

DREME: Development and Research in Early Mathematics Education

The DREME Network was created in 2014 to advance the field of early mathematics research and improve young children’s opportunities to develop math skills. The Network focuses on math from birth through age eight years, with an emphasis on the preschool years. Network members and affiliates collaborate to conduct basic and applied research and develop innovative tools that address high-priority early math topics and inform and motivate other researchers, educators, policymakers, and the public.

A NEED FOR MORE OPPORTUNITY AND ACCESS

There is a critical need for new knowledge and resources to guide and facilitate efforts to promote young children’s math learning and increase equity and excellence in math achievement. Although important research has been conducted in recent years, there remains much to learn about how to promote math learning in home and at school, especially for preschool-aged children, and about the organizational conditions that enable teachers to deliver effective instruction to young children.

DREME Network Members

Deborah Stipek (Chair)—Stanford University
Amy Claessens—University of Chicago
Douglas Clements—University of Denver
Cynthia Coburn—Northwestern University
Eric Dearing—Boston College
Dale Farran—Vanderbilt University
Megan Franke—UCLA
Herbert Ginsburg—Columbia University
Susan Levine—University of Chicago
Michele Mazzocco—University of Minnesota
Deborah Phillips—Georgetown University

DREME Staff

Graciela Borsato (Network Director)
Kimberley Kim (Finance Manager)
Jeannie Crumly Cole (Communications & Events)

The scarcity of scientific-based research is due in part to the small number of researchers who focus on teaching and learning for young children. Only a handful of senior scholars do this work, and there are too few young scholars and new researchers in the pipeline. As part of its mission, the DREME Network is developing new researchers and enticing current elementary math education, child development, and policy researchers to expand their work to include young children’s mathematical learning.

Recent developments in the fields of education and developmental science make this an opportune time to invest in building the field of research on early math teaching and learning.

New evidence on the importance of early math

Several empirical studies have found that compared to literacy and social-emotional development at kindergarten entry, early math concepts were the most powerful predictors of later learning. Across the nation, most children who have low math skills in kindergarten continue to lag behind their better-prepared peers throughout their school years. The least prepared and lowest performing are disproportionately children from low-income families, and children of color. Additionally, children with developmental delays and disabilities often struggle in math throughout their school years due to the lack of appropriate instruction. Any serious effort to close the achievement gap needs to include children before school entry and in the early elementary grades.

Increased evidence on the value of preschool and recognition of its importance

There is now strong evidence on the short- and long-term benefits of high-quality preschool; the evidence comes not just from small experimental programs but also from district and state preschool programs serving children at a large scale. President Obama’s commitment to making high-quality preschool available to every child in America is further evidence that publicly supported preschool is gaining momentum. This is a crucial time to make sure that

foundational mathematics instruction is an integral component of efforts to expand access to preschool.

Increasing acceptance of academic instruction in preschool

In the past, there has been resistance to discipline-based instruction in preschool, in favor of learning through play and a focus on social-emotional development. A review of the National Association for the Education of Young Children (NAEYC) Guidelines over the last few decades, however, reveals a shift toward productively integrating academic instruction with playful learning and efforts to develop social-emotional skills. This shift toward embracing academic instruction is clearly evident in reading, yet less so in math. The general acceptance that young children can and should learn basic academic skills provides fertile ground to also promote effective and developmentally appropriate strategies for teaching math to preschool-age children.

Common Core State Standards

Along with evidence indicating that early math learning is important, the new Common Core State Standards require significant changes in teaching at the elementary level (to help students meet the new standards) and at the preschool level (to prepare children for the instruction they will encounter in elementary school). The new standards have created a need for changes in teacher preparation at community colleges, four-year colleges, and universities, as well as for new tools and strategies to support teacher skill development.

