CENTER FOR THE STUDY OF
Child Care Employment

Policy
Report
March 2014

Strengthening the Math-Related Teaching Practices of the Early Care and Education Workforce:

Insights from Experts

Sharon Ryan, Marcy Whitebook, and Deborah Cassidy

Center for the Study of Child Care Employment
Institute for Research on Labor and Employment
University of California, Berkeley
2521 Channing Way #5555
Berkeley, CA 94720
(510) 643-8293

Photo Credits:
The photos were provided by the
Institute for Education Sciences (IES) -funded TRIAD project
The adult in the cover photo is Carmen Brown.
.

Suggested citation:

Ryan, S., Whitebook, M., & Cassidy, D. (2014).
Strengthening the math-related teaching practices of the early care and education workforce: Insights from experts.
Berkeley, CA: Center for the Study of Child Care Employment,
University of California, Berkeley.

Introduction

As a growing body of evidence links school success and early mathematical experiences, there is increasing interest in offering young children opportunities to bridge their informal understanding of mathematics with more formal concepts and processes. At the same time, many teachers and caregivers in the early care and education (ECE) field may not be adequately equipped to provide appropriate math-related experiences and instruction to young children age birth through five. Research suggests that many ECE practitioners do not see themselves as competent in math (Copley, 2004), and as a consequence, are less likely to provide intentional support for children's mathematical learning (Ginsburg, Pappas, & Seo, 2001). Even if practitioners do view themselves as mathematically capable, they may hold philosophical objections to teaching math to young children, believing that early childhood programs should focus primarily on social-emotional and literacy goals (Platas, 2008). As Baroody, Lai, and Mix (2006) assert, "Early childhood educators have long viewed young children and mathematics education like water and oil, as things that don't mix."

Practitioners are not the only ones who have paid limited attention to formal mathematical teaching and learning in early childhood settings. Professional teacher preparation programs rarely address how to identify the wide range of informal mathematical understandings that young children bring with them to the classroom, or how to translate these into intentional, individualized math experiences for children with diverse backgrounds and needs. National surveys of two- and four-year early childhood education degree programs (e.g., Maxwell, Lim, & Early, 2006) reveal that math content receives limited attention in most degree programs, typically within integrated curriculum classes that address multiple areas of learning. More in-depth treatment is rare, such as stand-alone classes devoted to mathematics. Further, such treatment, whether within general curriculum or stand-alone mathematics classes, typically focuses on teaching children in Grades K-3 (Whitebook, Austin, Ryan, Kipnis, Almaraz & Sakai, 2012). Thus, even when ECE practitioners are exposed to courses that address children's mathematical

development, or the pedagogical content knowledge necessary for supporting it, there is no guarantee that such coursework will address children younger than age five.

The aim of this project, Strengthening the Math-Related Teaching Practices of the Early Care and Education Workforce, has been to identify promising practices and strategies for enhancing the ability of ECE practitioners to promote children's mathematical understanding and competence. This paper summarizes the perspectives of nationally recognized experts in the field of mathematics and early care and education, and how their work is being used, or could be used, in teacher education and professional development opportunities for practitioners working with children age five and younger. We explored the views of experts on three main areas of concern:

- the knowledge and competencies that practitioners need in order to teach mathematics to young children;
- effective strategies for educating practitioners to support young children's mathematical development; and
- The challenges and successes that these experts have experienced in math-related ECE workforce development efforts.

We begin by describing the experts who participated in structured telephone conversations with our research team, and how we went about learning their perspectives on math-related ECE higher education and professional development. We then present a summary of their responses, followed by recommendations to private funders and policymakers for better equipping the nation's ECE workforce to engage in teaching practices that promote children's mathematical competency and school success.

Project Approach

Experts Participating in Conversations

The CSCCE team identified potential math experts to participate in conversations about supporting practitioners' competence in facilitating children's mathematical learning. The identified experts included those whose research and practice focus on: 1) mathematical learning and development; 2) early childhood teacher education and professional development in mathematics; 3) contextualized work to help ECE practitioners, many of whom are nontraditional students, learn mathematics; and/or 4) math equity work, focused on improving the mathematics teaching and learning of historically marginalized groups. This process resulted in a list of 30 potential experts engaged in at least one of these categories of work.

After exploratory research with the aim of obtaining a diverse and representative group of experts working in early childhood mathematics, we reduced the list to 20 potential participants and sent an email to each, outlining the purposes of the project and asking for an indication of his or her willingness to participate. Of the original 20, two declined to participate, and four did not respond or were unable to arrange a mutually suitable time to talk after repeated emails and calls. The final expert group consisted of 14 early childhood mathematics leaders. (See Table 1.)

Seven members of this group work primarily as researchers (Kimberly Brenneman, Ben Clarke, Douglas Clements, Alissa Lange, Susan Levine, Jennifer McCray, and Betty Zan), and are affiliated with specific early childhood-related research centers, including the Marsico Institute of Early Learning and Literacy at the University of Denver, the National Institute for Early Education Research at Rutgers University, the Math Collaborative at the Erikson Institute, the Spatial Intelligence and Learning Center, an NSF-Funded Science of Learning Center, and the Regents Center for Early Developmental Education at the University of Northern Iowa. Five others (Juanita Copley, Elizabeth Graue, Amy Parks, Pamela Perfumo, and Whasoup Son-Yarbrough) work directly with pre-service and in-service teachers as teacher educators and researchers, in two- or four-year institutions of higher education. Some of the experts provide early childhood expertise for projects

involving mathematics instructors or researchers. Elizabeth Graue, for example, collaborates on a National Science Foundation-funded project with Anita Wager, a mathematics education colleague. Similarly, Whasoup Son-Yarbrough and Pamela Perfumo have worked with mathematics department colleagues to develop specific teacher-friendly math classes, but do not teach these classes themselves. Amy Parks, by contrast, teaches mathematics to pre-service and in-service early childhood educators as part of a teacher certification program.

