

Strengthening Early Math

A High Leverage Strategy for Meeting the Common Core Challenge



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When it comes to mathematics, California educators face two basic challenges. The first is to make sure every student who graduates from high school has high enough competencies and strong enough math skills to function well in a complex society. The second is to see that a larger portion of those students excel in math so our state and our country can take advantage of the growing job opportunities in technical fields in the 21st Century.

The Common Core Mathematics Standards don't change those basic challenges. But implementing the new standards gives local school districts a reason and an opportunity to re-evaluate their approach to math instruction at every level.

Doing so for their youngest students may yield the most dramatic results.

The timing is advantageous. New research sheds light on the importance of early mathematics education and the big payoffs in student knowledge that can result from a set of relatively straightforward, high leverage changes. Building a stronger math foundation will benefit all children, but is particularly important for those who begin school at a disadvantage; the same children the state is focused on with its new funding system. A key to doing that is increasing the subject matter competence and confidence of educators at the preschool and early elementary levels, an investment that can be made using state funding for Common Core implementation.

Other changes in California's education eco-system could support educators' ability to align instruction between the Early Childhood Education (ECE) and K-12 worlds. That would ultimately strengthen kindergarten readiness in mathematics. Systematic strategies for doing this have been tested in other states and a few California districts are also beginning to look at them. The on-going implementation of Transitional Kindergarten in this state, coupled with the Common Core adoption, provides a natural opportunity as well. And California is in the midst of creating an improvement strategy for ECE thanks to a federal grant.

All of this points to the strengthening of mathematics learning for PreK to 3rd grade children as a particularly powerful and cost-effective strategy for districts and schools to emphasize as they implement the Common Core. This guide provides information that education leaders can use to:

1. Raise awareness about why early math education is so important;
2. Narrow in on appropriate instructional and professional development resources;
3. Explore possibilities for aligning ECE and K-12 efforts; and
4. Create an action plan for moving forward.

Early Math Sets The Stage For School Success

New research sheds light on how vital early mathematics education is

For decades, educators at every level have easily quoted findings about the importance of children



appropriate ways, is equally important. Greg Duncan, a Distinguished Professor at UC Irvine, has done extensive research regarding what early skills are most predictive of later school success.

“The research consistently shows that math is equally important as reading in predicting school success,” Duncan said. “The standard result is that not reading well by third grade can predict dropping out of high school very strongly. But we find that persistent math problems are also extremely predictive. The implications are that while we don’t want to ignore reading, it has perhaps been overemphasized in the early grades and math has been underemphasized. The Common Core implementation can change that.”

In a longitudinal study from the National Center on Education Statistics (NCES), researchers looked at mathematics achievement scores for children as they moved from kindergarten to 8th grade. These national data (see Figure 1) show that children who begin school with poor math skills typically do not catch up. The baseline data came from an assessment of children entering kindergarten.

Preliminary data on kindergartners in 2010-11, from the first stage of a new Early Childhood Longitudinal Study by NCES, reinforce generally held perceptions that those children least prepared when they enter kindergarten are disproportionately from low-income families. These preliminary findings (see Figure 2) also underscore the extent to which parents’ education levels correlate with children’s early math abilities.

reading well by third grade. Getting there meant children needed early and frequent exposure to reading from the earliest ages. Teachers, policymakers, and parents grabbed hold of that research. Reading to your 1-year-old became a national pastime.

Early experiences with math are as important as early reading

A growing body of research indicates that early exposure to some key mathematical concepts, which can be provided in fun and developmentally