PreK-3 Movement

There is increasing attention to the need for continuity between preschool education and the early elementary grades. Districts and schools across the country have developed new initiatives to promote better alignment in standards, assessments, curricula, and instruction. These efforts are hampered by lack of clarity about how continuity should be defined; the paucity of curricula and assessments that are continuous preK-3; and limited understanding of the organizational and policy conditions necessary to create more seamless learning goals and trajectories for children. The desire to improve continuity, however, has created the need to better understand the policies, practices, and tools that produce genuine coherence in children's learning experiences.

DREME'S CENTRAL GOALS

With these current developments in mind, the DREME Network was formed with two goals:

The first goal was to convene a national network of scholars and researchers to conduct rigorous basic and applied research and development projects that address high-priority early math topics needed to inform and motivate other researchers, educators, policymakers and the public. The research conducted by multidisciplinary teams and disseminated by the Network does not represent "business as usual," but innovative efforts to move the field forward.

The second goal was to increase the number of highly trained researchers in the U.S. who are committed to studying questions related to developing young children's math competencies. The Network persuades researchers in elementary math teaching and learning to extend their research downward to preschool; researchers in child development to expand their research to include the learning of mathematics; and policy scholars to address questions related to implementation and scaling of innovative programs focused on improving young children's mathematical learning. In addition to well-established senior scholars, the Network involves researchers who are at earlier points in their careers. Engaging young scholars create a pipeline of researchers who will continue to study early math learning well into the future. A significant portion of DREME's funding goes towards doctoral students and postdoctoral fellows involved in Network-supported research.

CURRENT RESEARCH & DEVELOPMENT PROJECTS

Network members collaborate across four projects designed to address critical needs and issues related to improving math learning for young children.

Project 1: Mathematics and Executive Function

Empirical research has shown that a link exists between mathematical thinking in early childhood and executive function (EF) skills. EF skills focus on deliberate and effortful cognitive processes, including the ability to maintain attention during a task ("sustained attention"), the ability to resist making an automatic or desired response ("inhibitory control"), the flexibility to consider multiple perspectives ("cognitive flexibility"), and the ability to

simultaneously think about and manipulate information in one's "mental workspace" ("working memory"). EF skills enable children to pay attention; wait their turn; consider different approaches to solving problems; and remember and execute many steps when following directions. Thus, executive function skills play a critical role in math and other domains. Moreover, both math and EF skills are linked to a wide range of important long-term academic outcomes.

Preschool EF skills predict later math achievement, and students who excel at math tend also to have strong EF skills. It is clear that an association between math and EF exists, but it is not fully understood. Do these skills need to be taught separately? Does one cause the other? Are they mutually reinforcing? Does support for EF skills matter more for children who are at risk for low math achievement? How can competencies in math *and* executive function be enhanced through high-quality early childhood education?

Based on what is known about EF and its development, the Network is designing a variety of mathematical activities and examining whether and how these activities shape children's mathematical thinking and EF. The goal is to develop instructional materials that help teachers prioritize pedagogical practices that simultaneously promote the development of children's mathematical thinking and executive functions. The knowledge gained from this work will also be useful in guiding parents', caregivers', and teachers' interactions with children.

Project 2: Parent and Early Caregiver Engagement in Math

At home, children begin their initial explorations into everyday mathematics, progressively developing and refining knowledge and skills as well as their learning expectations, motivation, and beliefs about math and their own math ability. Yet, there is wide variation—linked in part to socio-economic status and culture—in the kinds of math learning experiences children enjoy at home and the ways parents stimulate their children's development and learning. Further, two-thirds of young children today spend significant time in non-parental care, including family childcare and organized preschool. Quantity and quality of math

learning stimulation in these early childhood care and education (ECCE) settings also vary enormously, with lasting consequences for academic achievement. Relative to the large body of research on language and literacy, less attention has been given to young children's mathematics learning at home and in ECCE settings. The Network seeks to address these limitations. The goal is to advance knowledge on effective ways to increase the quantity and quality of parents' and caregivers' engagement in young children's math learning, particularly for children growing up in poverty, many of whom are not native English speakers.