Several of the experts, Doug Clements and Herb Ginsburg in particular, had been instrumental in designing math curricula based on their research exploring young children's mathematical learning (Clements, 2007; Ginsburg, 1997). Some of the scholars (Kimberly Brenneman, Doug Clements, Elizabeth Graue, Alissa Lange, and Jennifer McCray) are currently working on grant-funded projects, the primary purpose of which is to implement professional development initiatives to improve early mathematics instruction. Others (Beth Casey, Doug Clements, Herb Ginsburg, and Betty Zan) have engaged in professional development with teachers related to research-based curriculum materials they have developed or with which they have been involved. Interestingly, most of the math professional development work that these leaders had done or were currently engaged in has been centered on in-service, degreed teachers working with children from three to eight years old. Few of the participants reported that their work focused on children younger than three years of age. Given the increasing diversity of student populations in ECE classrooms, it is also interesting to note that only two of the participants (Elizabeth Graue and Amy Parks) reported that they were directly engaged in working with teachers around issues of equity and math education.

Table 1: Math Experts Participating in Structured Conversations

Name/Title	Institution and State	Area of Math Work	Age Group Focus/ Experience	Works Directly With Teachers ?	Institutional Context
Kimberly Brenneman, Assistant Research Professor, National Institute of Early Education Research and Director, Early Childhood STEM lab at NIEER	Rutgers University, NJ	Design, delivery and research on professional development on math and science curriculum with a focus on English Language Learners	Pre-K	Yes	4-year university research center
Beth Casey, Research Professor and Professor Emeritus, Counseling, Developmental and Educational Psychology Department	Lynch School of Education, Boston College, MA	Created research-based supplementary math materials (books); research focuses on spatial reasoning and gender	Pre-K-2	No	4-year university
Ben Clarke, Research Associate, Center on Teaching and Learning	University of Oregon, OR	Design and research on math curriculum for at-risk students	K-5	Yes	4-year university research center
Doug Clements, Kennedy Endowed Chair in Early Childhood Learning, Executive Director of the Marsico Institute of Early Learning and Literacy	Morgridge College of Education, University of Denver, CO	Research on development of children's mathematical thinking & developmental trajectories; developed and evaluated *Building Blocks* curriculum	Pre-K	Yes	4-year university
Juanita Copley, Professor Emerita, College of Education	University of Houston, TX	Teacher educator; has written a number of practitioner-oriented books on teaching math; provides professional development around math	Pre-K-3	Yes	4-year university
Herb Ginsburg, Jacob H. Schiff Foundation Professor of Psychology and Education	Teachers College, Columbia University, NY	Research on children's mathematical thinking; developed curriculum *Big Math for Little Kids*, provides professional development on curriculum	Pre-K	Yes	4-year university

Name/Title	Institution and State	Area of Math Work	Age Group Focus/ Experience	Works Directly With Teachers ?	Institutional Context
Elizabeth Graue, Sorenson Professor of Curriculum and Instruction	University of Wisconsin-Madison, WI	Design delivery and research on culturally and family responsive math professional development intervention	Pre-K	Yes	4-year university
Alissa Lange, Assistant Research Professor, National Institute of Early Education Research	Rutgers University, NJ	Design, delivery and research on professional development on math and science curriculum	Pre-K	Yes	4-year university research center
Susan Levine, Rebecca Ann Boylan Professor in Education and Society, Co-Director of Center for Early Childhood Research	University of Chicago, IL	Conducts math circles with teachers; research on math talk in families and classrooms; the development of spatial and numerical aspects of math; math and spatial anxiety in children and adults, and their affect on math learning and teaching	Toddler-K	No	4-year university
Jennifer McCray, Director, Early Math Collaborative	Erikson Institute, IL	Research on teacher development in early mathematics and delivery of math professional development interventions, including school-focused initiatives, and a set of modules for community college faculty	Pre-K-3	Yes	Graduate School and research center
Amy Parks, Associate Professor, Department of Educational Theory and Practice	University of Georgia, GA	Teacher educator; research is focused on mathematics and equity; provides professional development	Pre-K-3	Yes	4-year university
Pamela Perfumo, Professor, Child Development Department	Los Medanos Community College, CA	Teacher educator; helped design contextualized math course	Birth-5 years	Yes	2- year community college
Whasoup Son-Yarbrough, Director, Early Childhood Education Division	Central Piedmont Community College, NC	Teacher educator; helped design contextualized math course	Birth-5 years	Yes	2-year community college
Betty Zan, Director and Associate Professor, Regents Center for Early Developmental Education	University of Northern Iowa, IA	Research on STEM and young children; helps design various professional development initiatives	Pre-K-K	No	4-year university research center

Conducting the Conversations and Summarizing Responses

To learn about the practices of these math experts, a structured telephone conversation (Patton, 2002) was employed to ensure that each conversation was conducted consistently, and to allow for participants to contribute beyond the questions asked.

First, we asked participants to identify the math knowledge and practices that all ECE practitioners need for working effectively with young children. As we were specifically interested in identifying promising practices for improving the math knowledge and expertise of the early childhood workforce, we also asked them to describe their work with this workforce, as well as specific strategies that they believed help practitioners to learn and apply mathematical knowledge in their work with young children. Next, we asked participants to identify any challenges they had encountered in their work. Finally, we asked them to share materials and identify resources, either that they had produced themselves or that they thought might be helpful to our investigation.

Conversations were conducted over the phone at a time convenient to each respondent, and took place during October and November 2013. All conversations were audio-recorded with the permission of the respondents, and were transcribed verbatim to ensure that we had captured participants' perspectives accurately.

To analyze the conversations, the transcripts were read individually by each of this paper's authors, using an agreed-upon analytic consisting of three broad categories or codes tied to the project purposes. The categories included: the knowledge and skills that ECE practitioners need for teaching mathematics to young children in developmentally appropriate ways; the strategies that these experts use or suggest using for educating ECE practitioners about mathematical concepts, children's mathematical development, and pedagogical approaches; and the lessons they have learned in working with ECE practitioners around mathematics. In scanning the transcripts, we wanted to identify where experts agreed and disagreed, and whether there were commonalities that might suggest promising practices or strategies that could inform efforts to improve math education for young children.

After reading and sorting the transcripts, the research team conferred to compare patterns in the data and to discuss any differences in how the data had been sorted, using the analytic as a means of ensuring internal validity. No differences among team members were recorded. We then created descriptive summaries of each category of data, using the voices of participants wherever possible for illustration. These summaries allowed the data set to be described in relation to each of the research topics, the findings of which are described below.

Math Competencies Necessary for Early Care and Education Practitioners

Participants agreed that ECE practitioners, regardless of whom they teach or where, need to know key math content and processes, and understand the developmental progressions in how children learn mathematical concepts. This knowledge should also be coupled with skills in understanding children's thinking and in building on their mathematical learning. Experts agreed that practitioners must be intentional in their mathematical work with children, which often requires unlearning how they have typically approached math activities before.

