State policies for ensuring students are proficient readers by the end of third grade have been gaining momentum across the country. These policies are strongly supported in research predicting future academic achievement. Unrecognized by many, early math skills have also been strongly linked to subsequent academic achievement, and are even more predictive than early reading literacy. Students who demonstrate proficiency in math have higher achievement at age 15, and higher socioeconomic status (SES, a combination of income, housing and quality of life) at 42.\textsuperscript{1,2} Additionally, investing in young learners has been demonstrated to produce significant returns on investment, as much as 7 percent to 10 percent annually.\textsuperscript{3}

This is the first in a series of briefs looking at early education. In this brief, research evidence, policy options and state examples are presented to provide legislatures with a framework for enhancing early math education. Policy options include developing mathematical knowledge in early education teachers, implementing research-based curricula and including early math in STEM (Science, Technology, Engineering and Math) education.

Why Early Mathematics?
While there has been a well-documented push for improving literacy skills in prekindergarten through third grade,
both in policy and research, a growing effort to develop early math skills is gaining traction. Bills introduced in 2015 in Alabama, Illinois and Iowa aim to provide developmentally appropriate instruction in preschool, create a strategic plan for redesigning K-12 STEM education, and fund K-12 math and science teachers, respectively. The importance of developing early math skills among the youngest learners comes at a time when workforce development is becoming one of states’ economic priorities, prekindergarten is gaining more attention and teacher education programs are drawing critical consideration.

Nationally, on average, substantially more time (as much as three times) is spent on reading-literacy activities. Because 48 percent of 3- and 4-year-olds in the United States do not attend any preschool program, only have informal math learning experiences and begin intentional math instruction in school up to two years later than many of their international peers, providing early math instruction could lead to significant educational growth in the nation’s students.

In 2013, only 42 percent of fourth-graders scored at or above proficient in math on the National Assessment of Educational Progress (NAEP), and this number decreased to 35 percent for eighth-graders. Additionally, large achievement gaps exist when comparing students with low socioeconomic status to those who are middle- and high-SES, beginning as early as kindergarten and extending into high school. With 51 percent of public school students living at or below the poverty line, developing early math skills could help reduce the achievement gap.

Policy Questions

- How can early math education improve long-term student achievement?
- How do state legislatures create support for early mathematics legislation?
- What are potential policy levers?

Potential Answers

- Recognize the importance of early math as a predictor of future academic achievement (stronger than early literacy).
- Include early math instruction within the expanding field of preschool.
- Highlight the importance of early math as a foundational element in STEM education; young students should understand and use math as a primary tool and language for learning these fields.
- Provide ongoing professional development for teachers and use research-based curricula to build a solid infrastructure in schools.

Policy Options

To improve math achievement and general long-term academic achievement for all students—and for those living in poverty, in particular—three policy options are presented: improving educators’ mathematical content knowledge and expertise, using research-based curricula and building math skills as foundational to STEM education. Figure 1 illustrates a selection of enacted legislation related to early math education in each of these areas over the past five years.

1. Improving Educators’ Mathematical Content Knowledge (Mathematics Specialization)

Research has demonstrated that students do better in math when their teachers have strong content knowledge; investing in early childhood education does not generate significant learning growth if teachers are inexperienced or poorly rated. Having a deep understanding of math concepts and how children acquire them allows teachers to recognize individual differences in students’ knowledge, leading to more effective assessment, differentiation and intervention. Further, providing graduate-level degrees for early math specialization presents the opportunity for strong infrastructure to be developed in schools; math specialists...
can coach and provide training to teachers in every school. Research has confirmed that teachers perceive deficiencies in their math professional development and that only 17 percent of sampled teachers received math-specific training in their school.\textsuperscript{13} By addressing this issue, legislatures can strengthen teachers’ skills and empower them to be confident in their math instruction. Recently, there has been a national push for improving teacher preparation programs. The Council of Chief State School Officers (CCSSO) has developed a pilot project for overhauling teacher preparation and licensing systems. To address the overproduction of elementary school teachers and not enough math, science, bilingual and special education teachers, researchers have suggested that requiring schools of education to produce certain percentages of these types of teachers could become a potential lever for policy formation, along with scholarships and loan forgiveness programs.\textsuperscript{14} Examples of bills introduced in 2015 that support improving K-12 educators’ mathematical content knowledge include the following.

- **Utah HB 30**: Expands a grant program by providing stipends, professional development and leadership opportunities to an experienced math teacher to help him or her become a teacher leader.

