Institute of Education Sciences

Building Blocks™

Intervention Report | *Preparing Young Children for School*

WHAT WORKS CLEARINGHOUSE™
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Young children, especially those from lower-resource communities, often do not have adequate exposure to robust mathematics instruction in preschool.[1] Well-organized and focused early mathematical interventions can help young children develop a foundation of informal mathematics knowledge and lead to greater mathematics knowledge upon entry into kindergarten.[2] *Building Blocks*[3] is a mathematics curriculum that aims to develop preschool children's knowledge of mathematics using activities that are intentionally sequenced based on the developmental progression[4] of children's mathematical learning.[5] The *Building Blocks* curriculum includes whole- and small-group instruction, center activities, and computer activities, as well as activities for the children's families to do at home to support classroom learning. Teachers' use of the *Building Blocks* curriculum is supported by professional development.

Goal: *Building Blocks* aims to develop preschool children's early mathematical knowledge and processes by incorporating mathematics into daily preschool activities, including intentional whole- and small-group instruction, as well as center activities and computer activities. The *Building Blocks* program follows the mathematics learning trajectories, a sequence of learning activities that are aligned with the typical progression of how children learn mathematics.

The What Works Clearinghouse (WWC) reviews existing research on educational interventions to identify evidence-based programs and practices. This WWC intervention report summarizes the available evidence on the effects of *Building Blocks* used in preschool sites on student outcomes.

Did *Building Blocks* improve student outcomes?

Three studies of the *Building Blocks* program meet WWC standards. Findings from these studies are summarized in Table 1. The table includes a row for the outcome domain that was studied in the research. An outcome domain includes a group of related outcome measures. The *Building Blocks* studies included one mathematics outcome measure that fits within the mathematics domain. Effects of the program on other outcome domains are unknown.

The WWC effectiveness rating indicates whether the *Building Blocks* program resulted in improved outcomes for children assigned to receive the program compared with children who were not. The table also indicates whether the evidence reviewed satisfies the Department of Education's requirements for strong, moderate, or promising tiers of evidence at the time this report was written. More information about these ratings and requirements is provided on the next page. Findings and conclusions could change as new research becomes available.

Table 1. Summary of findings on *Building Blocks* from three studies that meet WWC standards

Outcome domain	Effectiveness rating	Sample size	Evidence tier	Summary of impacts
Mathematics	Potentially positive effects	3,221	TIER 2 MODERATE	The research provides moderate evidence that *Building Blocks* improved student mathematics achievement. This assessment is based on two studies that meet WWC standards without reservations and one study that meets WWC standards with reservations.

CHARACTERISTICS OF THE STUDY SETTING AND PARTICIPANTS

Settings: Preschool sites in the United States.

Race:

Hispanic/Latino: 20%

English Language Learners: 15%

Female: 52%

Note: Demographic data were only available for two of the three studies that meet WWC standards.

HOW THE WWC REVIEWS AND DESCRIBES EVIDENCE

The WWC conducted a systematic review of interventions designed to improve children's level of preparation for school and selected and prioritized studies for review using the version 4.1 Review Protocol for *Preparing Young Children for School*. The WWC evaluated the quality and results of the selected studies using the criteria outlined in the version 4.1 Procedures and Standards Handbooks and the accompanying Review Protocol for *Preparing Young Children for School*.

The WWC considers each study's research design, whether findings were statistically significant and positive, and the number of studies contributing to this report. The WWC synthesizes evidence across studies—using a weighted average—to determine the effectiveness rating for each outcome domain. The WWC defines outcome domains in the Review Protocol for *Preparing Young Children for School*.

Effectiveness rating	Description of the evidence
Positive (or negative) effects	The evidence base primarily includes the strongest research designs, and the average effect across all high-quality research is statistically significant and positive (or negative).
Potentially positive (or negative) effects	The evidence base primarily includes research with some limitations, and the average effect across all high-quality research is statistically significant and positive (or negative).
Uncertain effects	The average effect across all high-quality research is not statistically significant, so the WWC does not classify it as a positive or a negative effect.

