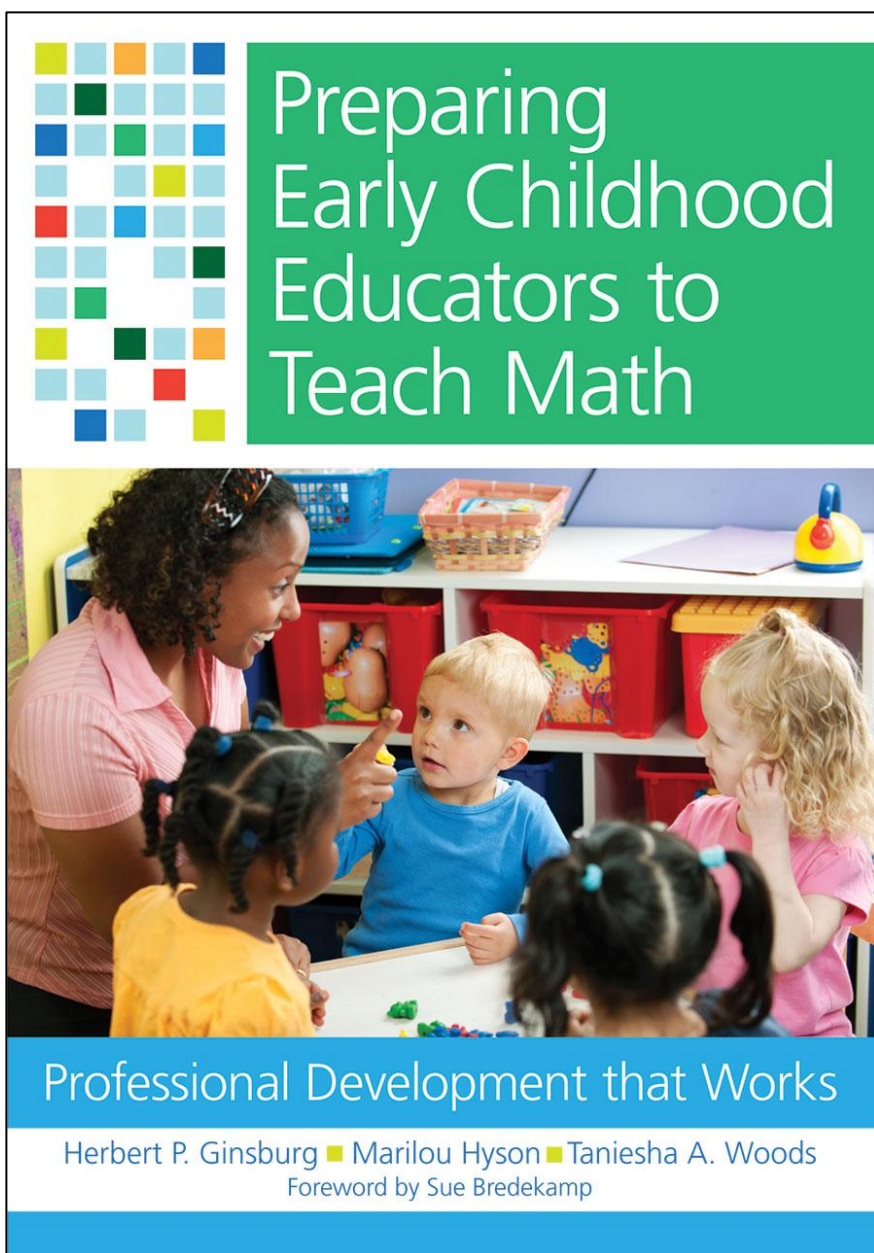




Preparing Early Childhood Educators to Teach Math

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5



General Features of Effective Professional Development

Implications for Preparing Early Educators to Teach Mathematics

Martha Zaslow

The research on early childhood professional development is burgeoning, and it is beginning to yield conclusions about features of effective professional development. This chapter asks the question: What from this growing body of work is important to draw on when seeking to prepare early educators to teach young children mathematics?

This chapter progresses primarily from the broad to the specific: from the research on early childhood professional development in general to implications for teacher preparation specifically in early mathematics (as indicated by the arrow pointing to the right in Figure 5.1). However, there are also important implications for early childhood professional development in general that can be gleaned from seeking to address challenges and opportunities that are specific to preparing early educators to teach mathematics. Accordingly, this chapter concludes with the question of how efforts to prepare teachers in early mathematics can be informative for early childhood professional development more broadly (as indicated by the arrow pointing to the left in Figure 5.1).

The chapter begins by providing background on two reviews of the research on early childhood professional development that serve as the primary resources for this chapter. The chapter discusses six features of effective early childhood professional development that emerge from these reviews. Next, the implications of these features for preparing teachers to instruct young children in math are noted. This discussion includes a cautionary note from the evidence on the status of early childhood professional development, especially inside institutions of higher education. The chapter concludes by asking how research on addressing the challenges specific to professional development in early mathematics can be generalized to strengthen early childhood professional development irrespective of the specific content.