Math Knowledge and Processes

Mathematics involves not only specific *concepts*, such as number, geometry, and measurement, but also a series of equally important thinking *processes*, such as representation, proof, and problem solving (Clements, 2004; National Council of Teachers of Mathematics, 2000). Interviewees also emphasized the interrelatedness of concepts and processes. As Beth Casey stated, "Children need content to be able to problem solve."

The concepts and processes that experts emphasized varied by their research interests and their work in mathematics education. In general, however, they identified three areas that are also reflected in national mathematics standards developed for young children (Clements, Sarama & DiBiase, 2004): number and operations, geometry and spatial reasoning, and measurement. Several experts asserted that much of what passes for

mathematics in ECE classrooms focuses solely on number and operations. Susan Levine commented:

> *Early childhood teachers need to feel confident about their own math skills and with teaching young children math. They should have a deep understanding of numbers, including fractions. They have to be comfortable with different ways of representing numbers and different ways of solving problems. They also need to further children's spatial learning and thinking and to relate numerical and spatial concepts.*

Similarly, Elizabeth Graue, Pamela Perfumo and Amy Parks asserted that teachers need to understand number and quantification on a deeper level, not just as rote counting. Beth Casey and Betty Zan spoke of the importance of teachers understanding spatial reasoning and geometry sufficiently to be able to facilitate children's learning. As Betty Zan observed, ECE practitioners need to understand that:

> *[Mathematics] is more than number and operations. It has an underlying logical structure to it that the learner has to construct. They also have to understand that mathematical understanding develops over time, that number is not a property of objects (but) a relationship, and that numbers only exist if I think about something in a quantitative relationship or in a numerical relationship.*

But more than just knowing this content, the experts asserted repeatedly that ECE practitioners must be able to use the language of mathematics with children, and to correctly name particular math concepts and operations, rather than approaching mathematics simply as a "bunch of factoids," as one researcher put it. In Doug Clements's words, practitioners need "a profound understanding of early mathematics" that includes "understanding the mathematics completely— mathematical vocabulary and procedures, certainly, but also mathematical concepts and the *connections* among all these."

Knowledge of Child Development

Not surprisingly, given their ECE backgrounds, often with an emphasis in developmental psychology, most of the experts also spoke about the importance of understanding child development: specifically, the different ways in which children approach mathematics, and the kinds of mathematical thinking they engage in. As Herb Ginsburg succinctly stated, "Teaching ought to be directly connected to your deep knowledge of the child." Thus, in addition to being proficient in mathematics, early

childhood educators need to understand how children develop mathematical ideas, and identify where each child is within the development of a particular concept or process. As Kimberly Brenneman of NIEER observed, "There are typical patterns of development in areas of mathematics, and teachers should be thinking, 'Where do I think this child is going now? What do I know about how to support this next step in learning?'" Ben Clarke suggested that teachers must have "a good robust understanding of how children acquire [a particular math concept or skill set], how they utilize it, and the types of mistakes they make in their development." Many of the experts cited the work of Doug Clements and Julie Sarama on developmental progressions. Doug Clements explained this construct during the conversation:

> *Any good teacher starts with where the child is. Then, the obvious question is: how do you identify where a child is going? You have to have an idea of the path, the road or trajectory, through which children develop these mathematical ideas. Formative assessment is one of the most powerful teaching strategies we have at our disposal, but it can't be done if you don't know the progression. Teachers must also be able to draw out the mathematics from children's everyday activities in play or in transitions, or in conversations with them, no matter the activity. How do you bring the mathematics out, and how do you push the mathematics forward, if you don't know the developmental progression?*

In addition, several experts argued that ECE practitioners need to understand how mathematical learning is mediated by class, gender, and culture. "There is an achievement gap at kindergarten that goes along socioeconomic lines," according to Jennifer McCray of the Erikson Institute. Susan Levine said that her longitudinal research on parents' and preschool teachers' "math talk" to preschool children—defined as talk about number and spatial relations—indicates that "the quantity and quality of this talk predicts important aspects of children's math knowledge by the time they reach kindergarten. Moreover, these early differences in children's knowledge are predictive of their long term math achievement trajectories, as Duncan and colleagues (2007) have noted. The wide variations in the quantity and quality of math talk in families and classrooms, she added, means that some children have a "much greater opportunity to learn math during their preschool years than others." Beth Casey argued that girls need teachers to "scaffold" their play in areas such as blocks, since they typically do not engage in the kinds of spatial thinking tasks that boys do, and spatial skills are predictive of later success in mathematics. As she noted,

"There are already gender differences in spatial problem solving as early as three years of age." Amy Parks, whose work focuses on how minority students are able to display their knowledge in classrooms, advocated for teachers to understand and accept the contributions of families and cultures to children's mathematical development rather than viewing them as mathematically deficient. She stated,

> *Teachers need to know that children in all communities and all cultures competently develop conceptions of mathematics, and that if [teachers] are not seeing them, it's because there's some kind of communication difficulty across these cultural divides.*

Intentional Teaching

There was common agreement among the experts that, as Juanita Copley said, "There needs to be purposeful, intentional teaching of math. It's not something that children just get." Many experts lamented how mathematics has been shortchanged in the ECE curriculum in favor of literacy, and how misinterpretations of "developmentally appropriate practice" have contributed to the assumption that math can be learned incidentally while children play. They further agreed that what have been typical assumptions and strategies for teaching math, such as a daily calendar time, are often inappropriate or "much ado about nothing," in Elizabeth Graue's words.

Rather than relying on traditional circle time activities, teachers need to develop a repertoire of math activities and teaching techniques that will enable them to include a range of math experiences in the curriculum on a regular basis, geared for different learners. Several experts argued that this pedagogical skill set starts with learning how to use time and space in the curriculum. As Susan Levine observed, "Teachers can insert math into activities that also promote both socialization and literacy. There are lots of opportunities to combine these goals." Juanita Copley suggested, "Teachers need to know what routines you can do with math, and every activity center should have math in it." In Amy Parks' view, "Teachers should be spending a lot more time with children in small groups around mathematical ideas, and a lot less time in whole groups."

