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Effectiveness of Comprehensive Professional Development for Teachers of At-Risk Preschoolers

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This study compared effectiveness of "business as usual" to that of 4 professional development (PD) programs that targeted teachers of at-risk preschool children. A 2 × 2 design was used to cross mentoring and progress monitoring conditions among the 4 PD programs. Specifically, some teachers received both in-classroom mentoring and detailed, instructionally linked feedback concerning children's progress in language and literacy. Some teachers received no mentoring but did receive the detailed, instructionally linked feedback concerning children's progress. Some teachers received in-classroom mentoring but only limited feedback on children's progress, which was not linked to curricular activities. Finally, some teachers received no mentoring and only limited feedback concerning children's progress. All 4 PD conditions included the same year-long, facilitated online course that emphasized language and literacy instruction, practice of learned material in one's classroom, and participation in online message boards with fellow teachers. Across 4 states, 158 schools (N = 262 classrooms) were randomly assigned to 1 of the 4 PD conditions or business as usual. The condition that included online coursework combined with mentoring and detailed, instructionally linked feedback yielded the greatest improvements in teaching behavior and children's school readiness.

Keywords: professional development, preschool, mentoring, curriculum-based measurement, technology

Understanding how to provide children with an early foundation in school readiness skills is critical given that many states estimate that half of their students arrive at kindergarten already far behind of where they need to be to have a good chance at succeeding in school ("Highlighting NAEP 2003," 2003; Zill & West, 2001). The most recent results of the National Assessment for Educational Progress indicated that only 31% of fourth-grade children in the United States performed above the proficient level in reading and only 32% performed above the proficient level in math ("Highlighting NAEP 2003," 2003). In both domains, children from lower socioeconomic status (SES) backgrounds (i.e., children eligible for free- or reduced-price lunch) performed significantly worse than children from higher SES backgrounds. Experts now generally agree that these disparities in children's skill levels begin before elementary school, and they persist throughout children's formal schooling (National Center for Education Statistics, 2001a, 2001b; Snow, Burns, & Griffin, 1998).

Recent evidence from basic science research and longitudinal and intervention studies has reaffirmed that a child's experience during the early years directly affects brain development in ways that affect later learning, behavior, and physical and mental health (e.g., DiPietro, 2000; Landry, Smith, Swank, Assel, & Vellet, 2001; Neville et al., 1998). Children from lower SES backgrounds are at the highest risk for not receiving the type of experiences that are most likely to promote school readiness. For example, because of life stresses, psychological distress, and poor parental role models, economically disadvantaged parents often use parenting approaches that inadequately support child development (Aber, Jones, & Raver, 2007; McLoyd, 1998). More specifically, children in economically disadvantaged families experience fewer instances of rich language input (Hart & Risley, 1995), fewer opportunities to interact with children's literature (Neuman, 1996), and parenting styles that are less responsive to children's interests (Landry et al., 2001). Children in economically disadvantaged families also experience poorer health care and nutrition than their economically advantaged peers. Thus, compounding risk factors place children from economically disadvantaged backgrounds at increased risk for poor academic achievement, school dropout, social maladjustment, criminal behavior, and physical and mental illness.

Quality early childhood education is a primary means by which children from low-income backgrounds can start kindergarten with the skills necessary to succeed (Bowman et al., 2001; Snow et al., 1998). Evidence has shown that when children are supported by teachers with specialized techniques who are sensitive to emerging developmental skills, they generally achieve at higher levels (e.g. Howes, 1997). In fact, children from impoverished backgrounds demonstrate average levels of development at the time of entry into kindergarten if they receive such support (Landry et al., 2001). Because families at poverty levels of income are more likely to rely on center-based early childhood programs that accept federal subsidy (Phillips, Voran, Kisker, Howes, & Whitebook, 1994), it is

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important that these programs provide learning environments that optimally promote school readiness.

Although there is growing consensus that high-quality preschool experiences can lay a strong foundation of school readiness even among economically disadvantaged children, there is a serious mismatch between the preparation of most early childhood educators and the preparation needed to optimize classroom practices. Educating young children is a complex and challenging endeavor because teachers are asked to promote high levels of child achievement, have a deep understanding of curriculum content, pay attention to young children's capacity to learn, understand the optimal conditions under which they learn, and have an ability to engage in reflection on their own teaching practices (Bowman et al., 2001). Promoting optimal learning for young children is thought to require some unique instructional strategies. Theories of early learning suggest that early childhood educators need to be responsive and sensitive to individual differences in children's abilities, home environments, and cultural characteristics (Bowman et al., 2001). Although early childhood educators may not always have the formal educational background to prepare them for the classroom, effective professional development has been shown to improve the quality of early childhood programs (Howes, Phillips, & Whitebook, 1992; Kontos, Howes, & Galinsky, 1997). Therefore, professional development may serve as a buffer to inadequate teacher preparation, which is commonplace in early childhood education.

In the past decade, knowledge has burgeoned about the key foundational skills children need to enter kindergarten ready to learn academic skills. This includes an understanding and use of vocabulary, complex oral language, and early writing (National Institute for Literacy, 2007). Preschool children's phonological processing skills, such as phonological awareness, phonological short-term memory, and the efficient use of phonological representations of words, are also important precursors to acquiring literacy (Anthony et al., 2006; Anthony, Williams, McDonald, & Francis, 2007). A child's knowledge of letters, including naming letters and knowing that they are associated with sounds, is also a critical foundation skill. In a recent meta-analysis, these foundational skills were unique predictors of reading achievement in early elementary grades (National Institute for Literacy, 2007). It has been documented that teachers trained in instructional strategies that expose children to experiences with emergent literacy skills are more likely to have students who show cognitive gains that carry into kindergarten (Whitehurst & Lonigan, 1998; Zevenbergen et al., 1997).

Theoretical Frameworks for Proposed Professional Development

A first step toward the goal of school readiness for all children is to examine whether teachers can be provided with professional development that results in teachers providing early learning experiences that foster school readiness. To accomplish this goal, it is often necessary for teachers to change their beliefs about appropriate content and pedagogy and to change their beliefs about their roles and responsibilities in supporting children's learning in the classroom. One belief that can interfere with teachers making use of professional development is the longstanding belief that children need to construct their own knowledge through self-directed discovery and that the teacher's responsibility and role is one of supporting that discovery. This explicit belief system often is at odds with professional development that encourages teachers to provide explicit information about vocabulary, number concepts, and letters in a more intentional approach (Bereiter, 1972). Thus, one challenge for professional development programs for early childhood educators is how to encourage a properly sequenced and balanced integration of teachers' efforts at supporting children's play and self-discovery while also providing planful and purposeful instructional activities.

Recent theoretical frameworks for teacher professional development describe the importance of acknowledging teachers' philosophies in an effort to help them understand how new information can fit within existing attitudes and beliefs (Bransford, Brown, & Cocking, 2000; Kennedy, 1997; Richardson, Anderson, Tidwell, & Lloyd, 1991; Speck, 1996). Intellectual engagement in the subject matter through opportunities to understand the theory and rationale for new instructional practices is of critical importance. Such frameworks additionally indicate that adults will learn most effectively when (a) the learning is situated in authentic contexts (e.g., demonstrating techniques with teachers in classroom settings, which is perceived as realistic and relevant to day-to-day activities), (b) there are opportunities to do collaborative problem solving and practice specific skills, and (c) learning experiences are extended over time rather than in one workshop (Bransford et al., 2000; Elmore, 2002; Learning First Alliance, 2000; Putnam & Borko, 2000; Speck, 1986; Sullivan, 1999).

Professional development may be further enhanced if teachers receive ongoing, in-classroom coaching, or mentoring (Spodek, 1996). Mentoring is thought to provide teachers with opportunities to try new approaches with guided support and a knowledge resource without concerns regarding the mentor's having a supervisory role (Eisenhower National Clearinghouse for Mathematics & Science Education, 1998; International Reading Association & National Association for the Education of Young Children, 1998). The availability of a network of professional support, which could include mentoring, has been shown to improve teacher–child interactions (Corsini & Caruso, 1989), to decrease feelings of isolation (Hayes, Palmer, & Zaslow, 1990), and to reduce high rates of teacher turnover (Landry, Swank, Smith, Assel, & Gunnewig, 2006). With "in-house" trainers who tailor the program to teachers' needs, higher levels of adult–child interaction and more positive child developmental outcomes are observed (Epstein, 1993). An advantage of mentoring is its ability to individualize professional development to the needs of the learner, which may be particularly important for early childhood teachers who vary in education and training. Although the importance of mentoring is becoming more recognized among early childhood educators, experimental studies of the mentor–teacher process and outcomes remain limited. Of note is a lack of studies with adequate methodology, as most are quasi-experimental or correlational with no control group (Kontos, Machida, Griffin, & Read, 1992).

Assessment of students by their teachers for the purpose of informing instruction is becoming a more common practice in early childhood education, especially for early language and literacy (McConnel, 2000; Phaneuf & Silberglitt, 2003). Teacher-administered assessments of children's academic progress, also known as curriculum-based measures (CBMs), are usually very brief tests, may use timed tests, and are administered repeatedly across the school year. CBMs help teachers focus their instruction

on important learning outcomes. Children's scores on CBMs can be used not only to gauge children's response to instruction but also to group children according to their learning needs (Wesson, 1992), which has been shown to maximize instructional impact (e.g., Bowman et al., 2001; Leeper & Witherspoon, 1984). Research on teachers' use of CBMs to inform instruction is limited (Fuchs, 2004; Madelain & Wheldall, 2004), and there has been a call to examine the extent to which technology that directly links CBM results to grouping of children and to selection of instructional activities can improve children's learning outcomes (Fuchs, 2004).