Figure 1:
Children who start behind in math in kindergarten stay behind

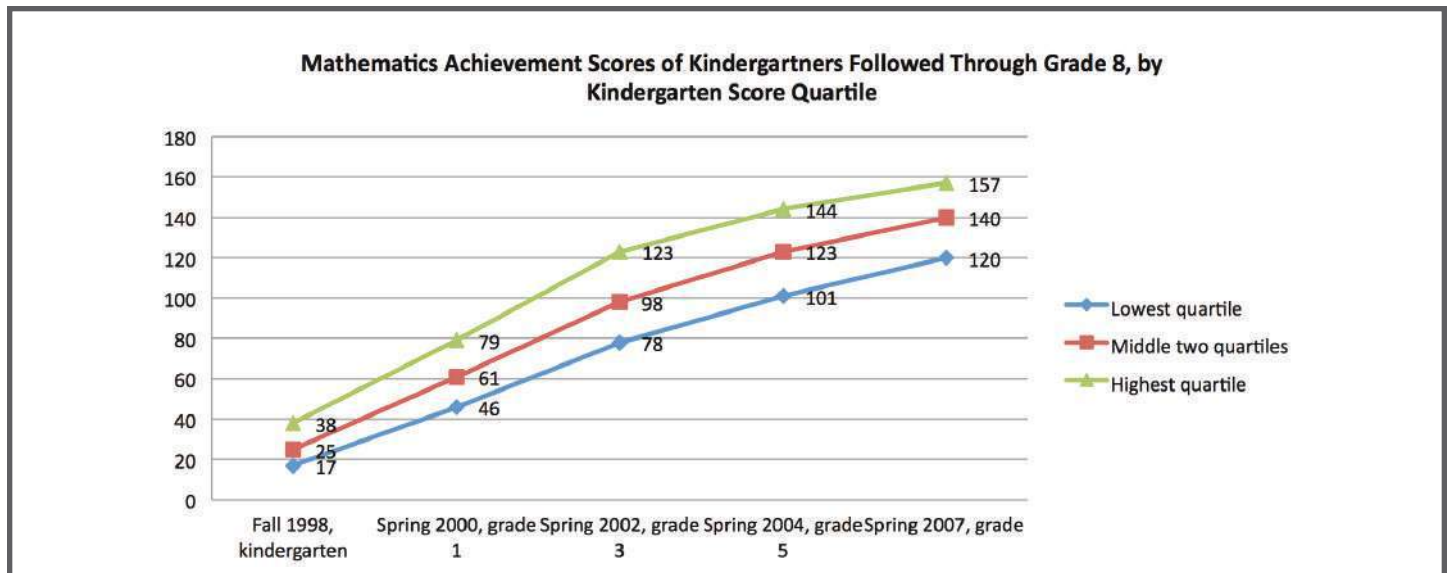


Chart from Math Matters: Children’s Mathematical Journeys Start Early, 2011 Conference Proceedings (Schoenfeld & Stipek). Data: National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 1998-99, fall 1998 and spring 2000, 2002, 2004 and 2007; and National Science Foundation, division of Science Resources Statistics.

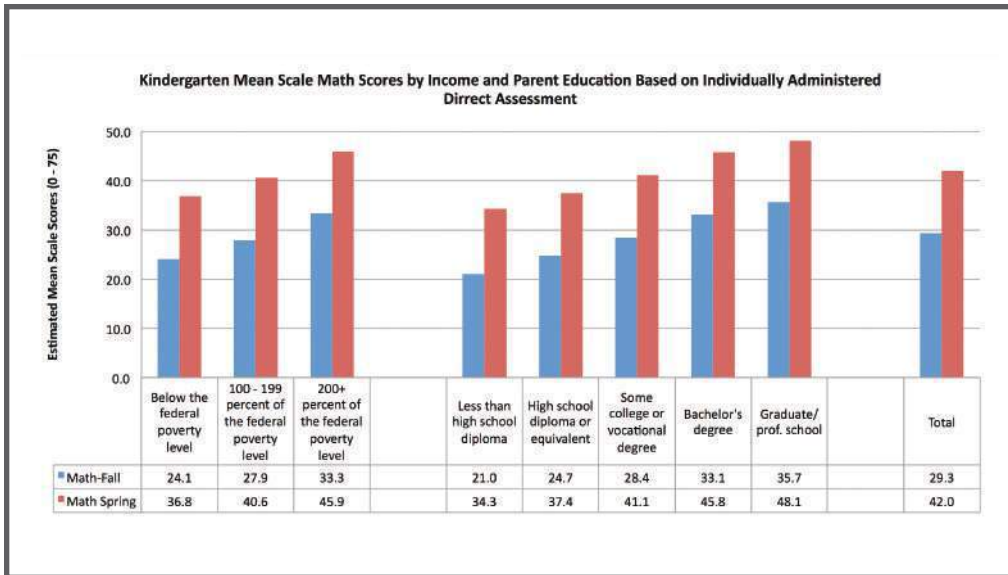


Figure 2:

