Effects of an Early Literacy Professional Development Intervention on Head Start Teachers and Children

Article *in* Journal of Educational Psychology · May 2010

DOI: 10.1037/a0017763

CITATIONS
250

READS
4,580

4 authors, including:

Karen E. Diamond
Purdue University
66 PUBLICATIONS **2,399** CITATIONS

SEE PROFILE

Matthew J Koehler
Michigan State University
113 PUBLICATIONS **13,261** CITATIONS

SEE PROFILE

Journal of Educational Psychology
2010, Vol. 102, No. 2, 299–312

0022-0663/10/$12.00 DOI: 10.1037/a0017763

Effects of an Early Literacy Professional Development Intervention on Head Start Teachers and Children

Douglas R. Powell and Karen E. Diamond
Purdue University

Margaret R. Burchinal
University of North Carolina, Chapel Hill

Matthew J. Koehler
Michigan State University

Effects of a 1-semester professional development (PD) intervention that included expert coaching with Head Start teachers were investigated in a randomized controlled trial with 88 teachers and 759 children. Differential effects of technologically mediated (remote) versus in-person (on-site) delivery of individualized coaching with teachers also were examined in a random assignment design. Hierarchical linear model analyses revealed positive PD intervention effects on general classroom environment ($d = 0.99$) and classroom supports for early literacy and language development ($d = 0.92$), and on children's letter knowledge ($d = 0.29$), blending skills ($d = 0.18$), writing ($d = 0.17$), and concepts about print ($d = 0.22$). No significant intervention effects on teaching practices and children's outcomes related to oral language were found. There were no differential effects of remote versus on-site delivery of literacy coaching.

Keywords: early literacy, professional development, educational technologies, expert coaching, Head Start

Prekindergarten education programs are increasingly expected to significantly improve the literacy skills and related school readiness outcomes of children at risk of academic failure due to low-income status. Congressional reauthorization of the federal Head Start program in 1998 (Community Opportunities, Accountability, and Training and Educational Services Act of 1998) and again in 2007 (Improving Head Start for School Readiness Act of 2007) mandated improvements in specific literacy and language skills, for example. The press for improvements in early literacy outcomes stems partly from research on major disparities in literacy and language abilities at kindergarten entry (e.g., Jacobson-Chernoff, Flanagan, McPhee, & Park, 2007) that generally persist into the elementary school grades (e.g., Lee, Grigg, & Donahue, 2008). Prominent policy recommendations call for early childhood programs to contribute to the elimination of achievement gaps in the U.S. by strengthening early literacy instruction (e.g., Snow, Burns, & Griffin, 1998).

There is a substantial research literature to inform decisions about language and literacy skills to emphasize in early childhood programs. Narrative reviews of this literature have emphasized oral language skills, phonological awareness, and letter knowledge as key preschool foundations of later reading ability (e.g., Snow et al., 1998; Whitehurst & Lonigan, 1998). A recent meta-analysis conducted by the National Early Literacy Panel (2008) identified alphabet knowledge, phonological awareness, and writing or name writing among a set of variables that was consistently and moderately to strongly predictive of later conventional literacy outcomes. Concepts about print and oral language skills were among a second set of emergent literacy skills that was moderately correlated with at least one conventional literacy skill (i.e., reading, writing, spelling) but did not consistently maintain this relationship when other variables were accounted for. The National Early Literacy Panel also found that a range of interventions for promoting early literacy skills was effective, including explicit attempts to strengthen code-focused skills (e.g., phonological awareness) and enhance oral language. In addition to results of intervention research, nonintervention studies have identified associations between specific teaching practices and growth in children's literacy outcomes (e.g., code-focused teaching practices and children's letter-word recognition; Connor, Morrison, & Slominski, 2006).

It appears that results of this corpus of research knowledge have not been put into widespread practice in early childhood programs. Studies of prekindergarten programs serving at-risk children typ-

Douglas R. Powell and Karen E. Diamond, Department of Child Development and Family Studies, Purdue University; Margaret R. Burchinal, Frank Porter Graham Child Development Institute, University of North Carolina, Chapel Hill; Matthew J. Koehler, Department of Counseling, Educational Psychology, and Special Education, Michigan State University.

This study was supported by Grant R305M040167 from the Institute of Education Sciences, U.S. Department of Education, to Purdue University in collaboration with Michigan State University. Statements made in this article do not necessarily represent views of the research sponsor. We gratefully acknowledge the participation of Head Start teachers, administrators, and children, as well as the numerous contributions of research assistants. Hope Gerde coordinated data collection, Janet Wagner coordinated data management, and Nell Duke reviewed preliminary content of the hypermedia resource.