Bringing Professional Development Programs to Scale

Literature on scaling educational programs is not well developed (National Academy of Education, 1999), but successful models are available as guides (Culp & Honey, 2000; Slavin, Madden, Dolan, & Wasik, 1996). The current intervention includes a highly specified framework of what is needed in classrooms without scripting the program and flexibility that allows administrators' and teachers' input into implementation. The need to ensure a balance between faithful implementation of the key program components and local input was a goal (McLaughlin, 1990). This was accomplished, in part, through the development of partnerships with all stakeholders because gaining the support of local stakeholders is a critical process for bringing projects to scale successfully (Culp & Honey, 2000).

Consistent with successful scaling research, the current professional development programs included a highly systematic approach in which training goals were carefully sequenced and spread out over time to support transfer of goals into the classroom (Center for Children & Technology, 2000). Also, the programs were built from solid theoretical and research bases, but training was grounded in practical application. For example, professional development first focused on how to organize the classroom for effective teaching and behavior management. Subsequently, professional development focused on how teachers could promote important school readiness skills.

Project Overview

The main objective of this study was to demonstrate that teachers across the three primary types of early childhood education programs serving low-income children (i.e., subsidized childcare, Head Start, and public school prekindergarten) could be facilitated to use effective instructional practices that, in turn, promote children's development of language and emergent literacy. Participants were teachers from all three types of early childhood education programs that serve economically disadvantaged families. This multisite study tested the effectiveness of four overlapping professional development conditions that were based on scientifically based research and modern theoretical frameworks of professional development. To determine the effectiveness of the professional development programs, schools were randomized into one of five conditions, control (i.e., business as usual) or one of the professional development programs. The four professional development conditions included a common set of core components. Specifically, all professional development conditions involved the same small-group online training that included all the essential elements of high-quality professional development outlined above. Teachers in the four professional development conditions were also provided with the same supplemental curricula and associated materials. Teachers in the four professional development conditions also administered the same CBMs. The four professional development conditions differed in whether they included regularly scheduled in-classroom mentoring and whether they included detailed feedback regarding the progress monitoring data that included recommendations for grouping children and for instructional activities included in the supplemental curriculum. The study's design, which crossed mentoring and feedback conditions among the four professional development conditions and also included a business-as-usual control group, allowed us to test for the main effects and interaction effects of mentoring and detailed feedback and to compare each of the professional development groups with the control group. Before implementing the main study, all core components and condition-specific components of the professional development programs were field tested locally as part of a feasibility pilot (described below). We hypothesized that the main evaluation study would demonstrate effectiveness of the core professional development program and each of the supplemental components (i.e., in-classroom mentoring and instructionally linked feedback concerning children's academic progress).

Method

Feasibility Pilot Project

A pilot project was conducted locally with 25 teachers to examine the feasibility of small-group, facilitated, online professional development with teachers in early childhood education settings. All small-group training sessions were attended by the project manager to identify areas in need of change and the amount of specificity that needed to be included in the facilitator guide. The goals of the pilot study were to determine feasibility of (a) access to computer labs for small-group training sessions, (b) school programs' providing time for teachers to attend the classes, (c) teachers' willingness to attend classes, (d) teachers' comfort with Internet-based training, (e) teachers' willingness to post their efforts to try activities in their classrooms and to engage in online discussion outside of class, and (f) implementation of trained activities in classroom settings.

The pilot study highlighted a number of aspects of the program that needed to be changed or refined. For one, it was not possible for the early childhood educators to be relieved of their teaching responsibilities during work days. So, the small-group professional development sessions had to be held after hours. Therefore, it was deemed necessary to compensate teachers for their attendance with a stipend or college credit. It was also discovered that more detailed training materials were needed to ensure consistency of course content across small-group facilitators. Other necessary refinements included greater specificity of frequency of specific professional development activities, timelines for progress monitoring, and teacher availability for mentoring to ensure the project's fidelity. Finally, the pilot study brought to light that facilitators should have teaching experience in the early childhood field and that they should not have competing, nonstudy responsibilities.

Research Design of Main Study

After conclusion of the feasibility pilot, we conducted a randomized experimental study to evaluate the effectiveness of four overlapping professional development programs relative to a business-as-usual control group. The programs overlapped in that teachers in all four programs received the same small-group, facilitated online training (see *Online professional development* section, below). They were also provided with the same Center for Improving the Readiness of Children for Learning and Education (CIRCLE) Preschool Early Language and Literacy Training manual and supplemental CIRCLE curricular materials (Center for Improving the Readiness of Children for Learning and Education, 2006). Teachers in the four professional development conditions also administered the same CBMs. The research design additionally allowed for evaluation of the value added by regularly scheduled in-classroom mentoring and by immediate, instructionally linked feedback from progress monitoring. Finally, the 2 × 2 research design permitted examination of the interaction between mentoring and instructionally linked feedback. Specifically, participating schools were randomly assigned to one of five experimental conditions: (a) mentored with personal digital assistant (PDA)-based progress monitoring (detailed feedback), (b) nonmentored with PDA-based progress monitoring, (c) mentored with paper-and-pencil progress monitoring (limited feedback), (d) nonmentored with paper-and-pencil progress monitoring, or (e) control. Observation of teachers' behavior during classroom instruction and testing of children's literacy and language outcomes were conducted in the beginning of the school year and again at the end of the school year. Therefore, changes in teaching behaviors and children's school readiness could be attributed to experimental condition and associated components of the professional development programs.

Participants

This multisite study took place in Ohio, Maryland, Florida, and Texas. Classrooms in Ohio, Maryland, and Florida participated in the project during the 2004–2005 school year. Classrooms in Texas participated during the 2005–2006 school year. Across the four sites and 2 years, participants included 262 early childhood educators who were housed in 158 schools. These teachers were distributed across the sites as follows: Ohio, $n = 65$; Maryland, $n = 59$; Florida, $n = 65$; and Texas, $n = 73$. Participating schools primarily served children and families from low-SES backgrounds. Demographic characteristics of participating early childhood educators and classrooms are summarized in Table 1.

To be eligible for participation, early childhood educators were required to follow a published curriculum, but they were not required to follow any particular published curriculum. Curricula represented in participating classrooms included Creative Curriculum with training in Ohio, DLM Express with training in Maryland, Creative Curriculum online and some home-grown curriculum activities in Florida, and Scholastic's Building Language and Literacy and DLM Express in Texas. In general, the curricula used in control and intervention classrooms incorporated a scope and sequence for language and literacy learning activities that was implemented in a purposeful but playful way. The professional development model was created so that it could be used with a broad range of curricula, as participating programs in this intervention were allowed to choose their classroom curriculum.

Parents from participating classrooms were sent information letters and consent forms. From among those who returned signed consent forms, up to eight children were randomly selected from each classroom to participate in the assessments that informed the evaluation. Across the four sites, selected children ranged in age from 3 to 5 at the time of pretesting ($M = 4.3$, $SD = 0.5$). The sample of 1,786 children was 50% boys. Approximately 42% of

Table 1
Classroom and Teacher Characteristics by Study Site

Characteristic	Florida ($n = 65$)	Maryland ($n = 59$)	Ohio ($n = 65$)	Texas ($n = 73$)	$p <$
Classroom type (%)					.0001
Public school	0	74	0	38	
Head Start	27	26	100	37	
Child care	73	0	0	25	
Language of instruction (%)					.0001
English	40	96	100	85	
Spanish	60	4	0	15	
Length of day (%)					.0001
Full day	88	96	35	77	
Half day	12	4	65	23	
Teacher education (%)					.0001
High school/CDA	97	0	26	23	
2-year college	3	0	40	30	
4 or more years college	0	100	34	47	
Teacher ethnicity (%)					.0001
African American	19	53	37	6	
Caucasian	6	42	60	22	
Hispanic	75	5	3	72	
Pre-kindergarten teaching experience					.13
Mean years (*SD*)	7.31 (6.6)	6.00 (6.2)	8.55 (6.0)	8.15 (6.7)	

Note. CDA = Child development associate.

the sample were Hispanic, 34% were African American, 17% were Caucasian, 2% were Asian, and 5% were other. English was spoken in the homes of 73% of participating children. Spanish was spoken in the homes of 32% of participating children, and a language other than English or Spanish was spoken in the homes of 5% of the sample. (Percentages are greater than 100% because some families spoke multiple languages in their home.)

Procedures Related to Implementation of Professional Development Programs

Project management and oversight. Pauline Monseque-Bailey, as project manager, supervised eight facilitators. There were two facilitators in each state. Facilitators were responsible for both facilitating the online group training and mentoring teachers who were assigned to mentoring conditions. Each facilitator had individual, weekly telephone conference calls with the project manager to review the project status at their site, ask questions, and address any concerns. In addition, a weekly conference call that included the facilitators across the sites and the project manager was conducted to encourage collaboration, build a facilitator network, and discuss the online platform. The project manager made several scheduled visits to each site to visit classrooms and observe online professional development sessions, called eCIRCLE (described in the *Online professional development* section). Additional visits were conducted to address issues when they occurred. Susan H. Landry, as principal investigator, also visited each site at least once. The research team at the University of Texas Health Science Center, along with researchers from the online course development team, held half-day meetings three times each year to review the status of the project.