Figure 5.1. Professional development in *early math* draws on and contributes to the broader body of work on early childhood professional development.

RESOURCES DRAWN ON IN THIS CHAPTER

This chapter draws on two reviews of the research on early childhood professional development. The first review, by Zaslow, Tout, Halle, Whittaker, and Lavelle (2010), was conducted as part of a project for the U.S. Department of Education, providing a cross-site evaluation of the Early Childhood Educator Professional Development (ECEPD) programs. The ECEPD programs were funded by the Department of Education, as authorized by Congress, with the aim of strengthening professional development of early childhood educators working in low-income neighborhoods. Multiple cohorts of programs were funded over a period of years, with the Department of Education requiring each program to provide a description of the approach used to strengthen professional development as well as the methodology and results of an evaluation of the program. The cross-site evaluation looked across the evaluations of 18 ECEPD programs, gathering further information for a subset of projects (Tout, Halle, Zaslow, & Starr, 2009).

To provide a foundation for conducting the cross-site evaluation, the project called for conducting a literature review identifying features of effective early childhood professional development that could be used as a framework in reviewing the approaches taken by the ECEPD programs. The literature review, along with some of the findings of the cross-site evaluation, will be drawn upon in identifying key features of effective early childhood professional development.

One of the important features of professional development identified in Zaslow, Tout, Halle, Whittaker, and colleagues (2010) is a direct focus on practice, defined as a focus on observing and providing feedback on interactions with children and the structuring of those interactions through daily routines. Many professional development approaches for early educators historically have aimed at increasing knowledge through college coursework or workshops. An underlying assumption has been that increasing knowledge (such as knowledge of developmental sequences in children's understanding of early literacy or math) will by itself translate into improvements in actual practice.

Yet recent research has raised questions about whether approaches aimed at increasing knowledge ("knowledge-focused professional development" using terminology introduced by Neuman & Cunningham [2009]) on their own result in improvements in overall quality in early childhood classrooms or in gains in achievement for children. Early and colleagues (2006, 2007) found little relationship between early educators' educational attainment and either classroom quality or gain scores in children's achievement in the year prior to kindergarten. In addition, a study by Neuman and Wright (2010) contrasting the effects of college coursework and coaching as approaches to professional

development aimed at strengthening early language and literacy development found effects on practice only for coaching.

Particularly in light of such findings, a second key resource is Isner and colleagues' (2011) literature review focusing on coaching. This review looked across the results of 44 studies evaluating professional development approaches involving either on-site or technologically mediated coaching, seeking to determine the consistency of positive results for quality and child outcomes across coaching studies as well as to begin to identify the features of coaching that underlie positive effects. While the general review of the early childhood professional development literature conducted for the ECEPD project and the review of research specifically on coaching form the basis for much of what is discussed in this chapter, we note that because the research on early childhood professional development is progressing very rapidly, we complement summaries from these reviews with findings from individual studies published more recently. In addition, although the following discussion pertains to both preservice and in-service professional development, there are also issues specific to preparation for teaching early math at each of these stages, as discussed in detail by Michael Preston regarding preservice professional development (Chapter 6) and by Kimberly Brenneman regarding in-service professional development (Chapter 7).

KEY FEATURES OF EFFECTIVE EARLY CHILDHOOD PROFESSIONAL DEVELOPMENT

The literature review conducted to provide a framework for the cross-site evaluation of ECEPD programs identified six features of early childhood professional development programs that appear to be associated with stronger evidence of effectiveness. These features are briefly described here.

Clearly Articulated and Specific Objectives for Professional Development

It is not surprising that professional development programs or initiatives vary in terms of the breadth of their goals. For example, some professional development programs in early childhood focus on improving the observed quality of early childhood classrooms overall, whereas others aim to improve the stimulation children receive for development only in a specific domain, such as early language and literacy or early mathematics. However, in addition to breadth of goals, research indicates that there is also variation in the degree to which programs of professional development provide clear articulation of specific goals.

There is evidence that professional development approaches with more specific and clearly articulated goals are more effective. Fukkink and Lont (2007) reviewed the evidence on professional development training approaches that focused on strengthening early educators' interaction skills. A meta-analysis of the results of the relevant evaluation studies found significant overall effects of such approaches. Additional analyses contrasted the results of such training approaches when the focus was more specific versus open. The meta-analysis found stronger effects when the goals of the training were more specific.

Greater specification of goals can occur in multiple ways. Teachers and program directors can be introduced to and familiarized with an observational

measure of quality, and specific ratings on the measure can be used to set targets for improvements. Research suggests that it may be helpful to go beyond familiarizing early educators with observational measures of quality by providing opportunities for staff members to become proficient in actually rating recorded or live classroom interactions so that they can accurately identify positive practices (Hamre, Pianta, Burchinal, & Downer, 2010). Providing feedback to teachers on their own interactions with children *after* they have honed their skills in identifying specific positive practices may be more efficient and effective.