Correspondence concerning this article should be addressed to Douglas R. Powell, Purdue University, 101 Gates Road, West Lafayette, IN 47907-2020. E-mail: powelld@purdue.edu

ically find low levels of literacy and language instruction (e.g., Justice, Mashburn, Hamre, & Pianta, 2008), and results of recent experimental (Puma et al., 2005) and quasiexperimental (Zill & Resnick, 2006) studies point to modest Head Start impacts on children's literacy outcomes. Research also suggests there are limitations in Head Start teachers' early literacy knowledge (e.g., Powell, Diamond, Bojczyk, & Gerde, 2008).

Professional development (PD) for in-service teachers is frequently cited as a promising approach to improving early literacy and language outcomes. Recent early childhood initiatives (e.g., Early Reading First; R. Jackson et al., 2007) target improvements in teacher quality as a pathway to boosting the literacy outcomes of at-risk children. Intensive forms of PD such as coaching with teachers are of particular interest because the extant literature indicates that individualized and sustained work with teachers that provides guidance and feedback on implementation of evidence-based practices in their own classrooms is superior to one-time workshops in improving teacher quality (e.g., Wayne, Yoon, Zhu, Cronen, & Garet, 2008). In addition to the term *coaching*, some studies refer to individualized feedback to teachers as *mentoring* (e.g., Landry, Anthony, Swank, & Monseque-Bailey, 2009) or *consultation* (e.g., Pianta, Mashburn, Downer, Hamre, & Justice, 2008).

The basic premise of literacy-focused PD—that intervention with teachers will yield improvements in teacher quality that in turn will lead to greater gains in prekindergarten children's literacy skills—has been investigated in a small but growing set of studies. Results point to the positive impact of PD programs on classroom environments (Dickinson & Caswell, 2007; B. Jackson et al., 2006; Neuman & Cunningham, 2009), teaching practices (Landry et al., 2009; Wasik, Bond, & Hindman, 2006), and children's literacy skills (Bierman et al., 2008; B. Jackson et al., 2006; Landry, Swank, Smith, Assel, & Gunnewig, 2006; Wasik et al., 2006). Only several studies have examined PD effects on both teacher or classroom outcomes and children's outcomes (B. Jackson et al., 2006; Landry et al., 2009; Wasik et al., 2006), although studies focused primarily on children's outcomes have measured teacher behaviors as a fidelity of intervention implementation (Bierman et al., 2008; Landry et al., 2006).

PD Methods

The fledgling research literature on early literacy PD programs may have reached a point where greater consideration of pedagogical differences in the design and delivery of PD programs would advance researchers' understanding of PD intervention effects. PD programs differ in their approach to promoting change in existing teaching practices. Particularly needed is experimental research on literacy-focused PD interventions that include provisions for prekindergarten teachers to actively plan changes in their teaching practices in the context of information on evidence-based practices. Further research also is needed on technologically mediated delivery of PD, including effects of web resources and individualized feedback on teacher-submitted videotapes of their instructional practices. There is growing interest in the use of innovative technologies in teacher PD, partly due to logistical and financial cost issues associated with individualized work with teachers, yet there is limited research on effects of web-based work with in-service teachers.

Approaches vary in the extent to which new curriculum resources are an integral element of a PD intervention. For example, a language and literacy intervention in Head Start classrooms by Wasik et al. (2006) included theme-based prop boxes of concrete objects and trade books that teachers were trained to use in introducing new vocabulary. Intensive training with teachers emphasized conceptual knowledge, including explanations for the intervention activities, as well as procedures for implementing the activities. Also, an intervention focused on social–emotional and language–literacy outcomes by Bierman et al. (2008) trained teachers to use a well-specified curriculum, including scripted lessons and a prescribed scope and sequence aimed at supplementing the existing general curriculum in Head Start classrooms (see also Domitrovich et al., 2009). Both interventions included extensive in-classroom coaching with teachers.

In a contrasting approach to PD, some interventions provide teachers with information on evidence-based practices coupled with individualized coaching on how to enhance, extend, or modify existing teaching practices to incorporate evidence-based practices that promote literacy and language outcomes. For example, an intervention examined by Dickinson and Caswell (2007) offered a credit-bearing course to Head Start teachers that included information about early literacy and language development, illustrations of evidence-based practices in prekindergarten classrooms, and supports for teachers to apply the new knowledge to their classrooms (e.g., assignments designed to promote teacher reflection on implementation of new practices). In a PD program developed by Landry et al. (2006), literacy coaches worked individually with teachers to plan lessons, demonstrate activities, and provide feedback on teachers' implementation of teaching practices presented in intensive workshop trainings with teachers. The content of the Landry et al. (2006) PD program was the basis of a subsequent literacy and language PD program that provided systematic feedback to teachers on children's progress plus a yearlong online course and regular coaching (Landry et al., 2009).