The project blends research and development as a first step toward the experimental testing of books, games, and activities designed to maximize high-quality math interactions with preschool children. The Network is currently testing materials—some widely available and others developed for the purpose of this study—by observing how parents and informal childcare providers use the materials to engage young children in math activities. The findings emerging from these observations will help inform the design of experimental studies intended to determine which activities hold the most promise for increasing children's math learning. Additionally, the Network is piloting and testing teaching modules designed to help parents and caregivers engage in productive "math talk" with young children and to understand the development of children's mathematical thinking.

Project 3: Preschool Through Elementary School Coherence

Policy makers, educators, and researchers complain that math learning in preschool is often disconnected from math learning in the early elementary grades. This disconnect can lead to students experiencing uneven instructional practices, which can compromise their learning. In response, some state and district policy makers across the country are working toward creating greater alignment in elements of policy affecting preschool and elementary schools. Others focus on creating greater curricular coherence by coordinating learning goals and curriculum within and across grades. But there is limited research on the impact of these policies and practices on students' experiences and learning outcomes as children move from preschool through the early elementary grades.

To address this gap, the DREME Network is collaborating with San Francisco Unified School District (SFUSD) to document district efforts to create policy alignment and curricular coherence, and study whether and how these efforts influence math teaching and learning from preK through grade 2. The study includes an examination of how the policies at the district level play out in schools, and how school-level policies and practices mediate the effects of district policies on classroom instruction and, ultimately, students' educational experiences and learning.

During the first phase of the project, the Network conducted classroom observations and measured students' attitudes toward math, experiences with math instruction, and knowledge and skills in math. Some of the measurement instruments were developed for the study, with the goal of creating tools that could be used by researchers and practitioners. The Network is currently assessing the psychometric properties of those measures and the associations among them, including the relationship between instruction and student outcomes. In addition, DREME is analyzing extensive qualitative data on SFUSD district policy collected during the 2015-2016 school year. The findings from this research will illuminate the relationship between efforts to create policy alignment and curricular coherence and students' learning opportunities, experiences, and achievement in math from preK through grade 2. In the next phase of the project, the Network will extend the research to a second school district and will investigate the research questions longitudinally, following children from preK through the early elementary grades.

Project 4: Teacher Educator Professional Development

Improving early math learning requires teachers to know the content; understand children's thinking; engage in pedagogical practices that support learning; and see themselves as capable math teachers. Currently, most preservice teachers do not have access to robust course offerings in early childhood math and there are few faculty members at the college level who have sufficient expertise in early math teaching and learning to teach the needed courses. Inservice professional development opportunities are also few and far between in part because there are not enough

experts in early math teaching available to provide them.

To support the training of prospective and practicing early childhood teachers, the Network is creating a system of resources, including flexible professional development modules that can be used in a variety of settings (e.g., live or online college courses, continuing education institutes, and ongoing inservice workshops). Some modules will be organized around mathematical content (e.g., cardinality, rote counting, one-to-one correspondence, and place value). Others will be organized around teaching practices (e.g., assessing children's mathematical thinking) and mathematical activities for students. Each module will address the integration of mathematical content, teacher practice, pedagogical approaches to support teacher learning, and resources to support that learning. All of the modules will be available on the DREME website.

COLLABORATION AND SYNERGY

The four projects vary on a number of dimensions and in their emphasis on research versus development. Perhaps most importantly, there is synergy among the projects. The work that is undertaken in one is used to inform others. Network members also collaborate across projects to develop measures of children's math skills and attitudes; math anxiety in parents, caregivers and teachers; and rubrics for assessing math teaching.

To facilitate collaboration, the Network meets four times a year at various locations across the country. Guests are invited to each meeting to inform the network's mission and projects. Project work is conducted at members' own research institutions, or in the field.

FOR MORE INFORMATION,
VISIT OUR WEBSITE AT <https://dreme.stanford.edu/>
OR EMAIL US AT contactdreme@stanford.edu

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