The issue of specificity of goals may be especially important in preparing teachers in the area of early mathematics. The research on how young children grow in their understanding of math points to not just a specific set of concepts and skills but also their sequencing into learning trajectories (National Research Council [NRC], 2009; Sarama, Clements, Starkey, Klein, & Wakeley, 2008). Thus it may be important in goal setting for professional development in early mathematics to specify both which specific early mathematics concepts and skills are being targeted and how teaching focusing on this set of concepts and skills is part of a sequence, building on earlier learning and laying the foundation for later learning (Clements, Sarama, Spitler, Lange, & Wolfe, 2011).

Direct Focuses on Early Educator Practice

As noted, research is increasingly pointing to the importance of changing early educators' interactions with children by focusing professional development directly on practice. Rather than improvements in knowledge being assumed to lead to changes in practice, the research is increasingly supporting the conclusion that a direct focus on practice is needed in order to improve quality and child outcomes.

This body of research is raising the possibility that introducing general concepts about children's development within a domain such as early literacy or math may work better when the concept is illustrated to the early educator through showing and practicing its application in working with children than through decontextualized discussions. Interesting approaches are emerging in which the focuses on teachers' practice and knowledge are tightly interwoven. Actually seeing the concepts in direct work with children may help teachers gain confidence in the relevance of the concepts for children's development and in their own ability to work with children on these concepts. This may be especially important in the area of early mathematics, where knowledge about specific concepts is central but where teachers may lack the background knowledge and confidence (Ginsburg, Lee, & Boyd, 2008). We now turn our attention to the emergence of practice-focused professional development and then to approaches in which practice- and knowledge-focused professional development are tightly aligned.

Practice-focused professional development is now occurring through on-site individualized coaching and through technologically mediated approaches. In the former, a coach—who is herself an experienced early childhood educator with skills in establishing rapport and helping adults reflect on and improve their educational practices—models positive practices and then observes

teachers and provides feedback on their practices. In the latter, a video library provides the models of positive practice, and teachers receive feedback on videos they record in their classrooms and send to their coaches. Practice-focused professional development approaches may also involve a hybrid of on-site and technologically mediated modeling and feedback. For example, Powell, Diamond, and Burchinal (2012), in their work on coaching to strengthen children's oral language skills in early childhood classrooms, have found that initial on-site coaching sessions can be effectively combined with subsequent technologically mediated sessions. They have also carefully piloted the way in which the technologically mediated sessions unfold so that appropriate (and not overwhelming) amounts of information about positive practices and feedback on behavior are provided.

As noted earlier, Isner and colleagues (2011) conducted a review of 44 studies focusing on coaching in early childhood classrooms. Of these studies, 31 examined whether the coaching resulted in improvements in observed quality, with 27 studies (87%) providing some evidence of positive effects. Thus, although there is a fairly consistent pattern of coaching studies showing positive effects, it is important not to assume that all coaching approaches will be effective. A similar pattern was identified in the cross-site evaluation of ECEPD programs (Tout, Halle et al., 2009). All 18 programs in the cross-site evaluation included on-site individualized coaching for the early educators. Of the 18 programs, 10 were found to have evaluations that met criteria for rigor in the way they presented the methodology of the study and in the way the study was conducted. Of these studies, eight showed evidence of positive effects on quality and/or child outcomes. Coaching was present in the programs showing positive effects but did not suffice to assure positive effects.

Such a pattern suggests that it is very important to begin specifying in greater detail which aspects of the various coaching approaches underlie positive effects. Isner and colleagues (2011) concluded that existing studies provide only a limited basis for identifying which features of coaching approaches are most important. Very few studies vary specific dimensions of coaching (such as how much coaching is provided, how coaches are trained or supervised, what specific steps coaches take to model positive practices, or how they provide feedback on early educator practice) and study the outcomes in light of this variation. A new project with funding from the Administration for Children and Families, Office of Planning, Research and Evaluation is laying the groundwork for a study of coaching in Head Start that will seek to systematically vary dimensions of coaching with the goal of learning which dimensions are most important to positive outcomes (Administration for Children and Families, n.d.-b).

Coaching approaches are a frequently used strategy for quality improvement initiatives such as Quality Rating and Improvement Systems (QRIS). QRIS seek to provide parents with readily interpretable summary ratings of quality to inform their choices of early care and education while also providing incentives and supports for quality improvement to early care and education providers (Tout, Zaslow, Halle, & Forry, 2009). A compendium profiling the specific approaches taken in 26 state and local QRIS (Tout et al., 2010) found that each one included on-site assistance to support quality improvements. QRIS generally involve in-service work with teachers, focusing on improving

practice with those already in positions working with children. Furthermore, much of the research to date on coaching focuses on quality improvement approaches conducted as part of in-service professional development. Yet there is no reason coaching cannot be directly incorporated into preservice training or coursework, making coursework explicitly practice-focused and helping to combine theory and practice, thus supporting the development of more reflective practitioners. Although we have early promising evidence on coaching as incorporated into college coursework (Hamre et al., 2010), more work is needed evaluating coaching as a component of preservice training to complete licensing requirements or as part of preservice college coursework.