The WWC considers the effectiveness rating, the sample size, and the number of educational sites (states, districts, local education agencies, schools, postsecondary campuses) across studies to determine the evidence tier for each outcome domain. When the effectiveness rating is *uncertain*, *potentially negative*, or *negative effects*, there is no evidence tier.

Evidence tier		Criteria based on evidence synthesis
Strong evidence of effectiveness	TIER 1 STRONG	• Receives an effectiveness rating of positive effects, and • Includes at least 350 students from at least two educational sites
Moderate evidence of effectiveness	TIER 2 MODERATE	• Receives an effectiveness rating of potentially positive effects, and • Includes at least 350 students from at least two educational sites
Promising evidence of effectiveness	TIER 3 PROMISING	• Receives an effectiveness rating of potentially positive effects or positive effects, and • Includes fewer than 350 students or two educational sites

How was *Building Blocks* implemented?

This section provides details of how preschool sites implemented *Building Blocks* in the three studies that contribute to this intervention report. This information can help educators identify the requirements for implementing *Building Blocks* and determine whether implementing this program would be feasible in their districts, schools, or early childhood education centers.

Teachers implemented *Building Blocks* through weekly whole- and small-group instruction, center activities, and computer activities. In addition, a letter was sent home each week describing the mathematics children were learning and related activities the families or other caregivers could do at home to support their child's learning. Teachers regularly assessed children's learning and adapted activities to build on and extend the level of children's mathematical thinking. Activities were implemented over 26 to 30 weeks. Teachers' use of the *Building Blocks* curriculum was supported by professional development.

Comparison group: In the three studies that contribute to this intervention report, children in the comparison group were taught by teachers who did not participate in *Building Blocks* training and did not implement the *Building Blocks* sessions. Teachers may have participated in other training offered by their district, school, or early childhood education center.

WWC standards assess the quality of the research, not the quality of the implementation. Studies that meet WWC standards vary in quality of implementation. However, to be included in an intervention report, a study must describe the relevant components of the intervention and how each was implemented with adequate detail. Table 2 identifies and describes the components of the program that were implemented in the studies.

Table 2. Implementation of components of *Building Blocks*

Component	Description of the component	How it was implemented
Whole-group instruction	During whole-group instruction, the teacher leads short instructional activities and introduces the day's mathematics topic and new center or computer activities.	Teachers typically implemented whole-group instruction during circle time. Whole-group instruction took place for approximately 5–15 minutes, four or five times per week.
Small-group instruction	During small-group instruction, the teacher guides children through activities related to the day's mathematics topic(s). The teacher adapts the activities to the children's developmental levels.	Teachers provided small-group instruction to groups of 3 to 6 children, while the rest of the children worked on center activities, including computer activities (see below). Small-group instruction took place for approximately 10–15 minutes, two or three times per week.
Center activities	Center activities are intended to provide hands-on learning tasks related to the day's mathematics topic. The teacher adapts the activities to the children's developmental levels.	Children worked on center activities independently, guided by a teacher or assistant as needed. Most teachers implemented these as free-choice activities, as the curriculum suggested; others organized the time so that children rotated through all centers. Therefore, frequency and duration varied. Teachers used the Teacher's Edition to locate relevant activities.
Computer activities	Computer activities are intended to provide learning tasks related to the day's mathematics topic. The activities automatically adjust when children progress well or need additional help.	Children worked on *Building Blocks* computer activities individually during center time, often while teachers led small-group instruction. Computer activities took place for approximately 10–15 minutes, twice per week.
Family/caregiver letters	Family/caregiver letters are intended to describe the mathematics children are learning and related activities the family or other caregivers can do at home to support that learning.	Teachers sent family/caregiver letters home with children weekly.
Professional development	Teachers implementing *Building Blocks* in their classrooms received training and coaching. The training provides teachers with an introduction to the curriculum and related materials. The coaching includes observations and feedback to help teachers improve their implementation of the curriculum.	The content and duration of the professional development support provided to the teachers varied across the studies. Teachers received 4–8 full days of initial training, monthly 2-hour refresher classes, and on-site coaching 1–2 times a month.