Facilitators. Facilitators were required to have a background in early childhood education and to have an appreciation for the research process. At the beginning of the school year, facilitators also attended 4 days of training at the University of Texas Health Science Center. This training included CIRCLE's 2-day workshop, which informed the online professional development course (see *Online professional development* section, below). The 2-day workshop covered topics of classroom management; language-rich classroom environments; literacy-rich classroom environments; child development in areas of oral language, phonological awareness, letter knowledge, reading, and writing; and instructional strategies and activities that promote preschool children's language and literacy. Facilitators were introduced to the online professional development and the facilitator guide. The training also covered effective mentoring strategies, how to administer the CBMs, and how to use results from the CBMs to guide instruction.

The facilitators had two roles: One, to guide small groups of teachers through the online professional development course, and two, to mentor those teachers who were additionally assigned to receive mentoring. Each facilitator was responsible for around 30 teachers who attended the small-group online sessions twice per month. Approximately half of these teachers also received 4 hr of in-classroom mentoring each month. Separate training sessions were conducted for mentored teachers versus nonmentored teachers whenever possible.

Online professional development. The genesis of the online professional development program used in this study was the face-to-face training workshops developed by CIRCLE (Landry et al., 2006). Given the challenge of scaling up the professional development program across multiple states, the multiple-day workshops were adapted to be appropriate for an online application, called eCIRCLE. The nine courses covered the following topics: classroom management, best practices and responsive teaching, setting the stage for children's talk, reading aloud, phonological awareness, letter knowledge, mathematics, written expression, and language development. Consistent with theoretical frameworks, the online course involved (a) small-group interactive learning facilitated by a trainer, (b) extensive videotaped modeling of content-related activities and expert commentaries that allowed teachers to see examples in realistic contexts that were relevant to their classroom experiences, (c) interactive engagement with online coursework and online assessments of knowledge, (d) opportunity for independent review of all course content, (e) opportunity to practice specific skills within the small group (e.g., role playing and development of lesson plans), (f) practice of specific instructional activities in one's own classroom, (g) teacher postings of classroom experiences, and (h) trainer review of postings and feedback. The eCIRCLE online professional development program was developed to provide teachers with the appropriate balance between implementing developmentally appropriate activities that are teacher directed and designed to foster development of specific skills and implementing activities that are child directed and designed to allow children to enhance mastery and breadth of skills through active exploration. By acknowledging and working within teachers' existing philosophies of instructional practices, we expected that the program would be more effective in facilitating a high fidelity of implementation. Teachers in all four professional development conditions attended small-group eCIRCLE sessions (n = about16 teachers) that were facilitated by trained and experienced early childhood educators (see *Facilitators*, above). Teachers in the four professional development conditions attended 2-hr eCIRCLE classes twice per month for nearly the entire school year.

Mentoring. Mentoring is a complex and multidimensional process of guiding teaching practices and influencing and supporting teachers. The goal of this professional development was to provide opportunities in an interconnected way that helped teachers work through roadblocks, discuss instructional strategies, and discuss how instruction changes and develops over time.

During initial classroom visits, the facilitators assessed the instruction being used in the classroom and evaluated the classroom environment using the Teacher Behavior Rating Scale (TBRS; Landry, Crawford, Gunnewig, & Swank, 2001). Subsequent mentoring visits consisted of helping teachers with classroom arrangement, instructional lessons, and instructional planning. Facilitators also provided teachers with reflective follow-up designed to help the facilitator and teacher discuss positive instructional pieces and those that needed attention. Written feedback was provided using the CIRCLE Glows and Grows Mentoring Tool (Tuyman, Aston, & Gunnewig, 2001). Facilitators mentored teachers twice a month for 2 hr each visit.

Across the year, facilitators videotaped teachers during three activities: book reading, center time, and small-group instruction. The facilitators rated each videotape and provided feedback regarding how the teacher could improve his or her instructional skills. Data gathered from the videotaping session and a copy of

the video were sent to University of Texas Health Science Center. The project manager, Pauline Monseque-Bailey, reviewed these materials and provided written feedback to each of the facilitators. This was an effective strategy for supporting fidelity of implementation in a large, scale-up study. Through repeated use of the observation tool, facilitators were able to see how teachers developed an awareness of including quality literacy instruction over the course of a school year.

Progress monitoring. The CIRCLE–Phonological Awareness, Language, and Literacy Screener (C-PALLS) helps early childhood educators monitor how well their pupils are learning some of the major school readiness skills necessary for literacy acquisition. C-PALLS was administered by classroom teachers in all four of the professional development programs during the fall, winter, and spring. Teachers in all four professional development programs were encouraged to use C-PALLS results to help determine classroom grouping strategies, guide lesson planning, develop appropriate center activities, and inform parent–teacher conferences.

C-PALLS includes CBMs for phonological awareness, vocabulary, and letter knowledge. The Phonological Awareness screener evaluates a range of phonological awareness skills using short (six- to nine-item) untimed tasks. Skills evaluated include auditory discrimination, rhyme recognition, rhyme production, alliteration detection, sentence segmentation, syllable clapping, and onset-rime blending. For the separate Vocabulary and Letter Naming CBMs, children are asked to name as many pictures or letters as possible within 1 min. Scores from C-PALLS demonstrate good reliability and validity, in relation to their brevity (Swank et al., 2006). For example, 3-month test–retest correlations range from .79 to .86, internal consistency of the phonological awareness screener is .93, and correlations of scores from C-PALLS CBMs with scores from standardized measures of like constructs range from .40 to .80. Moreover, scores from C-PALLS CBMs have been shown to be sensitive to individual differences in rates of growth and classroom differences in rates of growth.

For two professional development conditions, the PDA version of C-PALLS was used by teachers, whereas in the other two professional development conditions the paper-and-pencil version of C-PALLS was used. The paper-and-pencil version requires that the teacher (a) tabulate scores for each child; (b) develop and maintain a tracking system to monitor individual children's change in scores over time; (c) use a high, medium, or low categorization of children's skills as outlined in the manual to cluster children for small-group instruction; and (d) choose appropriate activities for small-group instruction from the CIRCLE training manual. Within a week of each progress monitoring wave, teachers who used the paper-and-pencil version were provided a spreadsheet of children's scores for that particular wave. In contrast, the PDA version of C-PALLS completes all four of the steps above as part of the software programming. Content experts had predetermined which activities from the CIRCLE manual were appropriate for children of different skill levels within each school readiness domain. Thus, the amount of effort and skill required by teachers in the paper-and-pencil conditions was considerably more than that required by teachers in the PDA conditions. Of course, the PDA version also systematically guided teachers through the assessment procedures, assuring standardized administration.

Measures Used for Program Evaluation

Teacher outcomes. Seventy-five teachers evenly distributed across the four sites and five experimental conditions were randomly selected for observation. Each of the 75 teachers was observed for about 120 min early in the school year, before any professional development. Each was observed again for about 120 min at the end of the school year, after completion of the professional development program. Observations typically occurred in one session with the exception of a few instances when the daily schedule was disrupted (e.g., field trips or class party). Observers were unaware of classrooms' study condition.

Observers used the CIRCLE TBRS (Landry et al., 2000) to rate the quality and frequency of occurrence of specific teaching behaviors. The TBRS contains multiple subscales with a total of 50 items measuring multiple indicators of teaching behaviors. For the following subscales, quantity and quality summary scores are obtained: Oral Language, Book Reading, Print and Letter Knowledge, Written Expression, Phonological Awareness, and Total Composite, combining all individual subscales. For the Lesson Plan and Portfolio subscales, only a quantity score is obtained, and for the Centers subscale, only a quality score is obtained. Quality scores are based on a 3-point rating scale (i.e., low, medium, and high). Quantity scores are based on a 3-point rating scale, on which a score of 1 indicates *0–1 activities observed,* 2 indicates *2–3 activities observed,* and 3 indicates *4 or more activities observed.* An exception is the Portfolio quantity score, which involves a 5-point rating system. Specifically, portfolios of five children from a classroom are randomly selected for review. The highest score reflects that work samples across three skill areas were included in at least four of the five portfolios reviewed. Generalizability coefficients, which index interrater reliability for the various subscales, are high, ranging from .80 to .98 (Mitchell, 1979). Internal consistency also is high (.96). Although significant correlations between subscales are found, these are not so high that the information is redundant (Assel, Landry, & Swank, 2007).

Child outcomes. Examiners spent time talking with each child in a playful manner to help him or her become comfortable with the assessment process. Children were usually assessed across multiple visits to avoid fatigue. Children took frequent breaks for toileting, snacks, and/or to allow for movement. Children were assessed in the language of their instruction if instruction was predominately delivered in English or Spanish. For classrooms with bilingual instruction, teachers were interviewed by an examiner who used a standard set of questions to ask about each child selected for testing. From the structured interview data, a determination was made to test individual children in English or Spanish. Child outcomes included scores on tests of vocabulary, composite language, phonological awareness, letter knowledge, and print awareness.

The Expressive One-Word Picture Vocabulary Test (EOWPVT; Brownell, 2000) was used to measure children's expressive vocabulary. There are English and Spanish versions that are appropriate for examinees ages 2 to 18. Both versions present examinees with stimulus pages containing a colored picture that depicts an action, object, category, or concept. Examinees are asked to label each picture. Internal consistency values for 2- to 5-year-olds range from .93 to .98, depending on index of internal consistency. Test–retest reliabilities over a 20-day interval are .88 and .89 for 2- to

4-year-olds and 4- to 7-year-olds, respectively. A number of studies have shown concurrent correlations of EOWPVT scores with scores from other language measures that range from .64 to .87 and concurrent correlations of EOWPVT scores with scores from other vocabulary measures that range from .67 to .90 (Brownell, 2000).