The children who start behind come from lower income families and have less educated parents

Data: First-Time Kindergartners in 2010-11: First Findings From the Kindergarten Rounds of the Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011) (NCES 2012-049). (Mulligan, G.M., Hastedt, S., and McCarroll, J.C.) U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved September 2013 from <http://nces.ed.gov/pubsearch>.

Teachers and parents have important roles to play

Other research points to what basic mathematical understanding is most crucial for helping all children have a solid start in math. One of the most important, according to a study funded by the National Institutes of Health, is basic numeracy, a simple, straightforward understanding of the number system and its basic principles (see the box). The study tracked children based on their mastery of these first grade math skills and found that a low score “significantly increased a student’s risk of getting a low functional numeracy score as a teenager.” In this case functional numeracy equated to mastery of the 7th grade math skills adults need to function in any workplace and that students need for success in algebra. With the right curriculum and professional development, both preschool and K-3 educators could change the math trajectory for many children. And they can enlist parents to help as well.

More On The Research

- Math and Science in Preschool: Policies and Practice. Preschool Policy Brief, National Institute for Early Education Research, March 2009. [link: <http://nieer.org/resources/policybriefs/20.pdf>]
- California’s Math Pipeline: Success Begins Early. Matt Rosin, EdSource. 2011. [link: <http://www.edsource.org/pub11-math-success-begins-early.html>]
- Proceedings from two conferences on early math are available at www.earlymath.org.
- Math in the Early Years: A Strong Predictor for Later School Success, Education Commission of the States, October 2013. [LINK: <http://www.ecs.org/clearinghouse/01/09/46/10946.pdf>]

Basic Numeracy: The core principles of number system knowledge

The National Institutes of Health draws from a long-term study to describe first-grade math skills children need to master for later success:

- Numbers represent different magnitudes (five is bigger than four)
- Number relationships stay the same, even though numbers may vary. For example, the difference between 1 and 2 is the same as the difference between 30 and 31.
- Quantities (for example 3 stars) can be represented by symbolic figures (the numeral 3).
- Numbers can be broken into component parts (5 is made up of 2 and 3 or 1 and 4).

From an NIH news release, Feb. 27, 2013. <http://www.nih.gov/news/health/feb2013/nichd-27.htm>



Instructional And Professional Development Resources To Support Early Math

New standards provide clear roadmaps for seamless PreK-3 math instruction

Concurrent with an increased recognition of the importance of young children's readiness for kindergarten math, there is rich and powerful instructional guidance for both Early Childhood and K-3 educators in California. As is often the case, however, the guidance was originally provided in two separate sets of documents, one for the preschool community and the other for the K-12 world.

Preschool foundations set out early goals for math learning

In 2008, the California Department of Education (CDE) published the California Preschool Learning Foundations: Volume 1 "to provide early childhood educators, parents, and the public with a clear understanding of the wide range of knowledge and skills that preschool children typically attain when given the benefits of a high-quality preschool program." Mathematics was one of the four domains covered, along with social-emotional development, language and literacy, and English-language Development. The mathematics foundations were divided into five main developmental strands:

- Number Sense: important aspects of counting, number relationships, and operations.
- Algebra and Functions (Classification and Patterning): sorting and classifying objects; recognizing, extending, and creating patterns.
- Measurement: comparing and ordering objects by length, weight, or capacity; precursors of measurement.
- Geometry: properties of objects (shape, size, position) and the relation of objects in space.
- Mathematical Reasoning: using mathematical thinking to solve problems in play and everyday activities.