Other experts focused on math-related teacher-child interactions—the kinds of talk and questions that teachers regularly engage in with young children. They advocated for teachers to ask children to reflect on their thinking, not to ask for a "correct answer," but

rather, "How did you do that? How do you know that? Why did you do it? What were you thinking about?" As Ben Clarke expressed it, teachers need to know how to "elicit lots of responses from children, how to engage them in discourse" around mathematics. As Jennifer McCray explained,

> *A lot of that language is what the teacher says about what's going on, the connections the teacher makes between ideas and experiences to help children make generalizations. You can't just talk about the math if you don't know it. You need to understand it, so that you recognize what it is that's mathematical about building a tower from blocks.*

For teachers to interact with children consistently and intentionally around math, they should also know how to observe and assess children's mathematical learning, in order to plan math instruction for the entire class as well as for individual children. Susan Levine noted,

> *It is important for teachers to use quick formative assessments that provide them with information about what a child understands about a particular math concept and what they need to learn. The regular use of such assessments can show teachers that "this child knows this about numbers, but not that, this about shape, but not that, and [therefore] can inform the instruction the child needs to build their math knowledge. These assessments can also provide information about whether a particular instructional strategy is working – that is, whether the child is learning."*

Finally, given the wide variation in math understandings that children bring with them to ECE programs, several participants noted that teachers should also have skills at working with families around math. As Kimberly Brenneman expressed it, "If you get the adults to a certain place, then they're in a much better position to help children become ready and excited about [math]."

In summary, learning to teach math to young children requires, in Betty Zan's words, "a skilled teacher who recognizes all those learning opportunities for what they are, and then knows how to capitalize on them." Doug Clements summed up the complexity of knowledge and skill that ECE practitioners need in order to teach math well as the three parts of a learning trajectory: "the goal, i.e. the mathematics; the developmental progression, i.e. children's thinking and learning; the instructional activities; i.e., the environmental and teaching strategies fine-tuned to each level of developmental progression."

Helping practitioners to develop these competencies is no easy feat. The following are an array of practices that the experts recommended for helping them become intentional teachers of mathematics.

Work With Early Childhood Practitioners: Possibilities and Challenges

Considering that their work with teachers varies both in theory and in practice, there was a compelling level of agreement among the math experts about what ECE practitioners should know and be able to do in order to teach math effectively. Their varied research interests, areas of focus, and institutional positions, yielded a range of insights about how to engage early childhood teachers in learning about mathematics.

Teacher Development Approaches

According to Herb Ginsburg, it is particularly challenging to tailor math education and professional development opportunities to the needs of ECE practitioners because, in his opinion, "They are afraid of math, they're afraid of teaching it, and they don't think it ought to be taught." This presumed aversion to math among ECE practitioners could be a double-edged sword for the field: practitioners may be less likely to engage children around mathematics, and may even be attracted to the field in the first place, in part, because they assume that their teaching will not involve math. Several of the experts commented on this dilemma. Susan Levine spoke of how teachers may cover up their own math anxiety and dislike of math by saying, in effect, "Children don't need to do this until they are in elementary school, so it's not my problem." Betty Zan noted, "Early childhood education majors have actually been heard to say, 'The reason I majored in early childhood is because I'm not good at math and I won't have to teach much math in early childhood.'" Similarly, Doug Clements commented,

> *The view of so many is that it's just counting and naming a few shapes; what's the big deal? If you believe that, then you don't even have a motivation to get more professional development to fill in the gap. You don't see the gap.*

All of the experts commented, in some way, on low levels of math-related confidence as a common barrier for ECE practitioners in gaining the necessary knowledge and skills to teach mathematics well to young children. Ben Clarke noted,

> *It's really difficult for teachers to impart a deep foundational understanding of mathematics in their students because they've never fully developed it themselves, either through the way they were taught or through their teacher prep program.*

In response to these issues, a number of experts described their approaches to working with teachers—regardless of education and experiential level—as beginning with what Amy Parks called "emotional recovery work": recognizing the limitations and anxieties that teachers may bring to the task. They also identified specific teaching techniques that they have found to work well with ECE practitioners.

Starting with Teachers

Shifting early care and education teachers' beliefs and practices is likely to require targeted professional development opportunities that respond to who they are as adult learners (Whitebook & Ryan, 2011). Alissa Lange noted, "What I have found works best is that teachers need to be treated as learners, and *then* they need to be treated as teachers." Concurring with this statement, all of the experts reported that the first step was to make math accessible and interesting—either though targeted professional development activities, or through contextualized math classes at the community college.

Adult Learning Activities

The experts who work with in-service teachers spoke of fostering "buy-in" about the importance of mathematical learning for young children, by engaging them in hands-on activities—helping them both to think about math in a fun way, and to see it as a part of their everyday world.[1] Jennifer McCray explained:

[1] In a scan conducted by the Center for the Study of Child Care Employment (2013), California educators who offered math-related training and professional development also spoke of the importance of engaging practitioners themselves in math activities, as a way of building enthusiasm and buy-in for more intentional teaching of mathematics with young children.

Every learning lab involves at least one activity where the grownups in the room are doing the math. It'll be something that connects to what children need to do, but it will be at a level that is challenging for adults, and that helps them remember what it's like to be a learner of this content, and refocus on what the foundational understandings are. We find this to be very powerful, partly because these teachers are not so confident; they've often had such bad experiences.

Amy Parks described an activity she does with teachers:

We build buildings with little colored blocks, and participants have to represent their 3D structure in a drawing on asymmetric math paper. This is challenging for people who don't have visual strengths, but a lot of times, the teachers who have struggled most in mathematics do have these visual backgrounds, and they are the ones who are able to produce this drawing for the people in their group. In conversations afterwards, someone might say, "I never knew that that was math." So, some of it is opening up their idea of what math is, because a lot of them think that they're "bad at math"—but then they get the idea that mathematics is so much bigger.

Elizabeth Graue and Amy Parks spoke of engaging practitioners in play-based mathematics that would be typical of what children might do in an ECE classroom, because, in Amy Parks' words, "They start to say things like, 'I had no idea that math could be fun.'" Betty Zan described the teacher workshops that she and her colleagues conduct:

When we have a three-hour workshop on unit blocks and block play, we give the teachers lots of time to explore the blocks. Then we give them the vocabulary for what they already know: that you can take two right angle triangles, for instance, and when you put them together, they make a square. Anybody who's a quilter would know how to do that. Just as we would do with young children, we build on what teachers already know.