Random assignment designs have been employed in research on PD interventions that involved implementation of new curriculum resources (Bierman et al., 2008; Wasik et al., 2006), whereas quasiexperimental designs dominate the small number of studies of PD programs that provided teachers with information about early literacy coupled with assistance in translating evidence-based knowledge for use in their classrooms (Dickinson & Caswell, 2007; B. Jackson et al., 2006; Landry et al., 2006). Moreover, studies of the latter approach of providing evidence-based information paired with coaching typically have examined large-scale delivery of a PD program, including a statewide PD initiative (Landry et al., 2006) and a course delivered throughout New England by different universities (Dickinson & Caswell, 2007). An information and coaching approach to PD, then, would benefit from a randomized controlled trial focused on efficacy rather than scalability.

With regard to technologically mediated forms of PD, an important question is whether web-based strategies can be effectively employed to extend literacy coaching to a wide range of teachers. The two main functions of literacy coaching, providing information and examples of evidence-based practice plus individualized feedback on ways teachers can improve their instruction (International Reading Association, 2004), are conducive to delivery through innovative technologies. Information on evidence-based

practices, for example, can be communicated in a case-based hypermedia resource that provides narrative and video exemplars of evidence-based instruction for teachers (Koehler, 2002). Videotapes of teachers' instruction can be used by coaches to provide individualized feedback on teaching practices (Pianta et al., 2008). A major advantage of video, compared to live observation, is the opportunity for repeated viewings that facilitate targeted attention to specific teaching practices that may not be noticed or easily recalled during the act of teaching (Sherin & van Es, 2005). In addition to reducing or eliminating the logistical complexities of in-person visits to classrooms (e.g., long-distance drives to geographically remote classrooms), the affordances of technologically mediated PD include the opportunity for teacher and coach to participate at any time of the day or week rather than accommodate a classroom schedule.

Recently Pianta et al. (2008) examined effects of web-mediated coaching with prekindergarten teachers via review of teacher-submitted videotapes of their instructional practices. Teachers also had access to a website of video exemplars of high-quality teacher–child social and instructional interactions with students. Positive effects of coaching on teacher–child interactions were found in a comparison to a control condition in which teachers had access to website resources only. Research is needed on effects of web-mediated coaching in comparison to in-person coaching with teachers.

Current Study

Two questions were investigated in the current study: What are the effects of a literacy-focused PD intervention involving expert coaching with Head Start teachers on classrooms and children? Are there differential effects of technologically mediated (remote) versus in-person (on-site) delivery of expert coaching with teachers?

The study was designed to provide two sets of randomized controlled trial comparisons of a one-semester PD intervention implemented with Head Start teachers. In the first comparison, intervention effects were examined in relation to classrooms randomly assigned to a wait-listed control group that received intervention in the spring semester, using classroom observation and child assessment data collected at the beginning and at the end of the fall semester. Remote and on-site coaching conditions of the fall PD intervention were combined and compared to the control condition in this analysis. In the second comparison, effects of remote versus on-site delivery of the PD intervention were examined in classrooms randomly assigned to one of the two intervention conditions in either semester. Classroom observation and child assessment data were collected at the beginning and at the end of the intervention. The study was conducted across two years, with a separate cohort of teachers and children participating in each year.

Method

Participants

The study was conducted in 88 classrooms located in a total of 24 centers across five Head Start programs that collectively serve 11 counties in a midwest state. One program served an urban area of approximately 1.1 million residents, with most Head Start centers located in a central core of about 380,000 residents. Two programs were located in small cities and served counties of approximately 160,000 and 100,000 residents, respectively, and two programs served rural counties ranging from about 20,000 to 39,000 residents. Four Head Start programs used the Creative Curriculum (Dodge, Colker, & Heroman, 2002), and one program used a curriculum based on the Galileo assessment system (www.ati-online.com). Most classrooms also used a supplementary curriculum resource (Second Step; Committee for Children, 2002) to promote children's problem-solving, emotion management, and related social skills.

Characteristics of teachers ($n = 88$) and children ($n = 759$) included in data analyses are reported in Table 1 (first column). Most of the teachers were women (97%). A majority of children (69%) represented ethnic–racial minority backgrounds. Per federal Head Start regulations, children were from low-income families. On average, children were 54 months of age ($SD = 5.4$) as of September 15 of the year of their study participation. A majority of participants (60% of teachers, 57% of children) were in classrooms located in a large urban area. Others were in classrooms located in small cities (22% of teachers, 23% of children) or rural communities (18% of teachers, 20% of children).