Note: The descriptive information for this intervention comes from the intervention website https://mheducation.com, the three studies that meet WWC standards, and correspondence with the developer. The WWC requests that developers review the intervention description sections for accuracy from their perspective. The WWC provided the developer with the intervention description in July 2023, and the WWC incorporated feedback from the developer.

How much does *Building Blocks* cost?

This section provides educators with an overview of the resources needed to implement *Building Blocks*. Table 3 describes the major resources needed for implementation and approximate costs.

Table 3. Resources needed to implement *Building Blocks*

Resource	Description	Cost
Teacher training	The teacher training provides teachers with an introduction to the curriculum, the Teacher Resource Guide, and the ConnectED *Building Blocks* web-based application. The training also introduces teachers to the learning trajectories, developmental progressions, and related activities for each mathematics topic. The publisher provides a half- or full-day introductory professional training (3–6 hours, depending on the time the district has available for training teachers). Additional professional development ranging from 20–60 hours can be obtained from the developers.	A full day of in-person professional training for up to 30 teachers currently costs $3,500. Virtual training options are also available by request.
On-site coaching	On-site coaching includes observing teachers using the curriculum in their classrooms and meeting with them to reinforce implementation of the curriculum and to collaboratively solve problems when necessary. The publisher can provide on-site coaching or train district staff to do the coaching. Additional information on coaching can be obtained from the publishers.	The current cost for a coaching visit is $3,500 per day.
Teacher's Edition (volumes 1 & 2)	The Teacher's Edition provides weekly lesson plans, outlining the learning trajectory for each mathematics topic, the developmental progression of children's thinking, and related activities to support children in progressing from one level of understanding to the next.	The current cost of the Teacher's Edition is $170.12 per volume.
Teacher Resource Guide	The Teacher Resource Guide offers resources to support implementation of *Building Blocks*, including the family letters (in English and Spanish) for each week, support for English learners, and some curricular materials such as counting cards, shape sets, puzzles, and flip books.	The current cost of the Teacher Resource Guide is $106.24.
***Building Blocks* computer activities**	The *Building Blocks* computer activities are completed by children during computer time. The computer activities are recommended (but not required) for effective implementation of the *Building Blocks* program.	An online subscription to the computer activities for children can be purchased for $12.12 per student or $212 for 22 students. Desktop or tablet computers are required for use of the *Building Blocks* computer activities. Preschool sites can provide a small number of computers for children to take turns using during center time, or a full classroom set for all children to use at the same time.
Additional resources	Additional resources for purchase include a classroom manipulative kit, four large math-related picture books, and an assessment guide.	The classroom manipulative kit costs $623.32, each large math-related picture book costs $74.28 or all four books can be purchased for $259.48, and the assessment guide costs $64.88.
ConnectED *Building Blocks*	ConnectED *Building Blocks* is a web-based application that includes electronic versions of the Teacher's Editions (volumes 1 & 2), the four math-related children's books (in English and Spanish), and the Teacher Resource Guide, as well as the online assessment tools and interactive whiteboard activities.	The cost depends on the number of teachers and years of subscription, ranging from $19.32 for a single teacher for a 1-year subscription to $7,029.84 for multiple teachers for a 3-year subscription.

For More Information:

About *Building Blocks*

Web: https://mheducation.com

Address: McGraw-Hill Education, 8787 Orion Place, Columbus, OH 43240

What research did the WWC review about *Building Blocks?*

This section provides details about the studies of *Building Blocks* that the WWC examined in its systematic review, including (1) the WWC's ratings of the quality of the available research, (2) the findings from the three studies that meet WWC standards, and (3) the characteristics of the studies that meet WWC standards.

The quality of evidence in the available research about *Building Blocks*

The WWC identified seven studies that investigated the effectiveness of *Building Blocks* from a literature search in the Education Resources Information Center (ERIC) and other databases of research studies from January 2005 to January 2022. Of these seven studies, three meet WWC standards and contribute to the summary of evidence in this intervention report. Studies that either do not meet WWC standards or are out of scope of this review do not contribute to this intervention report.