Doug Clements and Julie Sarama use a range of child-oriented activities, as he explains:

We play with shapes, and name them, and tell the teachers the definitions for these categories. And we say, "Let's start sorting. Mistakes are fine here." Julie always tells them that it can be hard, for example, to recognize that a square is not a separate shape from a rectangle, but rather, a special kind of rectangle. She says, "We don't need to teach children high architectural classifications, but we do want you to refrain from saying things like, 'I asked you to bring me a rectangle, which has two long sides and two short sides.'" We give teachers ways to recognize, 'I can teach better. The block activities I've been doing were the right thing to do—I just didn't know how much more I could get out of using them.'

Contextualized Math Classes

Unless they are part of an ongoing program, however, professional development activities may be insufficient for remediating the limited math knowledge of some ECE practitioners. Many teachers entering early childhood-related community college programs are nontraditional students who have not been enrolled in a formal educational setting for some time. Whasoup Son-Yarbrough described many of her two-year college students as being "in their 30s, 40s, and older, so they have a gap between high school and college, [and] they've forgotten a lot of the math content." Many ECE practitioners do not succeed when placed in math classes with students from a range of majors, or they are required to take developmental math classes before they can participate fully in ECE coursework; as a result, math classes often function as the "gatekeeper" to advancing to a two-or four-year degree (Whitebook, Schaack, Kipnis, Austin, & Sakai 2013).

Contextualized math classes, in which small groups of ECE students are taught basic mathematics in a context of activities linked directly to the work of teaching young children, can be a creative way to address this issue. Whasoup Son-Yarbrough defined contextualization as "understanding the surrounding elements of an idea." She and her colleagues (Son-Yarbrough & Bradham, n.d.) provided the following example:

> *A typical way to teach a concept like proportions is to ask practitioners in a class to solve the proportion of x when 1/15 = x/42. Teaching the same concept using a contextualized approach, the class at Central Piedmont Community College instead asks students to solve the following problem: The teacher-to-student ratio for a three-year-old child care setting is 1:15. If there are going to be 42 children in a program, how many teachers need to be hired?*

Throughout the class, students engage in a range of ECE-related math activities such as planning menus and budgeting the cost of meals, measuring the square footage of classroom space to consider how it could be used more effectively, or exploring ECE classroom rating scales, such as ECERS or FDCRS, that use graphing (Harms, Clifford, and Cryer 2005; 2007).

Embedding math in activities related to the everyday work of ECE practitioners makes the math more relevant, while also enabling students to gain mastery over basic mathematical concepts and processes. Whasoup Son-Yarborough, who worked with

colleagues in her college's math department to design such a class, reported that over 90 percent of students have passed the class each semester since it was first offered in 2008. Pamela Perfumo described a similar effort at her college: ECE teacher education faculty chose a math instructor who was open to drawing number problem examples from ECE programs, and also chose a tutor who leads structured peer sessions for students after each class.

In addition to contextualizing the math, both experts also identified the importance of an appropriate learning environment for ECE practitioners to engage with math content. For these experts, a small, collaborative learning environment composed solely of ECE practitioners was key to helping them feel comfortable and confident in tackling the math. As Pamela Perfumo explained:

> *We work hard to make it a social and collaborative experience for the students, especially the tutoring section. This way, they're building some accountability with each other, and they're encouraging and helping each other not to give up, because obviously the math gets more challenging as they go along.*

Specific Curriculum and Teaching Models

To help practitioners see what math instruction can look like in ECE classrooms, and to counter any claims that there is not enough time to teach math, many of the experts described using various models or demonstrations. As Pamela Perfumo observed:

> *Almost all of the toys that I bring in for students to play with and then to analyze are mathematically based, because I see that they don't really recognize how prevalent math learning is in the young child's world.*

Betty Zan, Alissa Lange, and Kimberly Brenneman talked about using games with teachers; Zan has created a website of games that teachers can download; and Beth Casey and Doug Clements have developed a series of math lessons that use children's books.

Several math experts recommended particular curriculum models, such as *Big Math for Little Kids* (Balfanz, Ginsburg, & Greenes, 2003) or *Building Blocks* (Sarama & Clements, 2004; 2007; 2013), which, in the words of Ben Clarke, "take care of the content for the children and the correct sequence." All the experts identified video as the most effective strategy to help teachers learn to teach mathematics to young children intentionally; as Elizabeth Graue put it, "teachers need to see other teachers and children doing math to

know what is possible." Beth Casey concurred: "Observation is one of the most important tools that you can give people, to start seeing in greater depth what students are doing." Several of the experts had created video archives that were accessible to their class participants. Herb Ginsburg, a strong proponent of this approach, was one of the first to use it:

> *Starting in the late '60s, I would make videos of clinical interviews with children that explored their math, to use in my teaching. I show [the students] a little, stop the video, and say, "What happened? How do you interpret it?" So they can't just say, "I think this kid's in preoperational stage," or something vague like that. They have to say, "Oh, I think he's struggling with this or that," and cite the evidence they see in the video. We have a web-based system where students can watch videos and write essays about what they saw, and they can use short video snippets they create themselves to justify their argument. We have developed a video library of interviews with children.*

Similarly, Doug Clements commented on how video provides an efficient and effective model of professional development, particularly if an instructor is not working side-by-side with a teacher. He and his colleagues have developed a website called "Building Blocks Learning Trajectories" that connects video and text, around developmental progressions of specific math concepts.

Juanita Copley and Pamela Perfumo, both of whom have worked extensively with in-service and pre-service teachers, noted that video is also very helpful in helping students and teacher educators improve their own instruction.

Together, these math experts have amassed a large number of teaching materials and workshop activities that help practitioners learn about mathematical processes and concepts, and how to responsively engage young children in developmentally appropriate mathematical activities.

Comprehensive Professional Development

Over the past two decades, research about adult learning and about fostering lasting change in teaching practice has led to a shift in the design and implementation of professional development for teachers. In contrast to a previous emphasis on single workshops, in which trainers deliver information that teachers may or may not consider relevant to their classroom challenges, it is now assumed that teachers are more likely to

adopt new practices when they have opportunities to inquire into issues of practice with colleagues over an extended time, with the support of more knowledgeable teacher-leaders (Lave & Wenger, 1991; Warren-Little, 2001). As a consequence, such collaborative models as shared planning time, learning communities, and coaching have become common practices in educational reform initiatives.