In 2010, the state adopted the California Preschool Curriculum Framework Volume 1, which provided more detailed guidance to curriculum developers and educators. Among other things, it is replete with examples of how to integrate intentional mathematics instruction into play activities and classroom environments in ways that are developmentally appropriate for preschoolers. It also suggests home activities.

Aligning early goals and the common core

The preschool mathematics foundation and framework were developed before California adopted the Common Core standards. The foundations were provided as a point of reference when state officials began creating guidance documents for implementation of the new standards. For example, they are cited in the 2011 CDE publication *A Look at Kindergarten in California Public Schools and the Common Core State Standards*. That publication provides a general statement about what entering kindergarteners should know and then it details how the new kindergarten standards compare to the state's previous standards. The CDE provides a similar mapping for each grade level.

More recently, the CDE has published a comprehensive document that, among other things, maps the Early Learning Foundations in mathematics to the Common Core. Authored by experts at WestEd, this document provides a detailed mapping behind its statement that: "For every substrand of the preschool learning foundations, there is a category in the CCSS with corresponding content." Thanks to California's creation of Transitional Kindergarten programs, authorized in 2010 and implemented beginning in 2012-13, a growing number of districts have begun actively working on what that alignment looks like on the ground.

Early Learning Foundations map to the Common Core Math Standards for Kindergarten: Two Examples

Development of mathematical concepts and skills:

- Preschool children gradually learn to count up to 20 with increasing accuracy.
- By the end of kindergarten, they count up to 100 by ones and tens, and can count forward beginning from a given number within the known sequence (instead of having to begin at 1).

Geometry:

- Preschool children develop the ability to identify, describe, and construct a variety of shapes.
- By the end of kindergarten, they correctly name shapes regardless of their orientation or overall size and analyze and compare two- and three-dimensional shapes in different sizes and orientations.

Excerpted from *The Alignment of the California Preschool Learning Foundation with Key Early Education Resources*, California Department of Education, 2012

Recommended Curriculum Resources

- The California Preschool Curriculum Framework Volume 1 [LINK: <http://www.cde.ca.gov/sp/cd/re/documents/psframeworkkv1.pdf>]
- Pre-K Mathematics Curriculum, Alice Klein & Prentice Starkey, Published by Scott Foresman-Addison Wesley, Mathematics series - Pre-K level [LINK: <http://www.pearsonschool.com/index.cfm?locator=PSZ153&PMDbSiteId=2781&PMDbSolutionId=6724&PMDbSubSolutionId=6731&PMDbCategoryId=806&PMDbProgramId=28182&level=4>]
- Building Blocks, Douglas Clements, Graduate School of Education, University of Buffalo. [LINK: <http://gse.buffalo.edu/org/buildingblocks/>]
- Until California adopts new instructional materials fully aligned with the Common Core, the state has provided two lists of supplemental materials, one that ties to currently-adopted math materials [LINK: <http://www.cde.ca.gov/ci/cr/cf/simrcategory.asp>] and the other a generic set of materials for use with any curriculum program. [LINK: <http://www.cde.ca.gov/ci/cr/cf/mathcategory2.asp>]
- California's Instructional Quality Commission has completed a Mathematics Curriculum Framework which provides guidance for curriculum development at every grade level, including transitional kindergarten. [LINK: <http://www.cde.ca.gov/ci/ma/cf>]

Increasing the subject matter competence and confidence of educators at the preschool and early elementary levels could pay big dividends

When one looks at the concepts that underlie early math literacy—basic numeracy, the organization of the number line, constructing shapes—it's clear that virtually all adults understand these concepts. Some of the challenge in making parents and educators better math teachers for the youngest children is to remind them of what they already know and show them how to successfully nurture young children's understanding of those basic concepts. Spending more time on

“mathematics talk” can make a difference as can parent education (see box).