Three early childhood specialists served as literacy coaches. Each had a master's degree in early childhood education or child development and experience (range: 3–20 years) as lead teacher of a prekindergarten classroom. The coaches were women.

Procedure

Random assignment. Random assignment occurred at the teacher level, was stratified by the geographic location of the teacher's classroom (urban, not urban), and involved two steps. In the first step, teachers were randomly assigned to an intervention semester (fall or spring) and a participation year (first or second) within location (urban, not urban). In the second step, teachers within each intervention semester and location were randomly assigned to the on-site coaching condition or to the remote coaching condition.

In the first year of the study, one half of teachers assigned to the spring intervention semester were randomly assigned to the control group in the fall semester. In the second year of the study, all teachers assigned to the spring intervention semester served in the control group in the fall semester. Random assignment was conducted by Margaret R. Burchinal, who had no role in sample recruitment, data collection, or development and implementation of the intervention.

Each literacy coach's caseload consisted of approximately equivalent numbers of teachers in the on-site condition and in the remote condition. Caseloads also represented geographic diversity in that each literacy coach worked with teachers in programs serving urban and small city–rural areas. The full-time equivalent coach caseload was on average 14 teachers per semester. Of the three literacy coaches, one worked full time and two worked part time.

Participant recruitment. All lead teachers in each of the five Head Start programs were eligible for study participation. Information about the study was disseminated to lead teachers in written form and in presentations by one of the principal investi-

Table 1
Teacher and Child Participant Characteristics

Characteristic	Overall	Fall semester		Fall and spring semester: Coaching condition	
		Intervention	Control	Onsite	Remote
Teachers (*n*)	88	42	31	43	45
Education					
<2-year degree	4.5%	7.2%	0%	2.3%	6.6%
2-year degree	30.7%	26.2%	32.3%	29.3%	31.2%
4-year degree	52.3%	50.0%	64.5%	53.7%	53.3%
Graduate work	12.5%	16.6%	3.2%	16.3%	8.9%
ECE major (≥2-year degree)	78.6%	78.9%	74.2%	80.5%	76.2%
Years of teaching experience					
M	9.8	10.0	8.4	9.7	9.8
SD	7.3	6.8	8.0	7.4	7.2
Classroom quality					
M (1–7)	4.65	4.78	4.51	4.54	4.77
SD	0.88	0.94	0.87	0.94	0.79
Children (*n*)	759	362	280	359	400
Male	51.1%	53.9%	46.8%	52.1%	50.2%
Race–ethnicity					
African American	39.5%	30.9%	51.4%	42.1%	37.2%
White	29.8%	37.0%	23.2%	27.3%	32.0%
Latino	22.7%	22.9%	18.9%	23.4%	22.0%
Other	7.1%	8.1%	5.7%	6.2%	7.9%
Unreported	<1.0%	1.1%	<1.0%	1.1%	<1.0%
Home language includes English	84.2%	85.0%	87.9%	83.2%	85.2%
Parental education					
<High school diploma	26.2%	24.6%	26.8%	29.8%	23.0%
High school diploma	36.1%	37.8%	34.3%	32.5%	39.2%
Some postsecondary	26.2%	25.7%	26.4%	26.5%	26.0%
≥2-year degree	10.6%	11.3%	11.4%	9.7%	11.2%
Unreported	<1.0%	<1.0%	1.1%	1.4%	<1.0%

Note. ECE = early childhood education.

gators at staff meetings. The 88 teachers who participated in the study represented 73% of all lead teachers ($n = 121$) and 93% of all centers ($n = 26$) across the five Head Start programs at the time of the study.

All children who were 4 years of age by December 31 of the year in which their teacher participated in the study were eligible to participate in the study. This child age parameter targeted children who were likely to enter kindergarten the following year. Across the 88 classrooms, an average of eight children ($SD = 1.2$, range: 6–12) per classroom were assessed.

There was one wave of child–parent recruitment in each of the study's 2 years, conducted at the beginning of the school year. Information about research participation was communicated to parents and legal guardians in presentations by a member of the research team at program-sponsored orientation meetings for parents prior to the beginning of the school year and in a letter accompanied by the informed consent form. Parents were given a small cash payment as compensation for study participation, and each child received a book at the end of the semester. Program administrators facilitated researchers' access to teachers and parents but were not involved in communications between researchers and prospective participants about decisions regarding study participation.