We are beginning to see professional development approaches that not only combine but also carefully align knowledge-focused and practice-focused components. Close linkages between the focus of group training or coursework and of coaching was one of the features of the ECEPD programs showing evidence of effectiveness (Tout, Halle et al., 2009). The recent research of Wasik and Hindman (2011) provides an illustration of effective early childhood professional development with closely aligned group training and individualized coaching. In the professional development approach they report on, group training is provided in modules, each focusing on increasing early educators' understanding of specific aspects of children's language development and including discussion of practices that can support these. Teaching teams develop lesson plans for their classrooms as part of the group training. Coaches then go to individual classrooms, focusing the coaching they provide specifically on the practices related to the topic of the current module. Coaches first model practices related to the topic while teaching teams observe and record instances of positive practice, then teaching teams implement the lesson plan they had developed in the group training while the coach observes and subsequently provides feedback. As noted, approaches that tightly align practice-focused and knowledge-focused components may be helpful to consider in teacher preparation in early mathematics.

Collective Participation in Professional Development of Teachers and Other Staff from the Same Classroom, Program, or School

There is substantial variation across professional development approaches in whether only the lead teacher in a classroom participates, whether the entire classroom teaching team (including an assistant teacher) participates, or whether all program staff participate. Most of the coaching studies included in the review by Isner and colleagues (2011) described coaching approaches that focused only on the lead teacher or a family child care provider. However, a number of recent studies describe coaching approaches that encompass a lead teacher and the assistant teacher or aide. For example, the Chicago School Readiness Project (Raver et al., 2011), which aimed to enhance children's social and emotional development with a particular focus on self-regulation, included lead and assistant teachers together in both training and coaching. The Foundations of Learning program (Morris, Raver, Millenky, Jones, & Lloyd, 2010), which focused on improving classroom management of children's

behavior, also targeted lead and assistant teachers. There is less discussion of teams participating in group training or coursework, but some examples have been described in the literature (e.g., Ginsburg et al., 2006).

Inclusion of all staff members in a program—not only teaching teams but also directors, specialists, and support staff—tends to occur when the goals of quality improvement are at the program level as well as the classroom level. Such approaches may be especially important for sustaining the positive effects of professional development. Thus, for example, a study by Shlay and colleagues (2001) described a coaching approach aimed at supporting programs' work toward accreditation that included directors along with classroom staff. With QRIS also involving ratings at the program level, we are also seeing descriptions of coaching as part of QRIS quality improvement efforts that include directors as well as classroom staff. However, Isner and colleagues' (2011) case studies of four local QRIS found variation in the extent to which the program director was included in the coaching. *Not* including the director in the coaching appeared to carry with it the possibility of the director not fully understanding the coaching program and not conveying support for it in guidance to teachers, multiple coaching approaches being used within a program without coordination, and directors feeling undermined by coaches coming to work with staff members without their involvement. QRIS seek to improve quality across early childhood programs occurring in the full range of settings, including early childhood classrooms within public schools. Thus this research suggests the need to consider the issue of how best to inform and include school principals as well as directors of nonschool-based early childhood programs in coaching approaches.

We do not, as yet, have studies that systematically vary whether professional development focuses only on the lead teacher or encompasses other staff members as well. However, the literature review conducted for the ECEPD project found some indication of greater effectiveness when professional development approaches encompassed more staff members. The involvement of teaching teams, of staff at different levels of a program (e.g., directors as well as teachers), and also of staff working with children of different ages in a program can foster programwide consistency in practices. In contrast, a single teacher who has received professional development may be introducing practices into her classroom that other teachers or staff members do not understand or feel supportive of, and may even contradict. Including multiple staff members in the same professional development can also provide a starting point for reflective practice by groups of staff members, something that may be especially important to sustaining changes in practice, especially in areas that many teachers see as new and challenging, such as mathematics teaching.

Much more work is needed to provide guidance on how best to engage multiple staff members in coaching. For example, work by Allard Agnamba (2012) raises the question of whether those who are skilled in building relationships with individual teachers or teaching teams in a coaching relationship are necessarily the best staff members to work directly with principals or program directors. Different skills appear to be needed in these relationships. Furthermore, when models of positive practices are provided for technologically mediated coaching, the research to date generally describes videos of lead teachers alone. An important next step in the work on early childhood professional development

is to provide more specific guidance to programs on how best to incorporate staff members other than lead teachers. Video examples of teaching teams working together would also be extremely valuable. These could be used in both preservice and in-service teacher preparation (see Chapters 6 and 7).