- **Two studies meet WWC standards without reservations.** Two studies were cluster randomized controlled trials with low cluster-level attrition and low individual-level nonresponse.
- **One study meets WWC standards with reservations.** This cluster randomized controlled trial provides evidence of effects on individuals by satisfying the baseline equivalence requirement for the individuals in the analytic intervention and comparison groups, but has high individual-level nonresponse.
- **Three studies do not meet WWC standards.** Two cluster randomized controlled studies do not satisfy the baseline equivalence requirement for the individuals in the analytic intervention and comparison groups. One study was a cluster randomized controlled trial study that does not satisfy the baseline equivalence requirement for the clusters in the analytic and comparison groups.
- **One study is out of scope of this systematic review.** This study examined the effectiveness of an intervention that bundles the *Building Blocks* program with another intervention, so the effectiveness of *Building Blocks* cannot be isolated in this study.

The citations for these seven studies are included in the references. For information on how the WWC determines study ratings, see the version 4.1 *Procedures and Standards Handbooks*, WWC Standards Briefs, and the Review Protocol for *Preparing Young Children for School*, available on the WWC website.

More details about the three studies of *Building Blocks* that meet WWC standards

The three studies that meet WWC standards examined the effects of *Building Blocks* on one measure of preschool mathematics. Table 4 lists the name of the measure and the study in which the measure was administered, when it was assessed, the sample and setting, the means and standard deviations in the *Building Blocks* and comparison groups, the effect size, the improvement index, and whether the WWC determined the finding to be statistically significant.

Building Blocks had a potentially positive effect on student mathematics achievement. This assessment is based on evidence from three studies that meet WWC standards.

Table 5 describes characteristics of the three studies of *Building Blocks* that meet WWC standards, including the study setting and participants.

What is an effect size? The effect size is a standardized measure of the impact of an intervention that can be synthesized across outcome measures and studies. A positive effect size favors the intervention group, and a negative effect size favors the comparison group. Effect sizes further away from 0 mean there was a larger difference between the groups.

What is an improvement index? The improvement index is another measure of the intervention's impact on an outcome. The improvement index can be interpreted as the expected change in percentile rank for an average comparison group child if that child had received the intervention. For example, an improvement index of +5 means that a comparison group child at the 50th percentile would have scored at the 55th percentile if they had received the intervention. The effect size and improvement index measure the same concept in different units, similar to meters and feet for distance. The improvement index is not displayed for outcomes with uncertain effects.

What is statistical significance? A finding is statistically significant if the difference between the intervention and comparison group means was large enough that it is unlikely to have been obtained for an intervention without a true impact. The WWC considers *p* values less than 0.05 to be statistically significant.

Table 4. Findings by outcome domain from three studies of *Building Blocks* that meet WWC standards

Outcome	Timing of measurement	Sample	Setting	Means (standard deviations)		Findings		
				Intervention group	Comparison group	Effect size	Improvement index	Statistically significant (*p* value)
Mathematics outcome domain								
Research-Based[6] Early Mathematics Assessment (REMA) (Clements & Sarama, 2008)	End of 26 weeks of implementation	202 children	28 preschool classrooms in the United States	61.78 (7.46)	53.22 (8.38)	1.07	+36	Yes ($p < 0.01$)
Research-Based[6] Early Mathematics Assessment (REMA) (Clements et al., 2011)	End of 30 weeks of implementation	1,305 children	106 preschool classrooms in the United States	52.40 (17.25)	44.01 (17.89)	0.48	+18	Yes ($p < 0.01$)
Research-Based[6] Early Mathematics Assessment (REMA) (Hofer et al., 2013)	End of 30 weeks of implementation	1,714 children	139 preschool classrooms in the United States	48.00 (4.71)	44.91 (5.42)	0.55	+21	Yes ($p < 0.01$)
Summary for Mathematics: Potentially positive effects						**0.58**	**+22**	**Yes ($p < 0.01$)**

Note: The effect sizes and improvement indices are adjusted for baseline group differences.