Many of the leaders we spoke with were engaged in such comprehensive professional development work with teachers. The models they described typically included a series of workshops around key math topics, with every meeting designed for teachers to learn specific math content as well as how to teach it to young children. Juanita Copley described her six-day series with teachers in the following way:

> *On day one, we start by talking about what math is, how to recognize it, and how math practices relate to children. The next two days are about number and operation. The fourth day is on geometry, the fifth on algebraic thinking, and the sixth on measurement, as well as putting what they have learned into practice. Each session begins with the teacher as learner; the participants are essentially learning middle school math. Next, I connect each topic directly to [learning standards for young children]. In the afternoons, I set the room up as a children's classroom. My approach is: "Now, here's how what you learned this morning goes into a classroom."*

Some of the experts' approaches offered opportunities between workshops for teachers to reflect on and try out math activities in their classrooms. Susan Levine, for example, has implemented math "work circles" with teachers that have focused on the spatial aspects of math. These "work circles" provide opportunities for collaboration between teachers and researchers. As she explained:

> *A group of preschool and early elementary teachers come together, and we talk about what spatial thinking is. How is it related to math? How can you incorporate it into the way you teach math? We share relevant research findings. Then, teachers and researchers come up with activities that they think could strengthen the way they teach, using the kinds of learning tools that we've talked about. They're very creative, and it's empowering for them. Next, the teachers try these activities out in their classrooms, and provide feedback to us. Teachers have very good intuitions about whether what works in a lab will work in a classroom and how the activity might need to be modified for classroom use. This interdisciplinary approach—in which you bring together people who know a lot about math learning from a research point of view, and teachers who know a lot about classroom learning—has proven to be a very strong model.*

Jennifer McCray, Alissa Lange and Kimberly Brenneman have implemented a "reflective inquiry" model that spaces workshops apart, allowing teachers to practice what they have learned between sessions, supplemented by coaches who visit teachers' classrooms and provide individualized help. As Lange and Brenneman noted, their approach also foregrounds the needs of young children who are dual language learners:

> *We developed this model for and with district peer teachers who serve high numbers of dual language learners. They all believe that children who are given the opportunity to develop academic language around math and science in their home languages are going to be much better prepared for school and life, and much better prepared for true bilingualism.*
>
> *In addition to individualized coaching, we've created teacher workshops where we try to exemplify the planning process we'd like them to go through when we're thinking about math lessons for preschoolers. We discuss such questions as, "What would a child need to know about number, to be able to engage with this lesson? Where would he or she have to be on this trajectory?" [By the end of the session,] teachers walk away with what we call an annotated lesson plan.*

For those math experts with affiliations to a teacher education program, including Juanita Copley and Beth Casey, partnerships with schools were not unusual. Copley described her collaborative approach that brings together pre-service and current classroom teachers:

> *For example, I go into the school and teach in a first grade classroom, and videotape the lesson. Then I pull together all the first grade teachers to view the video and debrief the lesson that I just taught. At the same time, I send my college students to teach the first grade children, with graduate students watching them. Then I do the same thing with the second grade, the pre-K, and the Kindergarten class. I'm doing immediate professional development, but at the same time, I'm giving my students opportunities to practice. Finally, the students and I debrief at the end of the day.*

Jennifer McCray has also shifted some of her professional development work with in-service teachers to a more whole-school approach, rather than working with teachers from multiple schools. She explained the advantages:

> *At eight different schools, all of the faculty who teach pre-K to third grade are involved in the intervention. With coaching, we can run grade-level meetings once a month that are focused on math, and help teachers begin to use each other as resources. We also have a leadership academy for school principals; the principals of the eight schools come together with us four times a year, both to know what their teachers are doing and to make sure we're on the same page. Whole-school interventions can be*

extremely powerful. Working with the entire organizational structure makes a huge difference in what's possible.

Yet while there was broad consensus among the experts about how best to work on mathematics with pre-service and in-service teachers, they also agreed about systemic and structural challenges—detailed below—that warrant attention when seeking to improve the mathematical understandings and expertise of the ECE workforce.

Promising Practices and Challenges to Implementation

Insufficient attention to mathematics in the preparation and professional development of ECE practitioners does not stem from a lack of knowledge about how to promote better math-related teaching practices. While further research and experimentation may yield additional resources and models, a robust body of resources and models already exists that, if widely disseminated and employed, could transform mathematical instruction for young children. Building on a range of research studies and professional development initiatives, there are now a number of promising practices that could be disseminated more widely in teacher training and education. These include:

- *Preschool math curricula and accompanying materials*. In addition to *Big Math for Little Kids* (Balfanz, Ginsburg & Greenes, 2003) and *Building Blocks* (Sarama & Clements, 2004; 2007; 2013), Kimberly Brenneman, Nell Duke, M.L. Hemmter, Alissa Lange, Doug Clements and Julie Sarama are working on a curriculum that integrates math, social-emotional development, science, and literacy. Several of the experts commented on how these curricula provide a much-needed baseline of content for ECE practitioners, with guidelines about what to teach and how. To implement these curricula faithfully, practitioners need ongoing professional development, but at the very least, having a curriculum model minimizes the pressure on practitioners to come up with math lessons on their own. These curricula also offer the potential for achieving some consistency in math instruction among schools. Other curriculum

materials include Beth Casey's book series, Betty Zan's online compilation of games, and Jennifer McCray's math observation tool.

- *Video archives.* As a tool for modeling mathematics teaching and learning, and one that works well with practitioners of all levels of education and experience, all of the experts recommended the use of video. Several video archives, including websites maintained by Herb Ginsburg, Betty Zan and Doug Clements, offer valuable illustrations of children's mathematical thinking and developmental trajectories, and of teachers working with children on mathematical activities.
- *Comprehensive, well-studied models for math-related professional development.* Models for in-service teachers developed by Alissa Lange and Kimberly Brenneman, Jennifer McCray, and Elizabeth Graue, offer valuable guidance on how to structure and deliver math professional development that incorporates teacher learning communities and coaching. In addition, these models offer insight into the kind of training that math coaches need for working effectively.
- *Contextualized math curricula in community colleges*. These courses serve as models of how to responsively address the math learning needs of ECE practitioners, many of whom are nontraditional students who may not have been in a formal academic setting for some time. In the process of helping students meet math requirements for obtaining degrees, such curricula can build their awareness about opportunities for teaching mathematics in ECE settings.
- *Classes focused on mathematics for young children, now being developed for two- and four-year teacher education programs.* Pamela Perfumo's math/science class and Herb Ginsburg's online mathematics class are two examples that could be made available to students in other institutions, and could also be used as professional development for ECE teacher educators without strong backgrounds in mathematics.