Attrition. The teacher attrition rate was 7%. Specifically, four of the study's 88 teachers fully participated in the control group, as randomly assigned, but withdrew from the study prior to the beginning of the intervention in spring semester (two on-site, two remote) due to conflicts with the workshop schedule. End-of-intervention data were not collected on an additional two teachers who participated in the remote intervention condition (one in the fall, one in the spring) because they vacated their Head Start position immediately prior to the end-of-intervention data point. Child outcome measures were administered at one point only with 12.5% ($n = 95$) of the 759 children who participated in the study primarily due to departure from the participating Head Start classroom (72%). Child attrition rates did not differ significantly ($p = .19$) across control group (11%), on-site condition (12%), and remote condition (16%).

Intervention. The goal of the one-semester PD intervention, entitled *Classroom Links to Early Literacy*, was to improve teachers' use of evidence-based literacy instruction (proximal outcome) that in turn would lead to significant improvements in children's literacy achievement (distal outcome). Primary emphasis was given to classroom strategies to improve children's oral language skills and code-focused skills, particularly phonological awareness and letter knowledge. Attention to oral language included instructional practices aimed at improving children's vocabulary knowledge, listening comprehension skills, and syntactic knowledge, particularly teaching practices (e.g., asking questions) that elicit and expand children's use of language. Teachers were given

printed copies and demonstrations of phonological awareness activities developed by Adams, Foorman, Lundberg, and Beeler (1998) and were encouraged to emphasize letter sounds when teaching letter names and to use writing to promote letter knowledge (Diamond, Gerde, & Powell, 2008). The intervention gave secondary emphasis to instructional practices to improve children's knowledge of print concepts (Clay, 1979). Teacher participation was voluntary and entailed some involvement during most teachers' vacation time. The study provided teachers with a modest level of monetary compensation for their time.

The intervention comprised a 2-day workshop (16 hr total) followed by expert coaching. The 2-day workshop, attended by teachers in both coaching conditions, provided an overview of the intervention content, with emphasis on demonstration and guided discussion of evidence-based practices in areas delineated above. In addition to presenting content knowledge, a stated goal of the workshop was to promote the development of supportive relationships between coach and teacher. To this end, the literacy coaches led most of the workshop and met in small groups with assigned teachers to learn about each classroom. Teachers assigned to the remote condition received training in uses of the equipment (see below) while teachers assigned to the on-site condition prepared a predetermined literacy artifact (stick puppet) that also was made available to teachers in the remote condition. There were no differences across semesters in content coverage, presenters, and the amount of time devoted to each content area.

The main purpose of coaching was to provide individualized feedback to teachers in improving the implementation of evidence-based practices emphasized in the intervention. The coaching protocol followed an observe–assess–recommend sequence wherein the coach observed a specific instructional practice determined in advance with the teacher (e.g., teacher use of questions to support conversation at the end of large group book reading) and, based on the observation, provided two types of written feedback: statements about appropriately implemented aspects of the targeted practice (e.g., good work in taking time during the large group book reading to define and discuss three novel words) and recommendations for improving the practice (e.g., be sure to use new words discussed during large group at other times of the day). Coaches provided additional resources such as printed descriptions of instructional activities or demonstrations of a recommended action (in person or video exemplars) when deemed appropriate. The intervention design called for seven coaching sessions across a 15-week semester (approximately biweekly). Across the semester, coaching sessions were to focus on each of the two primary child outcome areas (oral language and code-focused skills), with the specific sequence and content individualized to classroom circumstances. No information exchanged between coach and teacher, including teacher-submitted videotapes and coach feedback to teachers, was shared by the study with others, including teachers' supervisors. Coaches were university employees.

In the on-site coaching condition, the coach observed classroom activities for approximately 90 min during each visit, scheduled with the teacher to maximize the opportunity to see implementation of a targeted practice(s). Subsequent to the observation, the coach met with the teacher for approximately 30 min to provide and discuss the two types of feedback specified above. The feedback was recorded in writing by the literacy coach on a form signed by both coach and teacher, with a signed copy given to the teacher at the conclusion of the session. The coach also completed a form to document the primary substantive focus of the session and resources provided to the teacher.

In the remote coaching condition, teachers submitted a videotape, approximately 15 min in length, of a targeted instructional practice(s) for the coach to review. Each teacher learned the result of this review using computer software that provided a split screen arrangement, with coach-selected segments of the teacher-submitted videotape on the left and written coach feedback on each video segment on the right side of the computer screen. Coach feedback also included direct links to video exemplars or other pertinent material in the intervention's hypermedia resource (see below). The first teacher-submitted videotape was a classroom tour, narrated by the teacher and focused on uses of classroom literacy resources.