- **Oklahoma SB 709**: Creates the Oklahoma Teacher Recruitment Act, providing that public school teachers will be eligible to receive an annual salary stipend of $4,000 if they received a bachelor’s degree in science, math or special education and 60 percent of their classroom activity is spent in their degree area.

2. Employing Research-Based Early Mathematics Curricula

Young children sometimes have few structured experiences to learn, such as preschool, and this is especially so for children from low-income families. For students in primary grades, there is evidence that using a high-quality, research-based mathematics curriculum can improve early
There are several research-based curricula for early math, including Big Math for Little Kids, Pre-K Mathematics and Building Blocks. Building Blocks is a National Science Foundation-funded prekindergarten through second-grade math curriculum based on a comprehensive research framework. This curriculum has been used primarily with students from low socioeconomic classes and has proven very successful in improving their early math achievement. The developers of Building Blocks have studied its long-term effects through the completion of first grade and found positive gains when compared to students not using the curriculum. Further, when follow-up is provided in the form of professional development and coaching for teachers over time, achievement was even higher.

An emerging number of early math bills in 2015 focus on using research-based curriculum, including the following.

- **Alaska HB 36**: Creates a statewide early childhood education plan for kindergarten through grade 12 that incorporates model curriculum; provides annual monitoring and accountability stipulations.
- **Minnesota HB 739**: Provides universal preschool for 4-year-olds; programs must offer compensatory services in language, literacy and mathematical thinking in a developmentally appropriate manner.
- **Wisconsin SB 1**: Employs a standard, consistent, research-based curriculum that is aligned with the state’s model academic standards, as determined by the state superintendent, and across grades in all schools.

### 3. STEM Education

Math is the language of STEM; it is the foundational element that enables the development of skills in science, technology and engineering. By pushing for early mathematics within STEM education, connections to economic and workforce development can be made and can garner increased attention and resources. Policy responses include the development of funding and grants, STEM centers to provide educational services, relationship development between public and private sectors, STEM curricula research and development, and study of long-term economic and educational effects. Examples of bills introduced in 2015 include the following.

- **Indiana HB 1001**: Creates the STEM Teacher Recruitment Fund. Appropriations may be used to provide grants to nonprofit organizations that place new science, technology, engineering and math teachers in elementary and high schools located in underserved areas.
- **Massachusetts HB 306**: Requires each school district to develop and implement a plan to include inquiry-based instruction for STEM-related fields taught in K-12 public schools.

### Early Math and Students’ Poverty Levels

<table>
<thead>
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<th>Students living in poverty represent the majority of all public school students nationally. Research-based mathematics curricula can help close the achievement gap and improve long-term academic achievement outcomes for all students.</th>
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<td><strong>40 percent</strong></td>
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<td><strong>87 percent</strong></td>
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<td><strong>83 percent</strong></td>
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• **Washington HB 1106**: Appropriates funding for expanding a mobile STEM center to students in rural, tribal and low-income communities.

Addressing the issue of early math education within STEM education acknowledges that math is the foundation for the development of skills in science, technology and engineering, and that early math is correlated to long-term academic achievement.

**Conclusion**

The policy options discussed here—developing mathematical content knowledge and expertise of early educators, creating and implementing research-based mathematics curriculum, and highlighting the importance of early math within STEM education—address early mathematics education and its potential to enhance long-term academic achievement. State legislatures may want to consider emphasizing early math’s predictive ability, enhancing school infrastructure through professional development, encouraging mathematics specialization and studying the economic implications of STEM education.

**Resources**

Colorado Department of Education, Office of Early Childhood-Early Childhood Leadership Commission

Council of Chief State School Officers
www.ccsso.org

Erikson Institute, Early Math Collaborative
http://earlymath.erikson.edu/

Heising-Simons Foundation, Early Math
http://earlymath.org/

MDRC, Making Pre-K Count
www.mdrc.org/project/making-pre-k-count
www.mdrc.org/project/making-pre-k-count#overview

National Council of Teachers of Mathematics, Main Page
www.nctm.org/

National Association for the Education of Young Children, State Trends
www.naeyc.org/policy/statetrends

NCSL, Education Main Page

National Governors Association, Center for Best Practices-Education Division
www.nga.org/cms/center/edu

Robin Hood, Early Childhood Research Initiative
https://www.robinhood.org/initiatives/early-childhood

What Works Clearinghouse, Math

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Notes


10. T. Watts, G.J. Duncan, R.S. Siegler, and P.E. Davis-Kean, “What’s past is prologue: Relations between early mathematics knowledge and high school achievement.”


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