Yet despite these promising practices and resources, much of this wealth of wisdom about mathematics education for the ECE workforce is not widely accessible. Unless an individual is affiliated with a project, an expert, or an institution engaged in mathematics work, there are few pathways that support broad dissemination and implementation. In

many cases, there are not even sufficient resources to maintain and build on the improvements begun by some of the well-studied initiatives.

Moreover, as mentioned earlier, most of this promising work has been targeted to in-service practitioners with bachelor's degrees, working in school settings with children ages three to eight. In contrast, the ECE workforce nationally contains many practitioners without degrees or even much formal education, working in a wide range of home- and center-based settings, and often with children younger than three years of age. Many of these settings are resource-poor, with few opportunities for professional development or even time for professional sharing among teachers.

While practitioners are central to improving math instruction in ECE settings, what they know about mathematics, and how well they are able to provide math learning opportunities for young children, are both mediated by the quality of their teacher preparation programs and the support available in their work environments (Whitebook & Ryan, 2011). Ideally, institutions of higher education should be playing the primary role in preparing teachers to promote children's mathematical learning. But as several experts working in teacher education programs noted, financial, policy, and other issues can keep teacher education programs from delivering the intensity and depth of math content that is needed for effective instruction for very young children. Despite having developed a contextualized math class, for example, Pamela Perfumo reported that shifts in state requirements and funding made it impossible to offer a curriculum course focused on science and math:

> *It's been about five years since we had such a class. A major budget crunch in California meant we had to reduce sections—and because the curriculum courses aren't part of the core 24 units that students need in California in order to transfer, those were the courses that were cut.*

Additionally, teacher education departments, particularly in four-year institutions, are primarily focused on children ages five and older. As Amy Parks observed, "At our university, people working with pre-K to Grade 5 are all together in one course, and the history has been to focus on mathematics in the upper end of that range." Finally, not all teacher educators with deep knowledge of children from birth to five have math expertise, and not all math experts are knowledgeable about children younger than five.

Because many in-service teachers did not receive adequate preparation in teaching math before they assumed responsibility for a classroom, or even when they returned to school for more education, many practitioners are learning the fundamentals of teaching math to young children for the first time, through professional development activities. Even those lucky enough to participate in a comprehensive professional development model, such as those mentioned by the experts in our conversations, may not receive sufficient ongoing support. This is due to the frequent lack of pedagogical leadership in ECE settings, including directors, educational coordinators, and coaches who have the knowledge to help sustain better practices that have been initiated by professional development programs. Any effort to enhance the math expertise of ECE practitioners requires investment in building the knowledge and skills of those members of the field who are responsible for supporting ongoing teacher practice (Ryan & Whitebook, 2012).

Conclusion and Recommendations

While there are some limitations to the innovative ECE-related math work currently being undertaken, in terms of age group focus, practitioner audience, and accessibility, much of this work carries strong potential for addressing the learning needs of ECE practitioners, provided that action is taken to address the structural and institutional barriers to promoting and sustaining change:

- *Access to resources.* We recommend that private funders and policymakers initiate and/or continue efforts to ensure access by faculty, professional development providers, and practitioners throughout the country to online resources that can contribute to expanding their math-related knowledge and skill. (This would include resources already in existence, such as the Transitional Kindergarten and WestEd websites). These should be linked to strategies and resources for different practitioner audiences (e.g., infant and toddler teachers, pre-K teachers, etc.) and for different professional development and faculty roles (e.g., 2-year and 4-year college faculty, coaches, etc.). Given the importance of video to teacher learning, sites should house relevant videos as well as games and children's literature that can show practitioners

ways to support mathematical learning in their daily curriculum. Ensuring that sites are updated regularly, and that information reaches multiple stakeholders, should be high priorities.

- *Adaptable courses of math study for college and university ECE teacher education programs.* Given that the expertise around math-related ECE teacher preparation often resides within particular research projects and individuals, and not more broadly in the ECE teacher education and professional development workforce, public and/or private resources should be made available to support a group of experts to build on and/or develop a series of math classes that could be used in any two- or 4- year program of ECE teacher preparation. As institutions of higher education tend to work in isolation, if not in competition with one another, it will be important to work with deans of education and with other higher education organizations and leaders to ensure that these modules and classes are taken up and used. As many ECE departments in institutions of higher education are composed of one or two individuals, it will also be necessary to provide orientation and professional development related to these math classes. One fruitful approach could be to create regional professional faculty learning communities.
- *Math coaching modules.* We recommend that private funders and policymakers support the development of a series of math coaching modules, to develop and support the work of those who facilitate change in ECE workplaces and classrooms. We anticipate that these modules would be available online, and would include not only specific information and activities related to mathematical teaching and learning in the early childhood years, but also information about adult learning and how to lead and sustain reform initiatives. This work has already been started by several of the experts cited here; therefore, support might include bringing these experts together to share the lessons they have learned in working with coaches and to develop this professional development curriculum.
- *Resources for math learning in the infant and toddler years.* As there appears to be very little work taking place around the preparation of infant and toddler teachers around math-related learning in the earliest years, we recommend convening a group of math

and infant/toddler experts to work together on developing a professional development curriculum tailored to educators in family day care settings and child care programs serving very young children. Again, it will be necessary to work with key leaders and organizations involved in the professional development and education of this workforce sector to ensure that such a curriculum is broadly taken up and used. This, along with other professional development resources, should be easily adapted to adult learners with varying literacy skills and language backgrounds.

- *Investigation of the "whole school" approach.* The promise of the comprehensive "whole school" (or center or program) professional development model warrants further investigation. This approach, while initially resource-heavy because it requires providing space and time for practitioners to meet regularly, as well as a coaching component and workshops from early childhood mathematics experts, may have strong long-term effects. We recommend that private and/or public resources be made available to test out this approach with different sectors and practitioner groups.