During the semester of participation in the intervention, teachers in the remote condition were given use of a case-based hypermedia resource developed for the intervention. There were 16 cases organized into five modules (reading, writing, conversations with children, phonological awareness, individualization). Each case included video exemplars of evidence-based instructional practices developed by the study, featuring Head Start teachers in programs not involved in the current study who participated in a previous literacy-focused PD intervention study conducted by the principal investigators. Each exemplar was generally 2–3 min in length and paired with bulleted text that delineated key features of the practice shown in the video. Cases also provided additional text pages, including research-based rationales for teaching strategies highlighted in the case, published articles written for early childhood educators, references to additional readings, and links to related cases. Across all cases in the hypermedia resource, there were 97 video exemplars, 139 text pages, and 33 articles (Powell, Diamond, & Koehler, in press). Although teachers in the on-site condition did not have on-going access to the hypermedia resource, coaches brought to each on-site coaching session a laptop computer with the hypermedia resource for the purpose of showing a video exemplar(s) during the meeting portion of the classroom visit. Teachers in the on-site condition also could receive from their coach copies of published articles included in the hypermedia resource.

Most of the Head Start centers and teachers did not have Internet connections of sufficient capacity to accommodate video transmissions. Because of this technical problem as well as confidentiality and security related to video recordings of teachers and children, the study provided each teacher in the remote condition with postage-paid envelopes for submitting videotapes to the coach. Coach feedback was offered in a compact disc mailed to the teacher for use on a laptop computer (iBook) provided by the study during the intervention semester. The study also provided each teacher in the remote condition with a video camera and tripod.

Fidelity of intervention implementation. Teachers in the on-site coaching condition participated in an average of 7.07 ($SD = 0.35$, range: 6–8) coaching sessions with an average length of 180 ($SD = 31.9$) min, including meeting time with the literacy coach ($M = 35.5$, $SD = 7.7$ min) and coach completion of the aforementioned forms. Teachers in the remote coaching condition submitted and received coach feedback on an average of 7.0 ($SD = 1.53$, range: 2–9) videotapes of their teaching practices; 12% of teachers in the remote condition submitted fewer than six video-

tapes. Ninety-eight percent of teachers in the on-site condition and 79% of teachers in the remote condition participated in the specified amount of coaching (seven coaching sessions–feedback on teacher-submitted videotapes). Nearly all teachers in the remote condition demonstrated proficiency in use of the hypermedia resource and videotaping equipment at the conclusion of the workshop. Typically there was one teacher in each semester who received individualized follow-up training on equipment use.

In the remote coaching condition, teacher-submitted videotapes were on average 15.45 ($SD = 6.05$) min in length. Coaches provided feedback on an average of 5.80 ($SD = 2.92$) segments of each teacher-submitted videotape. Web usage logs indicated that teachers in the remote condition viewed an average of 17.03 ($SD = 24.86$) video exemplars in the hypermedia resource. Coaching session records indicated that teachers in the on-site condition viewed a similar average number of demonstrations of evidence-based practice ($M = 16.85$, $SD = 9.96$). This included video exemplars in the hypermedia resource ($M = 10.92$, $SD = 5.92$) and instances of the coach modeling a practice in their classroom ($M = 5.93$, $SD = 7.96$).

The main content focus of coaching was teaching practices to promote children's oral language skills (36%) or code-focused skills (36% letter knowledge, 24% phonological awareness). A small percentage (4%) of coaching sessions–videotapes had a relatively equal focus on more than one of these literacy outcomes. There were no significant differences between on-site and remote coaching conditions in the main content focus of coaching sessions and teacher-submitted videotapes ($p = .11$). The total number of different literacy topics (e.g., promoting children's identification of initial sounds) pursued in on-site and remote coaching conditions was similar ($M = 7.9$, $SD = 1.0$ for on-site; $M = 7.7$, $SD = 1.8$ for remote).

A review of records of each of the 288 on-site coaching sessions and coach feedback on 301 teacher-submitted videotapes in the remote coaching condition indicated that 1.7% ($n = 5$) of all on-site sessions and 2.9% ($n = 9$) of all occurrences of feedback on teacher-submitted videotapes in the remote condition included one or more coach recommendations not directly related to the PD program content.