The math concepts at this level are relatively simple and commonly understood, but knowing how to teach them effectively is less so. In part the problem is that few K-3 teachers and almost no preschool teachers have had much training in math instruction.

The National Institute for Early Education Research emphasizes that having learning materials for the youngest children is not enough. “By understanding children's development, teachers are better prepared to identify moments when math and science learning is taking place, to assess what an individual child knows or needs to know about a particular concept, and to plan for future instruction. Recent studies have also demonstrated a direct link between teacher behavior and children's math learning. Specifically, the amount of math related talk a teacher engages in is correlated with the growth of students' mathematical knowledge over the school year.”

As Professor Duncan underscores, “Elementary teachers tend to avoid math because they're math phobic. We need to think hard about the supports they need to become good math teachers. Often they lack tools to understand the conceptual underpinning and math practice.”

In a report of the proceedings from a 2011 conference entitled Math Matters, authors Alan Schoenfeld and Deborah Stipek describe the minimal preparation that K-3 educators receive in math instruction and the extent to which it is nearly non-existent for preschool teachers. They also suggest some strategies for providing in-service support around mathematics to both sets of early educators.

“Teachers need to be given time to participate in continuing education that is directly related to their practice. Most early childhood education programs

Strengthening Parents' Awareness of Math Basics

Parents can play a key role in building early math skills with their children. The key is raising awareness among parents about the many simple, natural opportunities that exist. Sadly, teachers are often ill-prepared to help parents in this way. However, some good resources exist that can be easily duplicated (in whole or in part) and shared as a first step, including:

The California Preschool Curriculum Framework Volume 1 [LINK: <http://www.cde.ca.gov/sp/cd/re/documents/psframeworkkv1.pdf>] includes suggestions for parents on how to support their young child's understanding of mathematics.

Helping Your Child Learn Mathematics [LINK: <http://www2.ed.gov/parents/academic/help/math/index.html>], part of the parent's section of the U.S. Department of Education website.

and schools lack internal capacity, such as coaches with expertise in teaching math to young children. Such individuals could teach math directly to children across classrooms as well as support other teachers. Research has shown that efforts to prepare preschool and K-3 teachers to be effective math teachers lead to them having better knowledge and a greater inclination to teach mathematics. And preparing teachers to help parents and other caregivers promote mathematics learning at home could expand children's access to math learning opportunities.”

Implementation of the Common Core provides a “teachable moment” for addressing this gap in math competency among PreK-3 teachers. The new standards provide the immediate need and also come with a level of extra funding for professional development that schools have not seen for a decade. Given the lack of skills at K-3 and in pre-K, it could take a relatively modest effort to move the needle. Free, state-created online professional development resources provide a head start.

The investment in teacher skills and future student achievement can bear greater fruit if PreK-3 efforts are aligned and even occur together. But collaboration among different agencies can take time that many educators don't feel they have. From a policy perspective, it can also be complex when it involves education systems that are as different in structure, funding, and emphasis as the pre-K and K-3 systems are in California. Thankfully some research and initiatives provide guidance for how the systems might work together more effectively.

More On Professional Development

For both preschool math and the Common Core, the California Department of Education (CDE) has developed a compendium of materials and online coursework devoted to the professional development of teachers. They can be found at:

- The California Preschool Online Learning Center [LINK: <http://www.cpin.us/preschoolonline/index.htm>]
- On the Common Core State Standards page of the CDE website [LINK: <http://www.cde.ca.gov/re/cc/ccssplm.asp>]

General suggestions for improving PreK-3 teacher competency in math, including changes in preparation, are summarized in these documents:

- Math and Science in Preschool: Policies and Practice. Preschool Policy Brief, National Institute for Early Education Research, March 2009. [link: <http://nieer.org/resources/policybriefs/20.pdf>]
- Math Matters: Children's Mathematical Journeys Start Early, 2011 Conference Proceedings (Schoenfeld & Stipek), Heising-Simons Foundation. [LINK: www.earlymath.org]



Joining Forces: Pre-K And K-12 Together

Aligning instruction across the Early Childhood Education and K-12 systems faces obstacles but there are new opportunities and some models

On paper, California officials have advocated a developmental continuum for education from birth to age 8 for more than a decade. The California Master Plan for School Readiness, published in 2002, envisioned voluntary infant-toddler-preschool programs, with full day kindergarten, all aligned to a developmental K-3 curriculum.

