5] (*Pre-K Math* – comparison)	Effect size[6]	Statistical significance[7] (at $\alpha = 0.05$)	Improvement index[8]
Starkey & Klein, 2005 (randomized controlled trial; Cohort 2)[9]								
Child Math Assessment	3–4 year olds	40/286	0.58 (0.16)	0.47 (0.15)	0.11	0.70	Statistically significant	+26

1. This appendix presents findings for cohort two combined across state for measures that fall in the math domain. Combined scores across state for cohort one were used for rating purposes and are presented in Appendix A3.
2. The standard deviation across all students in each group shows how dispersed the participants' outcomes are: a smaller standard deviation on a given measure would indicate that participants had more similar outcomes. The posttest standard deviations were provided by the study authors upon WWC request.
3. The sample sizes were provided by the study authors upon WWC request.
4. The posttest means are covariate-adjusted means provided by the study authors upon WWC request.
5. Positive differences and effect sizes favor the intervention group; negative differences and effect sizes favor the comparison group.
6. For an explanation of the effect size calculation, see Technical Details of WWC-Conducted Computations.
7. Statistical significance is the probability that the difference between groups is a result of chance rather than a real difference between the groups.
8. 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. The improvement index can take on values between –50 and +50, with positive numbers denoting results favorable to the intervention group.
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 (corrections for multiple comparisons were not done for findings not included in the overall intervention rating). 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 statistical significance. In the case of Starkey and Klein (2005), no correction for clustering was needed because the study authors used HLM to analyze their data and accounted for clustering of children in classrooms.

Appendix A5 Summary of findings for comparisons between *Pre-K Mathematics* and *Building Blocks for Math* for the math domain[1]

Outcome measure	Study sample	Sample size (teachers/ children)[3]	Authors' findings from the study: Mean outcome (standard deviation[2]) *Pre-K Math* group[4]	*Building Blocks for Math* group[4]	WWC calculations: Mean difference[5] (*Pre-K Math – Building Blocks for Math*)	Effect size[6]	Statistical significance[7] (at $\alpha = 0.05$)	Improvement index[8]
Clements & Sarama, 2006 (randomized controlled trial with attrition problems)[9]								
Early Mathematics Assessment	Preschool children	21/152	55.84 (6.53)	59.39 (7.46)	–3.55	–0.49	Statistically significant	–19
Domain average[10] for math						–0.49	Statistically significant	–19

1. This appendix presents findings for the head-to-head comparison of *Pre-K Mathematics* and *Building Blocks for Math* for a measure that falls in the math domain. Comparisons of *Pre-K Mathematics* and the business-as-usual comparison group were used for rating purposes and are presented in Appendix A3.
2. The standard deviation across all students in each group shows how dispersed the participants' outcomes are: a smaller standard deviation on a given measure would indicate that participants had more similar outcomes. The standard deviations were provided by the study authors upon WWC request.
3. The child-level sample size was provided by the study authors upon WWC request.
4. The *Pre-K Mathematics* group mean (55.84) equals the *Building Blocks for Math* group mean (59.39) plus the program coefficient from the author-conducted HLM analysis (–3.55).
5. Positive differences and effect sizes favor the *Pre-K Mathematics* group; negative differences and effect sizes favor the *Building Blocks for Math* group. The mean difference was the program coefficient from the author-conducted HLM analysis.
6. For an explanation of the effect size calculation, see Technical Details of WWC-Conducted Computations.
7. Statistical significance is the probability that the difference between groups is a result of chance rather than a real difference between the groups.
8. The improvement index represents the difference between the percentile rank of the average student in the *Pre-K Mathematics* condition versus the percentile rank of the average student in the *Building Blocks for Math* condition. The improvement index can take on values between –50 and +50, with positive numbers denoting results favorable to the *Pre-K Mathematics* group.
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 statistical significance. In the case of Clements and Sarama (2006), no corrections for clustering or multiple comparisons were needed because the study authors used HLM to analyze their data and accounted for clustering of children in classrooms.
10. This row provides the study average, which in this instance, is also the domain average. The WWC-computed domain average effect size is a simple average rounded to two decimal places. The domain improvement index is calculated from the average effect size.

Appendix A6 *Pre-K Mathematics* rating for the math domain

The WWC rates an intervention's effects in a given outcome domain as positive, potentially positive, mixed, no discernible effects, potentially negative, or negative.[1]

For the outcome domain of math, the WWC rated *Pre-K Mathematics* as having positive effects. The remaining ratings (potentially positive effects, mixed effects, no discernible effects, potentially negative effects, and negative effects) were not considered, as *Pre-K Mathematics* was assigned the highest applicable rating.

Rating received

Positive effects: Strong evidence of a positive effect with no overriding contrary evidence.

- Criterion 1: Two or more studies showing statistically significant *positive* effects, at least one of which met WWC evidence standards for a strong design.

  Met. Both studies showed statistically significant positive effects and one of the studies met WWC evidence standards for a strong design.

AND

- Criterion 2: No studies showing statistically significant or substantively important *negative* effects.

  Met. The studies did not show statistically significant or substantively important negative effects.

1. For rating purposes, the WWC considers the statistical significance of individual outcomes and the domain-level effect. The WWC also considers the size of the domain-level effect for ratings of potentially positive or potentially negative effects. See the WWC Intervention Rating Scheme for a complete description.

Appendix A7 Extent of evidence by domain

Outcome domain	Number of studies	Sample size: Schools	Sample size: Classrooms/children	Extent of evidence[1]
Oral language	0	0	0	na
Print knowledge	0	0	0	na
Phonological processing	0	0	0	na
Early reading/writing	0	0	0	na
Cognition	0	0	0	na
Math	2	37+	61/430	Moderate to large

na = not applicable/not studied

1. A rating of "moderate to large" requires at least two studies and two schools across studies in one domain, and a total sample size across studies of at least 350 students or 14 classrooms. Otherwise, the rating is "small."