Classroom Observation Measures

Early Language and Literacy Classroom Observation (ELLCO). The General Classroom Environment (six items: e.g., organization, management) and the Language, Literacy, and Curriculum (five items: e.g., oral language facilitation, approaches to book reading) subscales of the ELLCO (Smith, Dickinson, Sangeorge, & Anasatosopoulos, 2002) were used. Each item was rated with a 5-point anchored scale that provided descriptions of ratings at Levels 1, 3, and 5. The ratings were made by a member of the research team after approximately 90 min of classroom observation that included large group time and free play (also called center or choice time) periods. Smith et al. (2002) report an internal consistency of $\alpha = .83$ for the General Classroom Environment subscale and $\alpha = .86$ for the Language, Literacy, and Curriculum subscale. For the two subscales in the current study, the internal consistency was $\alpha = .85$ and $\alpha = .86$, respectively.

Global classroom quality. Twelve items of the Early Childhood Environment Rating Scale—Revised (ECERS-R; Harms, Clifford, & Cryer, 1998) were used to measure global classroom quality for descriptive purposes only (not an outcome variable). This measurement strategy is supported by results of an earlier study that found 12 randomly selected items from the ECERS-R yielded an assessment of quality equivalent to the full measure (Perlman, Zellman, & Le, 2004). An overall score across the rating items could range from 1 to 7. The Cronbach's alpha was .87 for the current study. Authors of the ECERS-R consider a score of 1 as inadequate, a score of 3 as minimal, a score of 5 as good, and a score of 7 as excellent.

Teachers' instructional practices. At each data point, teachers were observed during a large group time that included book reading and also during 15 min of free play. During the large group time, a member of the research team scored a set of dichotomous (yes–no) items related to instructional behaviors and, with teacher permission, made an audio recording of the teacher reading a book of her–his choice. The audio recording was subsequently transcribed. Across all data points, the observed book reading time was an average of 8.96 ($SD = 3.98$; range: 2–23) min in length within a large group period that was an average of 21.6 ($SD = 8.44$; range: 6–49) min in length. Observation of the teacher during free play typically occurred at the conclusion of the observed large group session. The following three variables were coded from these records (omitting book text): number of language-eliciting prompts without regard to actual child response (questions or statements that ask for a child response; e.g., "tell me about this picture"), number of simple definitions of words (provides a synonym or short definition of a novel word; e.g., "tiny means small"), and number of code-focused instructions (points out the sound of a letter or word, points to a specific word or letter). The first two variables were coded from the transcript of the book-reading session, and the code-focused variable was derived from the observation form completed by the observer. The language-eliciting prompts were represented as the proportion of all teacher utterances in an observation. The score for definitions of words is the actual frequency of occurrence.

Prior to each data collection point, research team members participated in reliability training to achieve 90% interobserver reliability on the ELLCO and ECERS-R measures (i.e., agreement within 1 point on each item) and a minimum of 85% interobserver agreement on teachers' instructional practices during large group time and teacher utterance entries in the observation of the teacher during free play.

Similar procedures were used to establish and maintain reliability in coding records of the group time and free play observations. For each type of observation, two coders (four total) were trained in use of the coding system until interrater exact agreement of 90% on teacher utterance type was achieved for a set of 10 records. In addition, records for 25% of all large group observations and for 25% of all free play observations were randomly selected for double coding by two coders working independently on each type of observation (large group, free play). For each type of observation, coders maintained agreement above 90% ($k = .94$).

Child Assessment Measures

Peabody Picture Vocabulary Test—Third Edition (PPVT-III). The PPVT-III is a measure of children's receptive vocabulary skills, using standard American English. Children point to a

picture that best represents the meaning of a spoken word. Reliability of the PPVT-III has been assessed through internal consistency (.93–.95) and test–retest (.91–.94; Dunn & Dunn, 1997). Standard scores were used in analyses ($M = 100$, $SD = 15$).

Woodcock-Johnson III Tests of Achievement—Letter Word Identification. This measure of children's identification of letters and reading of words is appropriate for children aged 2 years and older. It has a test–retest reliability of .87–.96 (McGrew & Woodcock, 2001). Standard scores were used in analyses ($M = 100$, $SD = 15$).

Concepts About Print. The Concepts About Print (Clay, 1985) measure was used to assess children's understanding of print concepts. For this assessment, the researcher read a storybook and, while reading, questioned the child about parts of the book (e.g., front cover), text (e.g., words compared to pictures), and conventions of print (e.g., direction of reading). Questions focused on rules that govern reading, including knowing that one reads from left to right and top to bottom and that printed words rather than pictures convey the meaning of the story. The total number of correct responses was used in analyses (possible range = 0–11).

Alphabet knowledge. Children were tested for alphabet knowledge using the Letter Naming assessment employed in Head Start's Family and Child Experiences Survey (FACES; Zill & Resnick, 2006). All letters of the alphabet were represented, randomly and in uppercase, across three different cards. The researcher provided a card with letters for the child to view and asked the child to "point to the letters you know and tell me their names." After recording the child's responses, the researcher pointed to each of the letters the child did not name individually and asked the child "What letter is this?" This process continued so that each child was prompted to name all of the letters of the alphabet. The number of letters correctly named was used in analyses (possible range = 0–26).