The Auditory Comprehension subtests of the English and Spanish versions of the Preschool Language Scale—fourth edition (PLS–4; Zimmerman, Steiner, & Pond, 2002) were used to assess complex receptive language. These measures are highly sensitive to changes in young children's language development in response to teacher enhancement projects (Landry et al., 2006). Test–retest reliabilities over a 1-week time span are .87 and .95. Internal consistency ranges from .91 to .93. Validity of PLS–4 scores has also been established by correlating them with scores on other measures of language and accurately identifying children with differences in language development (Zimmerman et al., 2002).

English and Spanish versions of the Developing Skills Checklist (DSC and La Lista, respectively) evaluate a range of skills that develop during preschool and kindergarten ("Developing Skills Checklist," 1990). For this study, the Auditory Analysis subtests were used to assess phonological awareness. Items evaluate the following phonological awareness skills: rhyme recognition, segmentation of sentences into words, segmentation of compound words into words, and segmentation of words into syllables. Items also evaluate speech perception for phonemes by asking children whether two stimulus words are the same or different. Auditory Analysis does not assess higher levels of phonological awareness, such as blending or deletion of onset and rime or phonemes. The Kuder-Richardson reliability coefficient for this subtest is .84, and the standard error of measurement is 1.87 ("Developing Skills Checklist," 1990).

The Preschool Comprehensive Test of Phonological Processing (PCTOPPP; Lonigan, Wagner, Torgesen, & Rashotte, 2003) was designed as a downward extension of the Comprehensive Test of Phonological Processing (Wagner, Torgesen, & Rashotte, 1999). PCTOPPP provides assessment of phonological processing and print knowledge, the latter of which was included in this study. The Print Awareness subtest assesses children's knowledge of print concepts, letter discrimination, word discrimination, letter-name knowledge, and letter-sound knowledge. Internal consistency for the Print Awareness subtest is moderate to high for 3- to 5-year-old children (i.e., αs $=$.89 to .95, respectively), as are test–retest reliabilities (rs $=$ .50 to .90) and validity coefficients (rs $>$ .43; Lonigan et al., 2003).

Results

Approach to Data Analyses

The overarching approach we took to examine the effectiveness of the professional development programs was to predict end-of-year outcomes from experimental group membership while statistically controlling for variability in beginning-of-the-year scores on the outcome measures. This tends to be the most powerful approach to analyzing repeated measures data when pretest and posttest scores are correlated. This approach translates to analysis of covariance (ANCOVA) of teachers' behavior outcomes and to multilevel ANCOVA of children's language and literacy outcomes. In the latter case, we used multilevel ANCOVA to account for the lack of independence among observations, given that children were nested in classrooms. In analyses of both teacher and child outcomes, a priori contrasts had been specified. A priori tests included (a) control group versus professional development groups collectively, (b) control group versus each of the four professional development groups individually, (c) two mentored groups combined versus two nonmentored groups combined, (d) two PDA groups combined versus two paper-and-pencil groups combined, and finally (e) a test of the interaction between the mentoring and PDA conditions. All the contrasts except (b) are independent.

Teacher Behavior Outcomes

We used general linear modeling, specifically ANCOVA, to predict teachers' TBRS scores at the end of the year from experimental condition and teachers' pretest scores. Because pretest differences were covaried, only teachers who provided both pretest data and posttest data were included in analyses. Thus, sample sizes ranged from 62 to 69 depending on the number of teachers with both pretest and posttest data on each separate TBRS scale. No differences in pretest scores were found between teachers who had both pretest and posttest data and teachers who had only pretest data. Interactions between group and pretest scores, which reflect moderation of the intervention effects, were tested and if found significant were retained in the models. The effect sizes (ESs) reported were based on the difference between posttest means that were adjusted for covariates and interactions, if present, and then divided by the pooled pretest standard deviations of the groups.

Although most teacher behavior outcomes were normally distributed, six TBRS scores remained significantly skewed at posttest (i.e., quantity and quality of writing instruction, quantity and quality of phonological awareness instruction, and quantity and quality of child portfolios). Because these instructional behaviors were so infrequently observed, they were recoded as observed or not observed. To appropriately model these data, we used generalized linear modeling with a logit link function to predict outcomes having a binomial distribution (i.e., no–yes). Scores for these three areas represent the proportion of teachers rated as *yes*. Table 2 summarizes the content of each subscale, the anticipated quantity and quality scores, and the expected means by study condition.

Overall teaching quantity. Collectively, teachers in the four intervention groups demonstrated significantly more positive teaching behaviors across academic domains than did teachers in the control group, $t(69) = 2.45$, $p < .05$, ES $= 0.86$ (Figure 1, top). Collectively, the two professional development groups who used the PDA-based progress monitoring tool were observed teaching more than the two professional development groups who used the paper-and-pencil–based progress monitoring tool, $t(69) = 2.27$, $p < .05$, ES $= 0.64$. In addition, the professional development group who received both mentoring and the PDA demonstrated more teaching than the professional development group who received mentoring but no PDA, $t(69) = 1.97$, $p < .05$, ES $= 0.79$. Individual group comparisons also showed that teachers in the two professional development groups who received detailed feedback from the PDA-based progress monitoring tool were observed engaging in more teaching than teachers in the control group, ts$(69) = 3.29$ and 2.28, ps $< .001$ and .03, ESs $= 1.40$ and 0.96, for mentored PDA and nonmentored PDA groups, respectively.

Table 2
Teacher Behavior Rating Scale Subscale Expected Means by Study Condition

Subscale and pretest score	Control	Mentor + PDA	Mentor + P/P	PDA only	P/P only
Total teaching:[a] Summary scores obtained by averaging across subscale scores.	1.38	1.68	1.51	1.59	1.48
Quantity					
Quality					
Low	1.62	2.40	1.97	2.07	2.22
Mean	2.07	2.53	2.35	2.40	2.28
High	2.52	2.66	2.72	2.72	2.33
Phonological awareness:[b] Provides activities that follow the sequence of the developmental continuum with evidence that activities are integrated into other learning situations.					
Quantity	0.00	0.36	0.42	0.25	0.29
Quality	0.08	0.75	0.53	0.18	0.47
Writing instruction:[b] Teacher provides modeling and a variety of opportunities and materials to support this early skill.					
Quantity	0.02	0.11	0.04	0.08	0.04
Quality	0.04	0.26	0.11	0.14	0.17
Book reading:[a] Teachers expected to demonstrate two or more discussions about book features, vocabulary words, and details related to the book.					
Quantity	1.67	2.04	1.85	2.05	1.89
Quality	2.13	2.57	2.47	2.56	2.32
Print and letter knowledge:[a] Engages children in topic-related activities that promote letter–word knowledge and help them learn to associate names of letters with shapes and/or begin to make sound–letter matches. Teachers expected to show two or more examples of activities to promote this skill.					
Quantity	1.38	1.87	1.60	1.65	1.57
Quality	1.73	2.44	1.91	2.19	1.93
Play and learning centers:[a] Number of centers with clear boundaries that cover critical learning activities and objectives linked to the theme with rotation/refreshment of materials. Teacher explains routine to children regarding entering centers, moving between centers, etc.					
Quality					
Low	1.50	2.48	1.76	1.98	2.36
Mean	2.07	2.57	2.12	2.37	2.16
High	2.64	2.65	2.49	2.74	1.96
Lesson plan:[a] Evidence that theme-related materials and activities are linked to learning objectives. Teacher is observed implementing lesson-plan activities.					
Quantity					
Low	1.24	1.74	1.54	1.75	1.88
Mean	1.78	2.24	2.01	2.13	1.69
High	2.32	2.74	2.49	2.51	1.51
Portfolios:[b] Adequate use of portfolios as samples of work was seen in at least three portfolios.					
Quantity	0.16	0.56	0.34	0.46	0.66
Oral language:[a] Encourages children's use of language by modeling language, asking questions, and/or making comments; engaging children in conversations. Teachers expected to show at least two to three examples of this language support.					
Quantity	1.76	2.03	2.02	2.01	1.93
Quality	2.42	2.77	2.62	2.69	2.5

Note. PDA = progress monitoring with the personal digital assistant (PDA) system; P/P = progress monitoring with paper and pencil; P/P only = no mentor condition. Pretest score: Expected quantity and quality scores are >2 unless otherwise noted. Results that are related to pretest score are indicated where low = 1 standard deviation below the mean, *M* = average score, high = 1 standard deviation above the mean.
[a] Based on 3-point rating scale. [b] Based on percentage of teachers coded as demonstrating instructional practice; expected scores for quality and quantity > .60.