In many ways, the most daunting aspect of improving mathematical learning opportunities for young children in the United States lies not with issues of content or how to help teachers build their math-related knowledge and skills, but rather with the professional development infrastructure. Once teachers understand that early math instruction can occur in developmentally appropriate ways, they are frequently eager to learn and willing to change their practice. Twenty-five years ago, early educators were as resistant to early literacy as they are today to early math. Today, most ECE practitioners believe that engaging children in literacy activities is a central part of their work. This change in the field's beliefs and practices occurred because there was a steady flow of information, and most importantly, there were multiple learning opportunities that helped the field create a space for intentional literacy instruction.

The challenge, then, is to make meaningful math-related learning opportunities available in all settings where practitioners work with young children. The content is not the hard part; a strong enough knowledge base has already been developed to make a difference. It will be harder to revamp higher education programs to ensure that all

institutions have math more deeply embedded in their curricula, taught by math-capable faculty, but such a revamping would lead to an ECE teacher workforce much better prepared from the onset of their careers to support children's mathematical learning. Even more daunting than changing higher education, but equally important, will be securing resources to afford all practitioners, not just those in better-funded programs, the opportunity to engage in professional learning and sharing with colleagues that will lead to stronger early mathematics instruction for our nation's children.

References

Balfanz, R., Ginsburg, H. P., & Greenes, C. (2003). The Big Math for Little Kids early childhood mathematics program. *Teaching Children Mathematics, 9*(5), 264-268.

Baroody, A. J., Lai, M., & Mix, K. S. (2006). The development of young children's early number and operation sense and its implications for early childhood education. In B. Spodek, & O. N. Saracho (Eds.). *Handbook of research on the education of young children* (pp. 187-221). Mahwah, NJ: Erlbaum.

Center for the Study of Child Care Employment (2013). *Scan of early math-related professional development opportunities offered by organizations funded by the Child Care and Development Fund Quality Improvement dollars*. Berkeley, CA: Center for the Study of Child Care Employment, University of California, Berkeley.

Clements, D. (2004). Major themes and recommendations. In D. Clements, J. Sarama, & A. M. DiBiase (Eds.), *Engaging young children in mathematics: Standards for early childhood mathematics education* (pp.7-76). Mahwah, NJ: Erlbaum.

Clements, D. H. (2007). Curriculum research: Toward a framework for Œresearch-based curricula, Journal for Research in Mathematics Education, 38, 35-70.

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*, 136-163.

Clements, D.H., & Sarama, J. (2013). *Building Blocks, Volumes 1and 2*. Columbus, OH: McGraw-Hill Education.

Clements, D. H., & Sarama, J. (2014). *Learning and teaching early math: The learning trajectories approach* (2nd ed.). New York, NY: Routledge.

Copley, J. (2004). The early childhood collaborative: A professional development model to communicate and implement the standards. In D. Clements, J. Sarama, & A. M. DiBiase (Eds.), *Engaging young children in mathematics: Standards for early childhood mathematics education* (pp. 401-414). Mahwah, NJ: Erlbaum.

Duncan, G., et al. (2007). School readiness and later achievement*. Developmental Psychology, Vol 44(1), Jan 2008, 232.*

Ginsburg, H., Pappas, S., & Seo, K. (2001). Everyday mathematical knowledge: Asking children what is developmentally appropriate. In S. Golbeck (Ed.), *Psychological perspectives on early childhood education: Reframing dilemmas in research and practice* (pp. 181-219). Mahwah, NJ: Erlbaum.

Ginsburg, H.P. (1997). Entering the child's mind: The clinical interview in psychological research and practice. NY: Cambridge University Press.

Harms, T., Clifford, R. M., & Cryer, D. (2007). *Family Day Care Rating Scale*. New York: Teacher College Press.

Harms, T., Clifford, R. M., & Cryer, D. (2005). *Early childhood environment rating scale, revised edition*. New York: Teachers College Press.

Hyson, M., Tomlinson, H. B., & Morris, C. (2009). Quality improvement in early childhood teacher education: Faculty perspectives and recommendations for the future. *Early Childhood Research & Practice*, 11(1). http://ecrp.uiuc.edu/v11n1/hyson.html

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate, peripheral participation*. Cambridge: Cambridge University Press.

Maxwell, K. L., Lim, C-I., & Early, D. M. (2006). *Early childhood teacher preparation programs in the United States: National report.* Chapel Hill, NC: The University of North Carolina, FPG Child Development Institute.

National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics*. Reston, VA: NCTM.

Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage.

Platas, L.M. (2008). *Measuring teacher's knowledge of early mathematical development and their beliefs about mathematics teaching and learning in the preschool classroom*. Ann Arbor, MI: ProQuest LLC.

Ryan, S., & Whitebook, M. (2012). More than teachers: The early care and education workforce. In B. Pianta (Ed.), *Handbook of Early Education* (pp. 92-110). New York: Guilford Press.

Sarama, J., & Clements, D. (2004). Building blocks for early childhood mathematical understanding. *Early Childhood Research Quarterly, 19*, 181-189.

Sarama, J., & Clements, D. H. (2009). *Early childhood mathematics education research: Learning trajectories for young children*. New York, NY: Routledge.

Son-Yarbrough, W. J., & Bradham, M. (n.d). Contextualized developmental English, reading and math. PowerPoint presentation. Early Childhood Division, Central Piedmont Community College, Charlotte, NC.

Warren-Little, J. (2001). Professional development in pursuit of school reform. In A. Lieberman, & L. Miller (Eds.), *Teachers caught in the action: Professional development that matters* (pp. 23-44). New York: Teachers College Press.

Whitebook, M., Austin, L, Ryan, S., Kipnis, F., Almaraz, M., & Sakai, L. (2012). *By default or design? Variations in higher education programs for early care teachers and their implications for research methodology, policy, and practice*. Berkeley, CA: Center for the Study of Child Care Employment, University of California, Berkeley.

Whitebook, M., & Ryan, S. (2011). Degrees in Context: Asking the right questions about preparing skilled and effective teachers of young children. *NIEER Policy Brief* (Issue 22, April 2011). New Brunswick, NJ: National Institute for Early Education Research

Whitebook M., Schaack, D., Kipnis F., Austin, L., & Sakai L. (2013). *From aspiration to attainment: Practices that support educational success*, Los Angeles Universal Preschool's Child Development Workforce Initiative. Berkeley, CA: Center for the Study of Child Care Employment, University of California, Berkeley.