Alignment of Intensity and Duration of Professional Development with the Content Covered

The total “dosage” of a professional development approach may include the duration of each class or coaching session, the frequency and total number of such sessions, and the duration of the entire series of sessions. Different professional development approaches vary substantially in overall dosage, as well as how the overall dosage is arrived at through the frequency and number of sessions and their duration. For example, in their review of coaching studies, Isner and colleagues (2011) found the frequency of reported coaching to range from once a month to multiple times per week, with some coaching sessions lasting fewer than 90 minutes and others longer, and with coaching continuing from fewer than 2 months to longer than a year. Some recent studies of coaching underscore the need for a longer duration (2 years) in order for changes to be not only attempted but also solidified and sustained (Wasik & Hindman, 2011). Parallel variation exists in the frequency of classes involved in coursework or training, the length of each individual class, and the number of weeks classes continue. Approaches that include both knowledge-focused and practice-focused professional development will need to take into account the cumulative dosage of these components.

A key conclusion from the literature review conducted for the ECEPD project is that dosage needs to match the breadth of content being conveyed and the depth in which it is conveyed. Positive effects have been found for professional development that involved a limited dose when the specified goal of professional development was mastery by early educators of a single activity or strategy to use with children (see, for example, Whitehurst et al., 1994). However, a small dose of professional development is not appropriate if the goal is to convey theory and practice across multiple aspects of development in a domain (e.g., oral language, phonological awareness, alphabetic principle, and awareness of print in early language and literacy development) or to strengthen development in multiple domains. Given the current level of knowledge, skill, and beliefs in early childhood mathematics teaching (Hyson & Woods, Chapter 2), it would seem that larger doses of professional development are essential.

A further key issue is the distinction between dosage as intended and dosage as actually received. Evidence that dosage as actually received is important comes from a study by Mashburn, Downer, and Hamre (2010) regarding teacher use of technologically mediated coaching in a professional development approach called MyTeachingPartner (for further discussion of this professional development approach, see Brenneman, Chapter 7; Vick Whittaker & Hamre, Chapter 8). This study found that children’s gains in vocabulary during a year of preschool were greater when their teachers spent more time engaged in the online coaching.

Further work is needed examining effects on teachers and children when the dosage of coaching is systematically varied. To date, the research suggests

that calibration is needed between the scope of the goals of professional development and dosage and that it is important to assure that the intended dosage is actually received. Another important issue related to dosage is cost effectiveness. For example, there may be reluctance to put into place a 2-year course of professional development. Yet if the evidence shows that a larger dose is needed to bring about sustained change, this larger and more expensive initial dose may actually be cost effective. In the area of early mathematics, where, as we have noted, the focus is not on children's mastery of isolated concepts but on concepts that build sequentially over time, it again seems particularly critical to look at dosage relative to sustained effects over time.

Preparation for Conducting and Using the Information from Child Assessments

The reviews of the evidence for the ECEPD project suggests that effective professional development programs tend to incorporate training for early educators not only in conducting child assessments but in using the information from assessments to monitor children's progress and inform instruction. It is quite different to simply be able to administer or complete the observations needed for child assessments than it is to use the information obtained. Professional development on both is needed.

Such professional development is highly dependent on the availability of appropriate assessment tools. In this instance, the tools that are needed help pinpoint the progress a child has made in the development of specific concepts and skills as well as support and inform teachers' targeting of instruction. Such tools differ from tools needed for evaluation or for providing a descriptive picture of children's development across a geographical region. For example, in assessment aimed at guiding instruction, it is appropriate to probe or repeat an item so that a teacher is sure he or she has not missed capturing a child's level of understanding or skill. However, in assessment for evaluation or to describe the educational status of children in a region, the assessment must be conducted in a strictly standardized manner (Snow & Van Hemel, 2008).

We actually have very little information on how programs help to prepare their staff to conduct child assessments or how programs use the information from assessments to monitor children's progress and inform instruction. The Office for Planning, Research and Evaluation in the Administration for Children and Families, part of the U.S. Department of Health and Human Services, has recently launched a project on early educators' use of progress monitoring approaches to individualize teaching (Administration for Children and Families, n.d.-a).

The use of assessments to inform instruction may be particularly important in areas such as early mathematics, where there are sequences of learning such that one skill is foundational for mastering subsequent skills (see Ginsburg, 2009; Ginsburg, Chapter 3), and where teachers often know little about children's mathematical development (see Hyson & Woods, Chapter 2). Frustration for both child and teacher, and lack of progress in children, can result from instruction where foundational understanding is lacking. Using

assessments to diagnose a child's level of understanding can eliminate such frustration and strengthen learning.

Just as there can be lack of tight alignment between knowledge-focused and practice-focused professional development, there can also be a lack of alignment in professional development on assessments and instructional practices. Integrating these elements of professional development is critical so that teachers understand how to both assess whether a child has mastered a concept or skill and then build to the next step once the child is ready.