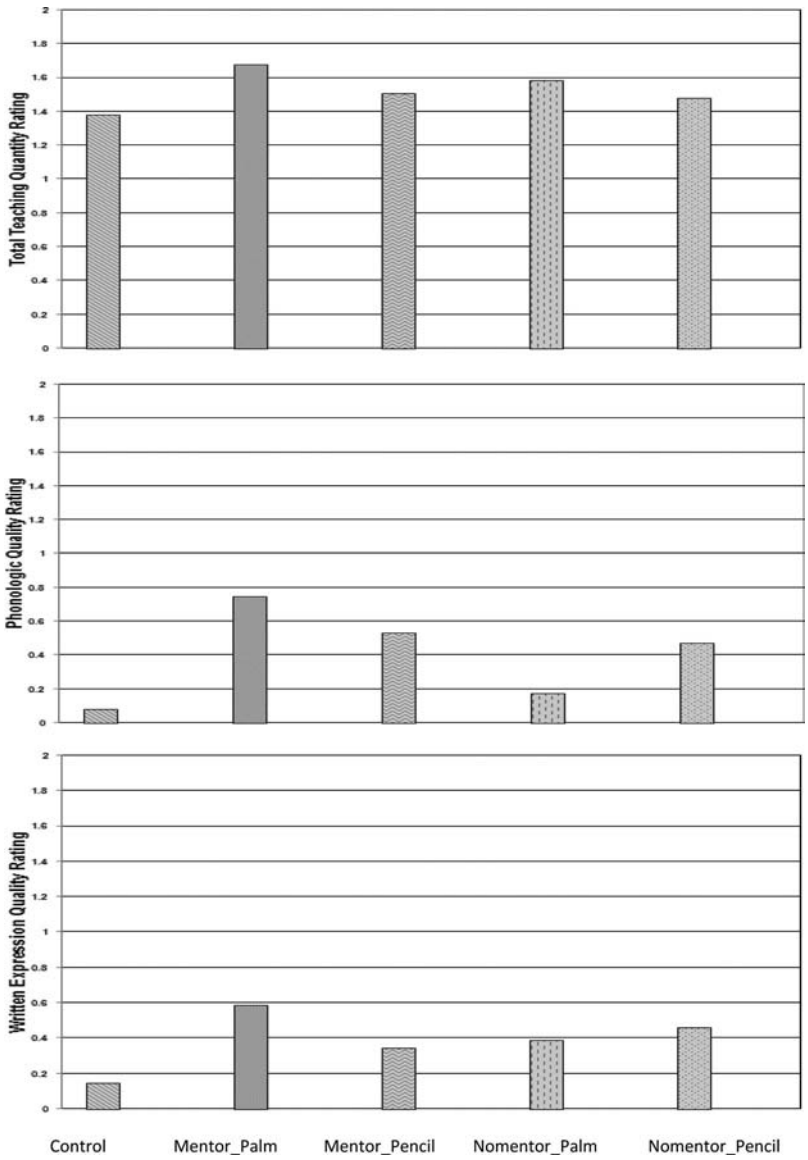

Figure 1. Quantity of total positive teaching behaviors (top), quality of phonological awareness instruction (middle), and quality of written expression instruction (bottom) by study condition collapsed across sites.

Overall teaching quality. The effects of the professional development programs on overall teaching quality at the end of the year were moderated by teaching quality at the beginning of the year, $t(65) = 2.54$, $p < .05$. Interpreted another way, the naturally strong relation between quality of teaching at the beginning of the year and quality of teaching at the end of the year was interrupted by the interventions. Specifically, there was a trend toward a stronger pretest effect in the control group than in the four intervention groups combined, $t(65) = 1.65$, $p < .10$. This trend was driven by a pretest effect in the control group that was significantly stronger than those in the mentored PDA group and the nonmentored paper-and-pencil group, $ts(65) = 1.95$ and 2.42, $ps < .05$ and .01, respectively. The Group × Pretest interaction revealed that the four professional development programs were most beneficial for teachers who evidenced poor quality teaching or only average quality teaching at the beginning of the year.

Even with the Pretest × Group interaction, teachers in the four intervention groups collectively still demonstrated higher quality teaching across academic domains than the control group across all levels of pretest, $t(65) = 2.14$, $p < .05$, ES = 0.76. Individual group comparisons showed that teachers in the professional development group who received mentoring plus PDA progress monitoring demonstrated teaching at the end of the year that was of significantly higher quality than that of teachers in the control group, $t(65) = 2.51$, $p < .01$, ES = 1.11. In fact, a significant Mentoring × Feedback interaction, $t(65) = 2.70$, $p < .01$, revealed that being provided with both a mentor and detailed feedback on children's progress was associated with the highest quality teaching and that being provided with neither a mentor nor detailed feedback was associated with the poorest quality teaching among intervention groups. Nonetheless, even teachers in the nonmentored, limited feedback inter-

vention group still demonstrated significantly higher teaching quality than teachers in the control group, $t(65) = 2.67$, $p < .01$, ES = 0.49.

Phonological awareness. When compared with control teachers, those across the intervention conditions showed higher quantity, $\chi^2(1, N = 75) = 8.80$, $p < .01$, ES = 0.76, and higher quality, $\chi^2(1, N = 75) = 7.19$, $p < .01$, ES = 0.91, of phonological awareness instruction. All comparisons of control teachers with teachers in individual professional development conditions showed a significantly higher quantity of phonological awareness instruction for intervention teachers, mentored PDA group, $\chi^2(1, N = 28) = 7.70$, $p < .01$, ES = 0.81; mentored paper-and-pencil group, $\chi^2(1, N = 27) = 9.05$, $p < .01$, ES = 0.91; nonmentored PDA group, $\chi^2(1, N = 29) = 5.17$, $p < .05$, ES = 0.64; and nonmentored paper-and-pencil group, $\chi^2(1, N = 27) = 6.01$, $p < .05$, ES = 0.70. With the exception of the teachers who were not mentored but had the PDA progress monitoring technology, those in all other intervention conditions showed higher quality implementation of phonological awareness activities when compared with control teachers, mentored PDA group, $\chi^2(1, N = 28) = 13.57$, $p < .001$, ES = 1.49; mentored paper-and-pencil group, $\chi^2(1, N = 27) = 6.69$, $p < .01$, ES = 1.03; and nonmentored paper-and-pencil group, $\chi^2(1, N = 27) = 5.25$, $p < .05$, ES = 0.90 (see Figure 1, center). When comparing teachers in the two intervention conditions with mentoring with teachers in the two intervention conditions without mentoring, results showed that mentored teachers had significantly higher quality phonological awareness instruction than those who did not receive mentoring, $\chi^2(1, N = 63) = 6.99$, $p < .01$, ES = 0.70.

Writing instruction. Relative to control teachers, teachers in all four of the facilitated online intervention conditions demonstrated higher quality instruction in written expression at the end of the year, $\chi^2(1, N = 75) = 4.10$, $p < .05$, ES = 0.43 (Figure 1, bottom). Teachers in the four professional development conditions also demonstrated a trend toward more frequent writing instruction at the end of the year than did control teachers, $\chi^2(1, N = 75) = 3.27$, $p < .07$, ES = 0.24. Those receiving mentoring plus the PDA technology that provided immediate detailed feedback regarding children's progress were observed engaging in more writing activities, $\chi^2(1, N = 28) = 5.32$, $p < .05$, ES = 0.42, and higher quality writing activities with their children, $\chi^2(1, N = 28) = 5.71$, $p < .01$, ES = 0.66, relative to control teachers.

Book reading. Results of comparisons on amount of shared reading performed by teachers in the four intervention conditions with the amount performed by teachers in the control group was in the expected direction and approached significance, $t(62) = 1.89$, $p < .06$, ES = 0.77 (Figure 2, top). This trend was driven by the two intervention groups who received PDA progress monitoring in that they demonstrated significantly more read-aloud activities than did teachers in the control group, $ts(62) = 2.04$ and 2.18, $ps < .05$, ESs = 1.00 and 1.02, for mentored PDA and nonmentored PDA groups, respectively.

Print and letter knowledge instruction. Relative to teachers in the control condition, teachers across all four intervention conditions showed higher quantity scores, $t(69) = 2.59$, $p < .01$, ES = 0.86, and higher quality scores, $t(69) = 2.48$, $p < .01$, ES = 0.75 (Figure 2, bottom). Furthermore, the two groups of teachers who received detailed feedback from PDA progress monitoring demonstrated more print and letter knowledge instruction than control teachers, $ts(69) = 3.61$ and 1.97, $ps < .001$ and .05, ESs = 1.46 and 0.79, for mentored PDA and nonmentored PDA groups, respectively. The two groups who received detailed feedback also demonstrated higher quality print and letter knowledge instruction than did control teachers, $ts(69) = 3.76$ and 2.48, $ps < .001$ and .01, ESs = 1.38 and 0.90, for mentored PDA and nonmentored PDA groups, respectively. When comparing teachers from the two PDA conditions with teachers from the two paper-and-pencil conditions, those who had the PDA that provided immediate detailed feedback showed higher quantity, $t(69) = 1.96$, $p < .05$, ES = 0.52, and higher quality, $t(69) = 3.22$, $p < .01$, ES = 0.78, print and letter knowledge instruction.

Play and learning centers. The effects of the professional development programs on quality of play and learning centers was moderated by the quality of learning centers at the beginning of the year, $t(65) = 3.09$, $p < .05$. Specifically, quality of centers at posttest was much more closely related to quality of centers at pretest in the control group than in the four intervention groups, $t(65) = 1.88$, $p < .06$. The nature of the Pretest × Group interaction was such that the professional development programs were most beneficial for teachers who had low-quality centers or average-quality centers at the beginning of the year.

Even with the Pretest × Group interaction, teachers in the four intervention conditions collectively still had higher quality centers at posttest than teachers in the control group across all levels of pretest, $t(65) = 2.27$, $p < .05$, ES = 0.43. Individual group comparisons found that the group of teachers who received mentoring and the PDA progress monitoring tool had better play and learning centers at the end of the year than did the control group, $t(65) = 2.31$, $p < .05$, ES = 0.91. Individual group comparisons also found that the group who received no mentoring and the paper-and-pencil progress monitoring tool had higher quality centers at posttest than the control group across all levels of pretest, $t(65) = 3.12$, $p < .01$, ES = 0.17.