Table 5. Characteristics of the three studies of *Building Blocks* that meet WWC standards

What was the study design?	All three studies used cluster randomized controlled trial designs. One study (Clements & Sarama, 2008) randomly assigned preschool classrooms to implement the *Building Blocks* curriculum or to continue with business as usual, while the other two studies (Clements et al., 2011; Hofer et al., 2013) randomly assigned preschool sites to implement the *Building Blocks* curriculum or to continue with business as usual.
What was the WWC study rating?	Two studies—Clements & Sarama (2008) and Clements et al. (2011)—are rated **Meets WWC Group Design Standards Without Reservations** because they are randomized controlled trials with low cluster-level attrition and individual-level nonresponse. One study—Hofer et al. (2013)—is rated **Meets WWC Group Design Standards With Reservations** because it is a cluster randomized controlled trial that provides evidence of effects on individuals by satisfying the baseline equivalence requirement for the individuals in the analytic intervention and comparison groups, but has high individual-level nonresponse.
Where did the study occur?	**Clements & Sarama (2008)** • The study took place in 28 classrooms in Head Start preschool sites in urban school districts and state-funded preschool sites in urban and suburban public school districts in New York. **Clements et al. (2011)** • The study took place in 106 classrooms in 42 preschool sites located in two urban public school districts in the United States. **Hofer et al. (2013)** • The study took place in 139 classrooms in 59 preschool sites in three urban public school districts in Tennessee, New York, and Massachusetts.
Who participated in the study?	**Clements & Sarama (2008)** • The intervention group included preschool children in 14 classrooms. The comparison group included children in 14 classrooms. The total number of children in the intervention and comparison groups was 202. • Approximately 43% of the children in the sample were White and 58% were Black, Asian, Native American, or Hispanic. Sixty-two percent of the children in the sample qualified for free or reduced-price lunch. **Clements et al. (2011)** • The intervention group included preschool children in 72 classrooms. The comparison group included children in 34 classrooms. The total number of children in the intervention and comparison groups was 1,305. • Approximately 51% of the children were female and 14% had limited English proficiency. Fifty-three percent of the children in the sample were Black, 19% were White, 4% were Asian, 2% were Native American, and 22% were another race. Approximately 22% of the children were Hispanic. Eighty-five percent of the children in the sample qualified for free or reduced-price lunch. **Hofer et al. (2013)** • The intervention group included preschool children in 88 preschool classrooms. The comparison group included children in 51 preschool classrooms. The total number of children in the intervention and comparison groups was 1,714. • Approximately 52% of the children were female and 15% were classified as English learners. Fifty-nine percent of the children were Black, 16% were White, and 25% did not report race. Nineteen percent of the children were Hispanic.

References

Studies that meet WWC standards with reservations

Clements, D. H., & Sarama, J. (2008). Experimental evaluation of the effects of a research-based preschool mathematics curriculum. *American Educational Research Journal, 45*(2), 443–494. https://eric.ed.gov/?id=EJ795943

Clements, D. H., Sarama, J., Spitler, M. E., Lange, A. A., & Wolfe, C. B. (2011). Mathematics learned by young children in an intervention based on learning trajectories: A large-scale cluster randomized trial. *Journal for Research in Mathematics Education, 42*(2), 127–166. https://eric.ed.gov/?id=EJ918252

Studies that meet WWC standards with reservations

Hofer, K. G., Lipsey, M. W., Dong, N., & Farran, D. C. (2013). *Results of the early math project: Scale-up cross-site results.* Peabody Research Institute. https://eric.ed.gov/?id=ED623690

Studies that do not meet WWC standards

Clements, D. H., & Sarama, J. (2007). Effects of a preschool mathematics curriculum: Summative research on the Building Blocks project. *Journal for Research in Mathematics Education, 38*(2), 136–163. https://eric.ed.gov/?id=EJ757034

Clements, D. H., Sarama, J., Layzer, C., Unlu, F., & Fesler, L. (2020). Effects on mathematics and executive function of a mathematics and play intervention versus mathematics alone. *Journal for Research in Mathematics Education, 51*(3), 301–333. https://eric.ed.gov/?id=EJ1255793