Consideration of Organizational Context as Well as Standards for Practice

A growing body of evidence indicates that the strength of any approach to improving quality in early childhood programs will reflect both the effectiveness of the initial approach as implemented in tightly controlled circumstances (e.g., in a demonstration project) and the way in which it is implemented on a larger scale (Halle, Metz, & Martinez-Beck, 2013). Implementation, in turn, reflects both organization-level factors and broader systems-level factors (Brenneman, Chapter 7). Failure to take organizational- and systems-level factors into account can result in a program failing to show the effects it had in a demonstration project when it is brought to scale (see the earlier discussion regarding the inclusion of directors and principals as well as other staff members in professional development).

For early childhood professional development, key organizational factors related to implementation will include the extent to which the professional development approach being introduced is in harmony with a curriculum that is already in place and the approaches taken by specialists such as curriculum specialists or family support workers. A new approach to professional development may also flounder if it does not take into account key characteristics of the population in a classroom or program, such as the concentration of dual-language learners.

In Chapter 1, Kagan and Gomez point to important systems-level factors that can facilitate or hinder the implementation of a program of professional development. For example, if the focus of the professional development does not align well with a state's early learning guidelines for early mathematics or build appropriately toward Common Core standards for K–12, it will likely not be given the attention and support that is needed for full implementation nor will it result in positive outcomes on assessments that align with these guidelines and standards. Similarly, if the state has developed or is in the process of working toward a kindergarten entry assessment as part of its work for Race to the Top/Early Learning Challenge funding, the way in which the assessment seeks to capture children's skills in early mathematics will be very important to the implementation of any particular professional development approach.

IMPLICATIONS FOR PROFESSIONAL DEVELOPMENT TO TEACH EARLY MATHEMATICS

In what ways can teacher preparation in the area of early childhood mathematics build on this set of features? Preparing early childhood teachers for instruction in mathematics fits readily with some of these features, whereas

for others there appear to be challenges. This section first turns to the general features of early childhood professional development that appear to align well with needs in preparing teachers in this specific content area and then turns to areas where greater attention is likely to be needed.

Features that Fit Well with Preparation of Early Educators to Teach Mathematics

Specificity of Goals

Early mathematics is unusual among the content areas that contribute to young children's school readiness because of the clear articulation of the central concepts and skills young children already possess and those they need to master to provide a strong foundation for later learning (NRC, 2009). This framework provides a critical starting point for the clear articulation of specific goals both for children's learning and for preparing teachers for instructing children so that they will progress toward these goals.

To briefly recapitulate what is discussed elsewhere in this volume in greater detail, there was a longstanding hesitance to provide intentional instruction in mathematics in the early years because such instruction was seen as developmentally inappropriate for young children and requiring didactic approaches. However, a substantial body of research (as summarized by the National Academy of Science Committee on Early Childhood Mathematics; NRC, 2009) indicates that understanding of math concepts begins at a very early age. The research also clearly indicates that learning of early mathematics concepts and skills can be fostered in interesting and engaging ways by instructional approaches and organized curricula appropriate for young children. Furthermore, understanding of concepts in early mathematics is among the strongest predictors of later achievement (Duncan et al., 2007). Therefore it is particularly of concern that discrepancies in early mathematics achievement by socioeconomic status emerge before kindergarten (Klibanoff, Levine, Huttenlocher, Vasilyeva, & Hedges, 2006). Fostering early math skills, especially among children at risk in terms of school readiness, needs to be a high priority.

The framework articulated by the Committee on Early Childhood Mathematics has fostered the identification of clear goals for the professional development of early educators, as is evident in Chapter 3 by Ginsburg—who served as one of the committee members and worked closely with Woods, the Study Director, as well as Hyson, who prepared a commissioned paper for the committee (Hyson, 2008). Other domains of children's school readiness do not have such clearly articulated frameworks. In the area of social and emotional development, for example, there are multiple and somewhat differing conceptualizations and articulations of key constructs (Hyson et al., 2011). The existence of an overarching framework for early mathematics concepts and skills and an understanding of how early math skills build progressively is a key resource to draw upon in addressing the feature of effective professional development of specificity in articulating goals. The availability of a framework does not, however, eliminate the need for substantial work in developing, testing, and refining comprehensive programs of professional development based on the framework.

Calibration of Dosage to Goals

This chapter has noted that in effective early childhood professional development, dosage is calibrated to the breadth and depth of content on which early educators are being prepared to provide instruction. In the review of the literature conducted for the ECEPD project, it was clear that some early mathematics interventions focus only on limited aspects of the overarching conceptualization of early math skills (e.g., Sophian, 2004, who focused specifically on the use of differing unit sizes in measurement and the implications of this for numerical outcomes), whereas others address a range of early childhood mathematics skills (e.g., Starkey, Klein, & Wakeley, 2004, who focused on enumeration and number sense, arithmetic reasoning, spatial sense, geometric reasoning, pattern sense and unit construction, nonstandard measurement, and logical relations). Thus calibration of dosage of professional development can occur in relation to the extent of the overarching framework that professional development is seeking to address. An important underlying question is whether seeking to teach children only selected aspects from the framework will suffice to lay a strong foundation for later learning in mathematics.