Lesson plans. Collectively, teachers in the four intervention groups were found to have significantly more lesson plans by the end of the year than teachers in the control group, $t(65) = 1.99$, $p < .05$, ES = 0.41. Interestingly, the two professional development groups who received regular mentoring were observed to have more written documentation of planned instructional activities than teachers in the two professional development groups who did not receive mentoring, $t(65) = 2.15$, $p < .05$, ES = 0.56.

Portfolios. Relative to control teachers, teachers across the four intervention conditions that included online professional development composed higher quantity portfolios of children's work samples and progress, $\chi^2(1, N = 75) = 5.39$, $p < .05$, ES = 0.67. Teachers who were mentored and received detailed feedback concerning children's academic progress had higher quality portfolios than did control teachers, $\chi^2(1, N = 28) = 4.96$, $p < .05$, ES = 0.77. Also, teachers who were not mentored and who received limited feedback concerning children's academic progress had higher quality portfolios than did control teachers, $\chi^2(1, N = 27) = 7.02$, $p < .01$, ES = 0.98.

Oral language instruction. Although in the expected direction, no significant differences were found between the study conditions on oral language instruction quantity or quality scores.

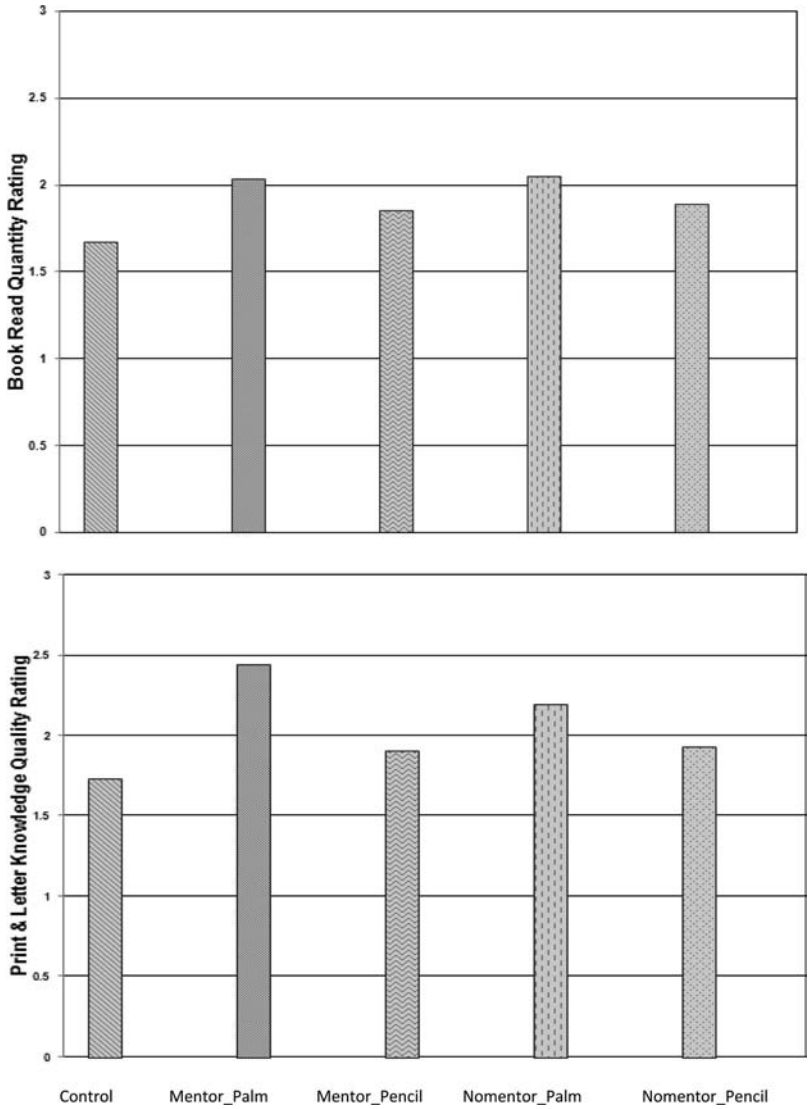

Figure 2. Quality of book reading (top) and print and letter knowledge activities (bottom) by study condition collapsed across sites.

Children's Language and Literacy Outcomes

We used multilevel ANCOVA to predict the scores that children obtained on the language and literacy measures at the end of year. Level 1 included fixed effects of children's pretest score on the outcome measure, amount of time between pretest and posttest, children's chronological age, language of test administration, and any significant interactions among these covariates and experimental condition. Level 1 also included a random intercept to account for children's classroom membership. We found the random effect of classroom membership to be a significant predictor of all child outcomes and therefore retained it in all models. Level 2 included a fixed effect of site and a Site $\times$ Experimental condition interaction if significant. Level 2 also included the fixed effects of experimental condition via inclusion of a priori contrasts of groups' effects on classrooms' average performances.

Because pretest differences were covaried, we included only children who provided both pretest data and posttest data for a given outcome measure in analyses. Thus, sample sizes ranged from 1,607 to 1,678. There were no significant pretest differences between children with complete data and children with only pretest data on tests of receptive language, phonological awareness, or print knowledge. However, children missing posttest data scored 1 to 2 raw score points lower on average on the expressive vocabulary measure (i.e., EOWPVT).

Vocabulary. There were no significant interactions of study condition with any of the covariates. A priori group contrasts revealed that the two PDA progress monitoring groups had significantly higher EOWPVT posttest scores than the two paper-and-pencil groups, $t(237) = 2.18$, $p < .05$, ES $= 0.15$ (Figure 3). The interaction between the mentoring and progress monitoring con-

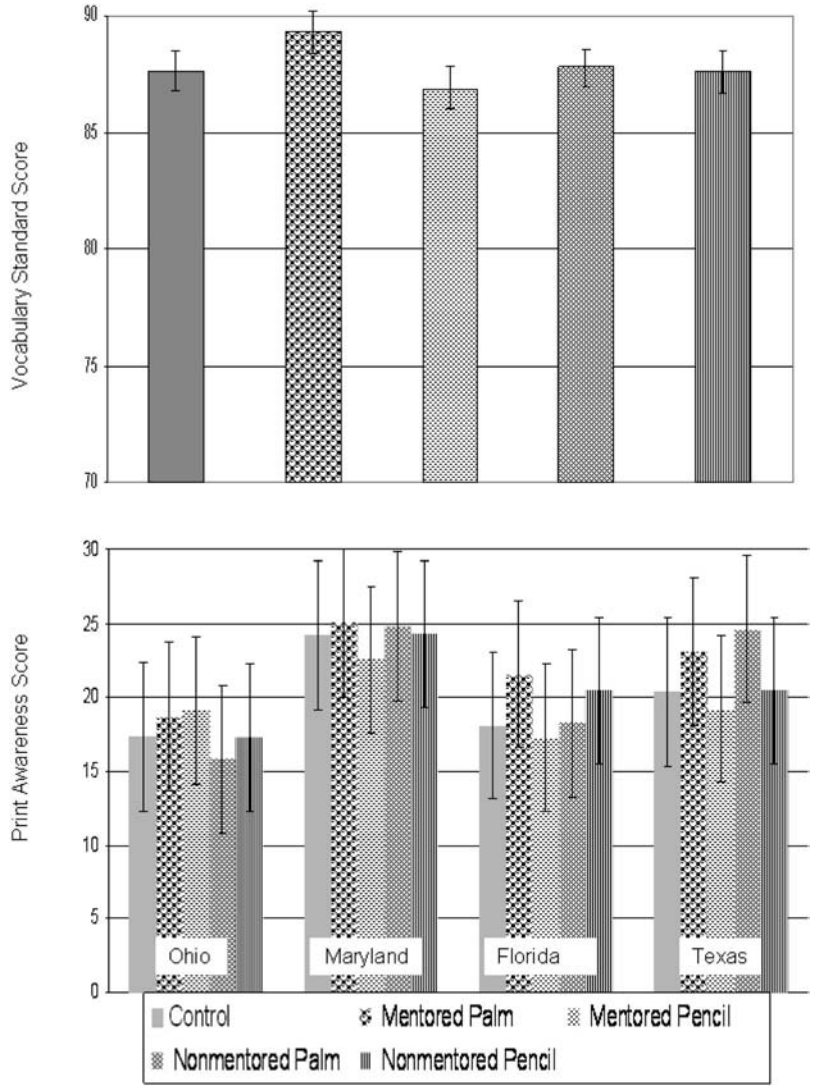

Figure 3. Standard scores on the Expressive One Word Picture Vocabulary by study condition (top) and letter knowledge by study condition and site (bottom).

ditions approached significance, $t(239) = 1.81$, $p < .07$, and favored those children whose teachers were mentored and received the PDA progress monitoring technology. In fact, this group of children had significantly higher posttest scores than the control group, $t(254) = 2.08$, $p < .05$, ES = 0.19 (see Figure 3).