The reality on the ground is quite different from this vision in most California communities.

One explanation is how differently the PreK and K-12 systems are funded and governed here. The public K-12 system has a formal governance structure with locally elected officials, compulsory attendance laws (beginning with first grade), funding the state allocates to school districts that in turn make decisions about school operations, and state-defined teacher credential requirements. Contrast that with a pre-K system with disparate public and private providers, a level of public funding that does not cover all the potential enrollment but does follow the child, and a workforce that is relatively low paid and not necessarily well-prepared. In communities where public K-12 districts provide PreK, the districts also sometimes see local private providers as competitors more than as partners helping get local children ready for kindergarten.

PreK-3 is further along in other states

The idea of a well-aligned PreK-3 education system is more commonplace in some other states. For example, it has been a focus of the Bill and Melinda Gates Foundation in their home state of Washington. A March 2013 publication documents the promising experiences of three Seattle area school districts that had foundation support to undertake the challenge of uniting preschool and K-3 efforts into a more unified early childhood learning system. They reported:

“... the coalition made striking progress during its first 18 months. It built bridges between early learning providers and elementary schools, improved teacher training while cutting its cost, and spread effective strategies. It also helped to implement Washington state’s new assessment and transition program for incoming kindergarten students (WaKIDS). Among its greatest accomplishments was that Edmonds, Everett and Seattle district leaders increasingly championed PreK-3rd inside and outside their districts.”

The idea of a PreK-3 early learning continuum is gaining traction in California

California’s commitment to early education has been uneven at best. State funding was cut dramatically after 2008 and restoration of the money has been slow. That said, the state’s work to create quality standards for preschool education helped it capture a federal Race To The Top Early Learning Challenge Grant.

California’s plans for spending the more than \$70 million from this federal grant are focused on

What Is PreK-3rd?

Key features of PreK-3rd early education programs:

- High-quality, voluntary, universal Pre-K for all 3- and 4-year-olds
- Full-day kindergarten
- Qualified teachers with both a bachelor’s degree and specialized training in how young children learn
- Opportunities for teachers to share data, planning, and professional development across grade levels
- Strong leadership committed to providing children with a seamless educational experience
- Opportunities for parent and community engagement
- Quality, developmentally appropriate curriculum and standards that are aligned from Pre-K through third grade
- Shared accountability, between preschools, public schools, parents, and communities, for ensuring that all children read and do math on grade level by the end of third grade

Source: America’s Vanishing Potential: The Case for PreK-3rd Education (New York: Foundation for Child Development, 2008), http://www.fcd-us.org/resources/resources_show.htm?doc_id=711495



supporting preschool quality. That includes the development of a Quality Rating and Improvement System (QRIS), a set of tools to help local agencies collect and disseminate information about, as well as improve the quality of early learning programs.

The 2010 requirement that districts provide a transitional kindergarten program creates a more specific opportunity and imperative around the articulation of preschool and K-3 programs. The Kindergarten Readiness Act called for a modified curriculum that is age and developmentally appropriate but left it to districts to define that. In August, 2013, as part of its draft Mathematics Curriculum Framework, the state's Instructional Quality Commission provided this admonition. "Articulation with preschool programs in the district and in the community and with traditional kindergarten classes is essential if transitional kindergarten is going to serve as a bridge between preschool and traditional kindergarten."

Communities and school districts throughout California have taken some formal steps as well. Santa Clara County adopted an early learning master plan in 2010, claiming that it was the first local initiative to begin implementing the core elements of the state's 2002 Kindergarten Readiness plan. In San Francisco Unified School District, 2011-12 marked the beginning of a PreK-3 initiative. This fall, a task force is scheduled to

make a recommendation to the Los Angeles Board of Education on the topic.