Direct Focus on Practice

As described by Hyson and Woods in Chapter 2, research points to hesitance or even resistance by some early educators to teach mathematics, based at least in part on lack of confidence in their own understanding of key concepts. Interestingly, the emerging evidence that effective early childhood professional development focuses on practice, and not simply knowledge, may help to allay such concerns. Just as some of the terminology for the key concepts in children's language development (e.g., phonological awareness) can sound jargony, terminology such as number sense in early childhood mathematics can also be off-putting.

Rather than introducing the important concepts for the development of early math skills in knowledge-focused approaches, the research on effective early childhood professional development suggests that it may be more effective in changing practice to emphasize and even begin with practice-focused approaches. Helping teachers to see the concepts in action may provide a starting point for understanding and discussing the concepts in group training or coursework. Indeed, although it was long assumed that knowledge of a concept would lead to successful practice, an alternative conceptualization is that enacting and reflecting on positive practices provides an effective basis for deriving and understanding the underlying concepts (Zaslow, Tout, Halle, & Starr, 2010). Professional development in early mathematics may provide a crucial context in which to explore how best to interweave the introduction of positive practices and mastery of concepts related to children's development.

Features with Which There Are Likely to Be More Significant Challenges

Collective Participation in Professional Development

This chapter notes the suggestive evidence that collective participation in professional development by teaching teams or all staff members in a program may result in greater change in behavior, and perhaps more sustained

change, than professional development addressed to only a lead teacher. Yet the chapter also notes that little guidance is available for how to effectively engage directors or principals in professional development, including whether the same professional development provider should work with a director as well as the teaching staff. Similarly, although a number of professional development approaches have been addressed to teaching teams, we lack written illustrations or a library of videos showing how the members of the team can be prepared to work in a coordinated way in providing instruction.

These gaps may pose a particularly significant challenge for professional development in early mathematics. The literature on implementation of early math curricula includes descriptions of directors who do not see the need to instruct young children in math, and who may not support, or who may even undermine, staff undergoing professional development to implement an early math curriculum (see, for example, Ginsburg et al., 2006). We urgently need to address the lack of guidance on how to include directors of early childhood programs, principals, and others responsible for program administration and oversight (such as master teachers and curriculum specialists) in professional development so that they are informed about and supportive of the preparation of their staff to teach mathematics.

Conducting and Using Information from Assessments

The lack of clear illustrations of teaching teams working together on the implementation of a curriculum may be especially problematic in a content area where individualization is so clearly called for. If mastery of one skill provides the needed foundation for the next, instruction in early math needs to take into account the progress individual children have made in order to set goals for next steps. Yet assessing individual children's progress and setting individualized learning goals is extremely difficult if the lead teacher alone is responsible for planning and conducting learning activities and assessments. Key decisions will need to be made about preparation for observation and assessment of children. Should both the lead teacher and assistant teacher monitor children's progress and therefore be prepared on recording observations or conducting assessments? If so, will staffing patterns ensure that assistant teachers are assigned to the same classroom over time so that they are available to monitor individual children's progress? How will such work in teams take into account and overcome the challenges of turnover among both lead and assistant teachers (see Kagan & Gomez, Chapter 1)?

Professional Development in the Context of Systems

A further challenge in professional development for early mathematics is that some key systems-level factors are currently in flux. A particularly important issue is that intensive work is currently in progress in multiple states to develop kindergarten entry assessments (see Kagan & Gomez, Chapter 1). It is impossible to align instruction in early mathematics with the measurement of early math skills when the measurement is still under development.

A CAUTIONARY NOTE: GAPS IN PRESERVICE AND IN-SERVICE PROGRAMS

Before concluding this chapter, it seems imperative to interject a cautionary note. A recent review of the evidence on professional development for early educators provided through programs of higher education by Hyson, Horm, and Winton (2012) raises questions about the extent to which the key features of effective professional development for early educators noted here are seen in higher education programs.

Hyson and colleagues (2012) summarize evidence that math receives less coverage than early literacy in associate's and bachelor's degree programs for early educators. For example, whereas 65% of associate's degree programs were found to have coursework in early literacy, 49% had coverage for early math. The parallel figures for bachelor's level programs are 77% and 59%. In surveys, faculty members themselves identify gaps in their knowledge base in early mathematics. Furthermore, vague responses by faculty members to survey questions about what they teach their students regarding math curricula for young children, and what math-related competencies they expect their students to show, raise concern about the specificity of goals in professional development focusing on early mathematics provided in higher education.