Morris, P. A., Mattera, S. K., & Maier, M. F. (2016). *Making pre-k count: Improving math instruction in New York City.* MDRC. https://eric.ed.gov/?id=ED569994

Studies that are out of scope for this intervention report using the topic area synthesis protocol

Sarama, J., Clements, D. H., Starkey, P., Klein, A., & Wakeley, A. (2008). Scaling up the implementation of a pre-kindergarten mathematics curriculum: Teaching for understanding with trajectories and technologies. *Journal of Research on Educational Effectiveness, 1*(2), 89–119. https://eric.ed.gov/?id=EJ873867

Additional sources

The WWC examined additional sources (such as preliminary reports, working papers, or other associated publications) related to the citations in the references to complete its review of these studies. The additional sources are listed on the WWC pages for each study review.

How possible conflicts of interest were addressed when preparing this report

Clements and Sarama led and/or contributed to the development of the *Building Block*s program and the measure used to assess the program's impacts. They co-authored two of the three articles that were reviewed and used for evidence for this intervention report. They contributed evidence from their work to the third study, which was completed under a subcontract to their IES grant. Because Clements and Sarama are the developers of the intervention and the measure used in those studies, the studies included in this intervention report are not independent evaluations of the program.

The intervention report was prepared by Instructional Research Group (IRG), under contract to the Institute of Education Sciences. The WWC team, including the WWC reviewers who assessed the quality of the research, was not involved in developing the program or studying its effectiveness and has no financial interest in the program. All studies that meet WWC standards and the synthesis of their findings were checked and verified through a peer-review process. The Statistics, Website, and Training (SWAT) team conducted an independent review of the evidence to ensure that the WWC's findings are accurate. The Tools, Online Assistance, Standards, and Training (TOAST) team conducted an independent review of the intervention report and the synthesis.

Recommended Citation

What Works Clearinghouse, Institute of Education Sciences, U.S. Department of Education. (2023, December). *Building Blocks*. https://whatworks.ed.gov

[1] Bodovski, K., & Farkas, G. (2007). Mathematics growth in early elementary school: The roles of beginning knowledge, student engagement, and instruction. *The Elementary School Journal, 108*, 115–130; Clements, D. H., & Sarama, J. (2009). *Learning and teaching early math: The learning trajectories approach*. New York: Routledge; Clements, D. H., Sarama, J., Spitler, M. E., Lange, A. A., & Wolfe, C. B. (2011). Mathematics learned by young children in an intervention based on learning trajectories: A large-scale cluster randomized trial. *Journal for Research in Mathematics Education, 42*(2), 127–166; Sarama, J., & Clements, D. H. (2009). *Early childhood mathematics education research: Learning trajectories for young children*. New York: Routledge.

[2] Clements, D. H. (1984). Training effects on the development and generalization of Piagetian logical operations and knowledge of number. *Journal of Educational Psychology, 76*, 766–776; Bowman, B. T., Donovan, M. S., & Burns, M. S. (Eds.). (2001). *Eager to learn: Educating our preschoolers*. Washington, DC: National Academy Press; Shonkoff, J. P., & Phillips, D. A. (Eds.). (2000). *From neurons to neighborhoods: The science of early childhood development*. Washington, DC: National Academy Press.

[3] The intervention report is based on three eligible studies (Clements & Sarama, 2008; Clements et al., 2011; Hofer et al., 2013) examining the impact of the *Building Blocks* curriculum. In Hofer et al. (2013), the intervention was referred to as *Technology-enhanced Research-based Instruction, Assessment, and Professional Development (TRIAD)*. In all three studies, teachers were supported with training and coaching. However, the level of support provided to teachers varied across the studies.

[4] Developmental progressions in mathematics outline the orders in which mathematical skills and understanding typically develop. For example, children learn to recognize and name shapes before they are able to combine or separate shapes to form new ones.

[5] The *Building Blocks* curriculum is designed for use in prekindergarten through grade 8. However, this intervention report provides evidence of its effectiveness only in prekindergarten.

[6] The developer chose to include the term "Research-Based" in the name of the measure. This term does not reflect the opinion of the WWC.