Resources related to PreK-3 Initiatives

- White paper documenting Washington state model of PreK-3 initiative [LINK: http://www.edmonds.wednet.edu/cms/lib02/WA01001167/Centricity/Domain/83/PreK-3_Coalition_paper.pdf]
- Framework for Planning, Implementing and Evaluating PreK-3rd Grade Approaches, by Kristie Kuaerz and Julia Coffman, College of Education, University of Washington, 2013. [LINK: <http://depts.washington.edu/pthru3/framework.html>]
- California's Early Learning Challenge grant [LINK: <http://www.cde.ca.gov/sp/cd/rt/>]
- Santa Clara County Early Learning Master Plan Executive Summary [Link: http://www.sccoe.org/depts/students/early-learning-services/Documents/Executive_Summary.pdf]
- San Francisco Unified 2012 report to the board regarding its PreK-3 Initiative [LINK: <http://www.sfusd.edu/en/assets/sfusd-staff/news-and-calendars/files/prek-3-collaboration-report.pdf>]

Next Steps For Districts: Creating An Action Plan

The end goal of California's Common Core adoption is that all students leave high school ready for college and career. A key element in reaching that goal is competency in mathematics, a competency whose foundation is most effectively begun before children even enter kindergarten. Given the weakness in current approaches and capacity related to early math instruction, a relatively modest investment could pay big dividends in terms of student learning.

Local districts and schools committed to improving student learning in early mathematics will need to commit to a comprehensive strategy that will take time and commitment. But the journey can begin with small steps and it can begin quickly.

Actions that school districts can take quickly

- Raise the issue of early math as an appropriate and important focal point for attention as part of the Common Core implementation.
- Build awareness of why it matters.
- Shine light on the most basic classroom strategies and what can happen at home. [It's not rocket science.]
- Use the adjacent check list to begin a local inventory of the capacity of the K-3 teaching staff, the key preschool providers, existing collaborations, and opportunities.

Longer term investments

- Create a vision and map out the steps toward getting there.
- Establish early math benchmarks, including Kindergarten readiness, as goals for the district's new Local Control Accountability Plan (LCAP).
- Develop a plan based on findings from your local inventory.
- Use Common Core implementation funds for professional development in math for TK-3 teachers.
- Build math into the agenda for Professional Learning Communities
- Open communications with local ECE providers and if possible and appropriate, invite them to any TK-3 professional development activities

Join the conversation to affect longer range and broader policy issues

- Advocate for more extensive math requirements in local elementary teacher preparation programs.
- Instigate and/or support public information campaigns about early math for parents and the

public comparable to what has been done for early reading.

- Consider ways to build the capacity of early childhood educators and the state's support of preschool opportunities for low-income children. To what extent should the state invest more?
- Get involved in the state's Race to The Top grant activities.

Local Capacity And Opportunities Checklist

Current early math performance

- Identify available performance measures for kindergarten readiness as well as student learning in K-3.
- Analyze and chart student performance over time, including subgroups, by using student level data.

Staff capacity

- Survey TK-3 teachers regarding their comfort level with math instruction.
- Analyze staffing data to identify teachers with specialized academic backgrounds, credentials or continuing education who could serve as math coaches.
- Have teachers do a self evaluation to identify areas of math instruction where they would find professional development to be most valuable

Parent education

- Identify current parent information that is in use and effective at schools within the district and make it more widely available.
- Look at any successful early reading campaigns that have been conducted and see if the same approach would work for mathematics.
- Look at ways that parent education events and resources already in place – e.g. conferences, open houses, web site offerings—could be leveraged to promote early math education for parents.

PreK linkages and resources

- Inventory the local ECE programs that prepare the children in your district, both public and private.
- Gather information about the local TK program and its successes bridging between the two systems.
- Appoint someone within the district to coordinate planning and programs among the local PreK providers, TK classrooms, and K.

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