Letter knowledge and print awareness. Analysis of children's end-of-year print awareness scores revealed a significant Intervention Condition × Site interaction, $F(12, 248) = 2.54$, $p < .01$ (Figure 3). There was also a significant Group × Pretest interaction, $F(4, 1635) = 4.58$, $p < .001$, in which pretest scores were less related to posttest scores for children in the intervention conditions compared with the control group. Thus, the intervention had more to do with child outcomes than did the child's initial letter knowledge ability. The results illustrated are across all levels of pretest. Examination of comparisons within each site showed that in Texas the two groups that received detailed feedback from PDA progress monitoring had better print awareness than children in the control condition, $t(227) = 2.17$, $p < .05$, ES = 0.15, and $t(213) = 3.54$, $p < .001$, ES = 0.47, for the mentored PDA and nonmentored PDA groups, respectively. Collectively, Texas children in these two PDA groups also had higher letter and print knowledge scores at the end of the year than did children in the two groups who received only limited feedback from paper-and-pencil progress monitoring, $t(229) = 4.38$, $p < .0001$, ES = 0.44. In Florida, there was a significant Mentoring × Progress Monitoring interaction, $t(252) = 3.18$, $p < .001$, ES = 0.75, that favored children in the mentored PDA group versus the nonmentored PDA group. In fact, Florida children whose teachers received both mentoring and detailed feedback from the PDA had higher print awareness scores at the end of the year than did Florida children whose teachers were in the control condition, $t(282) = 2.56$, $p < .01$, ES = 0.20. In Ohio, children in the two conditions in which teachers received mentoring achieved higher end-of-year print awareness scores than did children of nonmentored teachers,

$t(266) = 2.45$, $p < .01$, ES = 0.75. Across sites and pretest levels, there was a significant Mentoring × Progress Monitoring interaction, $t(238) = 2.41$, $p < .01$, ES = 0.26, that favored children in the mentored PDA group. Also, collectively children in the two PDA groups achieved higher end-of-the-year letter knowledge than did children in the two paper-and-pencil groups, $t(247) = 2.86$, $p < .01$, ES = 0.16.

Phonological awareness. There were no significant interactions of study condition with any covariates. Collectively, children in all four professional development conditions had significantly higher posttest scores on the DSC/La Lista than did children in the control group, $t(241) = 2.12$, $p < .05$, ES = 0.14. When comparing individual intervention groups with the control group, children of teachers in the nonmentored PDA progress monitoring group had significantly higher posttest scores than did children in the control group, $t(230) = 1.96$, $p < .05$, ES = 0.16.

Composite language. We found a significant Study Condition × Site × Pretest interaction, $F(12, 1566) = 3.97$, $p < .0001$, for PLS–4 scores, indicating that the effects of the professional development programs on children's oral language were moderated by their pretest oral language levels and site differences. Across the study conditions, the moderating effects of children's pretest language abilities were stronger in Texas than all other sites, $t(1570) = 2.11$, $p < .05$. In Florida, the moderating effects of pretest language abilities were weaker than all other sites, $t(1530) = 4.27$, $p < .0001$. The weaker effect of pretest language scores in Florida was because these pretest scores were less related to children's end-of-year composite language scores if their teachers were in one of the four professional development programs, $t(1314) = 3.29$, $p < .001$. There was a Control versus Mentored PDA by Pretest interaction, $t(1435) = 2.38$, $p < .05$, ES = 0.51. These results suggest that the intervention moderated the effect of children's initial language abilities for understanding their gains in language across the school year. In other words, amount of growth in language was less dictated by children's initial language ability if the children were in the mentored PDA group.

In Maryland, there was a significant Mentoring × Feedback × Pretest interaction, $t(1609) = 3.02$, $p < .01$, ES = 0.84 (Figure 4). This interaction demonstrated that children's oral language skills were benefited most if they had limited oral language at the beginning of the year and had teachers who were both mentored and received detailed feedback from the PDA (see Figure 4). There was also a Control versus Mentored PDA × Pretest interaction, $t(1616) = 3.84$, $p < .0001$, ES = 0.61. This demonstrated that there was less of a pretest effect in the mentored PDA group than in the control group.

In Ohio, children in the mentored groups had higher end-of-year PLS–4 scores than did children in the nonmentored groups, $t(290) = 2.89$, $p < .01$, ES = 0.24. However, the control group had higher PLS–4 scores than the four intervention groups combined, $t(250) = -3.33$, $p < .001$, ES = 0.26. This finding was largely because the control group had higher PLS–4 scores than the two nonmentored groups, $t(232) = -3.89$, $p < .0001$, ES = 0.37, and $t(238) = -4.02$, $p < .0001$, ES = 0.41, for the nonmentored paper-and-pencil group and nonmentored PDA groups, respectively. The controls were comparable to the two mentored intervention groups.

Discussion

The findings from this four-site experimental study show that research-based best practices can be scaled in typical child care and early childhood education settings via high-quality, ongoing professional development. The findings also demonstrate that professional development programs are most effective when they are comprehensive and well integrated. This study provided clear evidence for such a professional development program for teachers of at-risk prekindergarten children across multiple types of early childhood settings.

Gains in Teachers' Instructional Practices

The most powerful of the four professional development approaches for understanding greater increases in teachers' practices was the most comprehensive and well-integrated approach that involved having teachers participate in a year-long online professional development course with classroom mentoring and with progress monitoring that provided immediate, instructionally linked feedback. This combination of professional development components provided teachers with opportunities to practice what they learned in their classrooms and to communicate regularly with other teachers participating in small-group learning and via online message boards. It also provided weekly mentoring over the course of a year and detailed feedback on individual children's academic progress along with recommended child groupings and instructional activities. Teachers who received this comprehensive professional development package became better teachers. That is, they improved the overall quality of their teaching and specifically the quality and frequency of their instruction of early writing, phonological awareness, letter knowledge, and shared reading. They also showed more effective center-based instruction and kept more complete portfolios on children. In general, teachers who received the most comprehensive package were demonstrating shared reading and early literacy instruction at or above expected frequencies and/or levels of quality. Differences between teachers in this comprehensive condition versus those without the professional development program were of high practical significance because effect sizes were consistently moderate to large.

The effectiveness of the most comprehensive approach on the full range of instructional practices was seen across all four sites. This is a particularly encouraging finding because there was considerable variability across the sites in factors such as the type of early childhood setting, teachers' cultural backgrounds, and level of teacher education, all of which might be expected to interact with program effectiveness. For example, in Maryland the classrooms were all in the public schools and all teachers had at least a 4-year college degree. Historically, there had been a focus by administrators on improving the quality of the prekindergarten program to better prepare children from low-income families to enter kindergarten with age-level language and early literacy skills. In contrast, the classrooms in Florida were in childcare settings, and most of the teaching staff did not have a 2- or 4-year college degree. Also, the programs in Florida did not have as strong a mandate to support children to be school ready in cognitive skills. Ohio classrooms were all part of the National Head Start program, and like Florida teachers, the majority did not have 4-year degrees. However, unlike Florida, Ohio classrooms had a specified set of

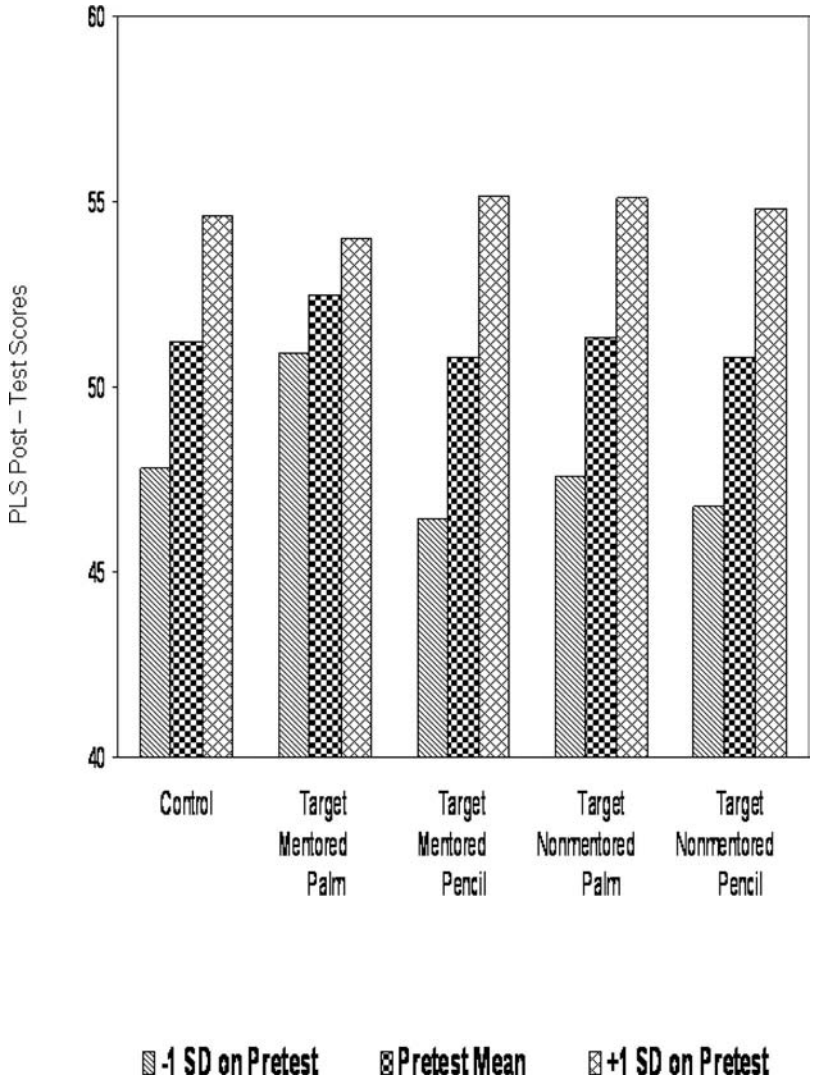

Figure 4. Relation between children's pretest and posttest scores on Preschool Language Scales (PLS) at the Maryland site.

school readiness standards and practices as part of the program's culture. Finally, the classrooms in Texas included a relative balance of the three types of settings found in the other three sites. In spite of these differences, the professional development program was equally effective in changing teaching practices across sites because there was no Professional Development Program × Site interaction. Thus, although teachers' initial scores on the TBRS may have varied across the sites, the comprehensive program resulted in similar gains in instructional practices.