The review by Hyson and colleagues (2012) also raises concerns about the extent to which higher education programs include an explicit focus on practice and also tight linkages between knowledge-focused and practice-focused professional development. Hyson and colleagues (2012) conclude that teacher preparation programs for early childhood educators in institutions of higher education provide limited attention to practice, focusing more heavily on the acquisition of knowledge (setting aside the key issue of the extent to which this knowledge is current according to recent research). Summarizing a study by Johnson, Fiene, McKinnon, and Babu (2010), Hyson and colleagues (2012) note limited intentional linking of coursework focusing on specific content areas (such as early science or mathematics) and field placement experiences involving observation and feedback on practice in the particular content area. Hyson and colleagues (2012) underscore the need for research on faculty skills in fostering student ability to implement specific practices.

Thus there is cause for concern about the extent to which early childhood education degree programs are incorporating the general approaches supported by the research on effective professional development, especially those related to specificity and focus on practice. We do not have a parallel review of the evidence that would permit an assessment of the extent to which training workshops that do not contribute to a higher education degree, or coaching conducted to address licensing requirements or for QRIS, encompass the features noted. However, just as for professional development provided through higher education, we have some troubling indications that professional development carried out outside of institutions of higher education does not always include all the key features of effective professional development discussed in this chapter (Zaslow, Tout, Halle, Whittaker et al., 2010).

One issue appears to be the degree to which on-site individualized professional development through in-service coaching is aligned with current systems for recognizing levels of professional development. A teacher's

participation in coaching to improve quality for a QRIS rating may not be accorded official recognition in terms of how the same QRIS marks progress on the teacher's professional development. In short, participation in coaching, even if it yields improvements in quality, may not contribute to in-service training requirements. As one example, in Washington State's Seeds for Success evaluation (Boller et al., 2010), even though coaching resulted in observed improvements in classroom quality, improvements on QRIS ratings of professional development were limited because the coaching did not contribute to improved ratings—that is, the system provided no way to recognize the coaching in existing markers of progress on professional development.

In sum, in order to make progress in early educators' preparation to teach mathematics, systems of professional development, both preservice and in-service, will need to be structured in ways that support such efforts.

CONCLUSION

This chapter has progressed from broad to specific: from a discussion of general features of effective early childhood professional development to the identification of implications for preparing early childhood teachers for instruction in the specific area of mathematics. However, the relationship is reciprocal. Growth in our understanding of how to prepare teachers for the instruction of young children in mathematics stands to yield insights relevant to our general understanding of effective professional development. The following are examples:

- Testing whether starting with a focus on practice and using that starting point to work toward knowledge of actionable concepts in early mathematics helps to allay teacher concerns about understanding the underlying concepts in math. This would suggest important possibilities for mastering concepts in other domains of development.
- Developing case studies of effective preparation of directors, principals, and other education leaders so that they understand and support professional development in early mathematics could pave the way for approaches to work with education leaders in preparation for professional development in other key domains or in integrative cross-domain curricula (see the discussion of integrated curricula in Chapter 7).
- Building a video library of lead and assistant teachers working together to implement an early math curriculum could yield insights about how to provide professional development for teaching teams irrespective of the content area.
- Similarly, a video library could be developed using interviews and assessments with children to help identify their understanding of key mathematical concepts. Such a video library would be useful for the design of professional development on using assessment to guide individualized instruction, a key issue across developmental domains.
- Grappling with how to align professional development in early mathematics with a kindergarten entry assessment, which is still in development, could yield improved strategies for collaborative participation in the development,

piloting, and refinement of the assessment. Such work could inform future steps to tighten alignment of kindergarten entry assessments and early childhood professional development across domains.

- Finally, there are important opportunities for intentional collaboration in professional development for instruction in multiple domains of early childhood development. For example, vocabulary development can be intentionally fostered in instruction in early mathematics. Similarly, expressive language can be fostered in teacher interactions with children as the children work on solving problems in math activities. Integrative goals for early childhood professional development build on an understanding of the interrelated nature of children's development across domains (Sarama, Lange, Clements, & Wolfe, 2011). They also hold the potential of diminishing overload when teachers receive professional development in multiple content areas (Bouffard & Jones, 2011; Brenneman, Chapter 7).

Thus strengthening professional development in early mathematics can both build on and also contribute in important ways to our understanding of the general features of effective early childhood professional development.



1. Zaslow summarizes two recent reviews of research on early childhood professional development. These reviews are well worth reading as background, especially if you are a researcher or leader of new professional development efforts in early childhood mathematics education. If possible, discuss their implications with colleagues.
2. A recurring theme in research on effective professional development is that there needs to be a strong focus on practice. Thinking about your experiences and observations, is there enough of a practice focus? If not, what seem to be the barriers?
3. As Zaslow notes, coaching has become a frequently implemented way of improving early childhood teachers' effectiveness. Again, what has been your experience with coaching, and how successful has coaching been (in math or in other domains)?
4. For your experience as a provider or leader in professional development for early educators, what are the main lessons you draw from Zaslow's discussion? What changes may you wish to make, based on what you have learned from this chapter?
5. As a sort of needs assessment, it might be helpful to design a checklist or rating scale to assess your organization's current professional development efforts in mathematics, using the six key features identified in this chapter.

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