Although the online program with the PDA progress monitoring approach consistently showed strong effects, the efficacy of mentoring was not always apparent. Specifically, having a mentor did not increase program effectiveness when examining gains in teachers' book reading or print knowledge instructional practices. One possible explanation may be that implementing effective book reading and early literacy activities that promote print awareness skills may already be more familiar to the teachers, and the online course with the PDA monitoring may have been explicit enough in how to carry out these activities that mentors did not provide measurable additional support. Also, the Print Knowledge subscale of the TBRS was unique in showing a significant advantage of the PDA, with or without mentoring, over the paper-and-pencil approach. In both of these conditions, teacher quality of print knowledge instruction exceeded the expected criteria, and the frequency of instruction was, on average, just below the expected score. The information teachers received from the PDA on gains in children's letter and print knowledge and how to promote further learning may function as a technology mentor for this particular type of instruction.

Mentoring was found to be particularly important for increasing teachers' quality of phonological awareness and writing instruction. Teachers across all sites were not used to incorporating these instructional activities into their daily practices. Thus, modeling and coaching concerning strategies for these skill areas may be

more important than mentoring other areas of school readiness that teachers were more familiar with and incorporated at some level of competence. Although mentored teachers did evince better phonological awareness and writing instruction, the frequency of activities in these areas was still less than desirable.

Child Outcomes

Not only was the most comprehensive professional development effective in improving the quality of teaching and classroom environments, but it was also effective in promoting children's learning. Teachers who received the most comprehensive combination of integrated professional development components graduated children with better language comprehension, more advanced phonological awareness, larger breadth of expressive vocabulary, and more print and letter knowledge than children in control classrooms. These effects were both reliable and practically important because statistically significant and educationally meaningful improvements in children's school readiness were demonstrated. Furthermore, that the program yielded small to moderate effect sizes through only indirect intervention is impressive. That is, children's learning outcomes were appreciably improved through professional development of hundreds of teachers rather than through costly and labor-intensive direct intervention with thousands of children.

Unlike the findings for teachers' behaviors, there were findings for children's abilities that varied by site. For example, Texas children whose teachers had the online course with the PDA showed greater gains in letter and print knowledge than control children whether mentoring was part of the program or not. However, in Florida only children whose teachers had the most comprehensive approach showed a significant advantage in letter and print knowledge over control children. Because teachers in Florida, on average, had less education and the childcare centers had not been as focused on children's school readiness before this program, the addition of mentoring associated with the most comprehensive approach seems to have been more important for these Florida teachers to effectively support children's development of this important school readiness domain.

The effectiveness of the program in promoting children's general receptive language also varied across the four sites. The positive effects of the professional development programs on this multifaceted aspect of children's school readiness were most noticeable among children with low levels of language comprehension at the beginning of the school year. In Florida, the four professional development approaches were more strongly related to children's language outcomes than their pretest, or initial, language abilities. In Maryland, the intervention also had an effect on children's receptive language skills. However, at this site the effect was seen most strongly for the children who started the year with the lowest language skills and particularly when their teachers had the most comprehensive professional development program, the PDA progress monitoring plus in-classroom mentoring. Also overall, in Maryland the children whose teachers had the PDA instead of the paper-and-pencil approach had better language comprehension at the end of the year. In contrast, the effects of the professional development program on general receptive language were not as strong in Texas, and no effects were seen in Ohio. It is not clear why professional development effects on receptive language varied across sites. It does not seem related to teacher education levels because the two sites where effects were seen—that is, Maryland and Florida—had the biggest education discrepancy. That is, Maryland had the most educated teachers and Florida had the least educated teachers. These two sites also differed on children's home language. In Florida, most of the children were learning English as a second language because their home language was Spanish. In contrast, most of the children in Maryland came from English-speaking homes. In light of the fact that Maryland and Florida probably showed the biggest differences on all teacher, child, and classroom characteristics (e.g., school district vs. childcare and degree of school-ready focus), the current results demonstrate that the professional development program can be effective across diverse early childhood settings.

Technology as an Instrument of Change

The use of technology is thought to be an important key to the success of this professional development program. The Web-based instructional course was developed with extensive use of videotaped examples of how teachers could implement the activities in the classrooms. Each lesson had videotapes of experts in the field explaining the importance of the particular area of focus. Commentary guided learners to note key aspects of the classroom videos. Because the lessons also included text that explained course objectives and included links to learning activities, the facilitators did not need the same level of expertise to facilitate teachers' learning as they would without the online course. One question that was not addressed in this experimental study was whether the online course could be effective without a person facilitating small groups of educators. As the success of the program was thought to be a result, in part, of the network of learners established through the facilitation of a trainer or coach, a key component for CIRCLE professional development is a supportive relationship (Landry et al., 2006). The benefit of this relationship is further demonstrated in the many teaching practices that were most effectively facilitated with the addition of an in-classroom mentor.

Some of the most robust findings from this study concerned the benefits of the PDA-based progress monitoring tool. Use of mCLASS C-PALLS consistently resulted in improvements in teachers' instruction and children's learning. Although the actual assessments were identical, the PDA version of the CBMs provided teachers with immediate feedback about children's learning from one assessment to the next, and it provided comparisons across multiple skill areas for each child. Perhaps more important, the PDA version recommended how to group children from the same classroom into small groups and specific instructional activities to use for particular small groups of children. Extending the work of Fuchs, Fuchs, Hamlett, and Phillips (1994), who studied elementary school teachers' use of CBMs in mathematics instruction, this study demonstrated the usefulness of technology to help early childhood educators use CBMs to plan their language and literacy instruction.

Challenges to Bringing the Program to Scale

Similar to others' efforts to bring an educational program to scale, we learned many things that could inform future attempts in

this area. Because of the tight timelines to carry out federally funded research, adequate time is often not available to develop relationships with administrators and teachers before starting a study. However, commitment to the project from multiple levels of staff (e.g., superintendents, directors, coordinators, and teachers) is critically important. A common problem is the person at the highest level in the program believing in the importance of the intervention but not gaining support from others in the organization. Thus, it is important for the research group to talk and work with staff at all levels to explain the intervention, including discussion of the demands on a teacher's time and the level of commitment requirement to achieve effects.

Not surprisingly, the extensive use of technology needed to deliver this professional development program brought about unique challenges. Local and centralized supports for technology were essential. Challenges in this study included minor problems with the technology platform, locating computer labs for group sessions, and teachers' inexperience with computers and PDAs. These obstacles, though, were surmountable.

That the implementation of this project occurred across four states made assuring fidelity of implementation one of our greatest challenges. Nonetheless, the programs' efficacy was supported across four states with only limited oversight from the research group who developed it. Fidelity was supported through regular conference calls among the project manager and facilitators, as well as regular monitoring of teachers' postings of their experiences and questions. Although funding only allowed for infrequent visits to the sites to work directly with staff, these visits appeared to be important, and more visits may have supported stronger results.

Finally, that the professional development program did not mandate a particular curriculum was both an asset and a liability. The benefit of such an approach was that the program can be widely used and then individualized through mentoring. However, experience with classrooms that used curricula that did not have a strong focus on emergent literacy seemed to put those teachers at a disadvantage because they did not have readily available a scope and sequence of specific instructional activities that paralleled the objectives described in the online courses.

Limitations and Future Directions

It is important to note that this study demonstrated impacts on teachers' behavior, classroom environments, and children's learning within the same year that teachers received the professional development. Effect sizes tended to be moderate to large on teacher and classroom outcomes, but they were sometimes small on child outcomes (e.g., vocabulary and phonological awareness). As improving children's school readiness occurs further down the chain of linked events than does changing teachers' behavior, it will be important to assess effects of the programs after teachers participate for a second year. This will help determine whether an additional program "dose" provides an opportunity for teachers to hone their skills, which may result in even better child outcomes. In line with trying to find the best dosage of professional development, it may be that teachers with the least amount of experience or formal training in early childhood education require the most professional development. This study anecdotally found that the more comprehensive, or intensive, approach was necessary for the least competent teachers to change their instructional practices to an extent that advanced children's learning. Identification of recommended dosage levels for teachers of different competence levels is an important area for future study because it will help ensure that resources earmarked for professional development are appropriately allocated.

A major goal of this study was to determine whether a professional development program could be brought to scale across a diverse range of early childhood education settings. In three of the four sites, early childhood services were delivered in a specified way such that in any one site, only childcare, Head Start, or public prekindergarten were available for participation. In the fourth site, it was possible to have classrooms from all three types of programs. This meant that factors, such as teacher education, that are highly associated with the type of program delivery, were confounded by study site. It would take a much larger sample of classrooms within sites, stratified by teacher education, to most adequately address the question of whether the effectiveness of this professional development program varied by teacher education. Another area that may be important for understanding program effectiveness that was not specifically measured was teachers' philosophies, including their attitudes and beliefs. This may be an important area to examine in future research.

A second limitation was the inability to examine the extent to which curricula that have a specific focus on language and literacy would provide an additional advantage for understanding gains in prekindergarten children's learning. Recent studies of the efficacy of specific language and literacy curricula suggest that this may be an important factor (Assel, Landry, Swank, & Gunnewig, 2006). Finally, future research needs to address other factors (e.g., language of instruction for English language learning children and teacher–child ratios) that may play an important role in understanding variability in the effectiveness of professional development programs for preparing teachers to effectively support young children's language and literacy development.

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