Writing. Each child was asked to write his–her name on a blank piece of paper. Children were encouraged to write as much as they could, and writing attempts that did not include letters were reinforced. Only three children refused to write. Each name writing sample was scored in one of nine writing forms ranging from little awareness of letters (e.g., scribbling, drawing as writing) to writing one's first name correctly (Diamond et al., 2008). Two research assistants were trained in the coding of name writing and writing samples until they reached $k = .90$. Twenty-five percent of randomly selected name writing samples were double coded with interrater reliability maintained at $k = .90$.

Blending. We used 21 items from a prepublication version of the Test of Preschool Early Literacy (Lonigan, Wagner, & Torgesen, 2007) to assess children's ability to combine sounds. On this measure, children are asked to identify words created by combinations of words (e.g., rain + coat = raincoat), sounds (e.g., /b/ + air = bear), and phonemes (e.g., /b/ + /i/ + /k/ = bike). Lonigan, Wagner, Torgesen, and Rashotte (2002) reported internal consistency of .78 and test–retest reliability of .79 in a sample of forty-one 4- to 5-year-old children.

Initial sound matching. Children's understanding of initial sounds was measured using the Alliteration Individual Growth and Development Indicator from Get it Got it Go! (Center for Early Education and Development, University of Minnesota, 2005). Children were asked to look at a card that included one target and three sample pictures. The pictures were named by the examiner. Then the child was asked to point to the one picture (e.g., cake) that began with the same sound as the target (e.g., cat). Assessment began with six training items and, if the child correctly pointed to the picture that matched the targeted initial sound on two of the final four training items, the assessment continued without further correction for 2 min. The child's score was the total number of correct responses in the 2-min testing period. There is moderate to strong evidence for test–retest stability (.62–.88) of this measure and medium to high correlations with other early literacy assessments (e.g., Test of Phonological Awareness, $r = .75$; Missall & McConnell, 2004; Missall et al., 2007). In the current study, scores on this measure were highly skewed, with many children (60%) scoring 0 at each testing time. As a result, we created a dichotomous variable reflecting whether or not children correctly completed at least two of the items (0 = none correct or one item correct; 1 = two or more items correct).

Data Collection

Classroom observations and child assessments were conducted by members of the research team at the beginning of the fall semester (September to early October), during the middle of the school year (December–January), and at the end of spring semester (mid-April to early May). In each of the participating Head Start programs, classrooms generally were in session from the first or second week of September to the second or third week of May. All assessments were conducted in the language of the classroom (English).

Results

Data Analysis

Hierarchical linear model (HLM; Raudenbush & Bryk, 2002) analyses were employed in the study's two sets of comparisons, intervention versus control group and on-site versus remote coaching condition. The models estimated a random intercept for each teacher in analysis of classroom–teacher outcomes and for each child to account for the repeated assessments per child. Center was added as the third level of the HLM to account for the nesting of classrooms within Head Start centers in analyses of classroom outcomes. Time was centered at the postintervention period so the main effect of intervention tested whether the intervention group outscored the control group at the end of the intervention. All other independent variables were categorical. A generalized estimating equation was used to fit logistic regression in which nesting in classroom or child is accounted for by a clustering term.

All analyses for the comparison of on-site versus remote coaching conditions included a season variable with values of fall, winter, and spring. The main effect of season in the Level 1 model for the child outcomes adjusted for the difference in levels across the school year. Specifically, the intervention effect on the intercept (i.e., main effect of intervention) and on the slope (i.e., the Intervention × Time interaction) adjusted for differences related to whether the two child assessments were in the fall and winter or in the winter and spring.

Year of participation (cohort) was used as a covariate in classroom–teacher outcome analyses. Child race–ethnicity, child gender, and cohort were covariates in child outcome analyses.

Analyses included all child and teacher participants with 1 or more data points, and no teacher was omitted from analyses due to level of participation in the intervention.

In sum, the three-level HLM for teacher outcomes with random intercepts for teachers and centers was

$$\text{Level 1: } X_{tcj} = \beta_{0tc} + \beta_{1tc}\,\text{Time}_j + E_{tcj}$$

$$\text{Level 2: } \beta_{0tc} = \pi_{00c} + \pi_{10c}\,\text{Cohort}_{tc} + \pi_{20c}\,\text{Intervention}_{tc} + E_{tc}$$

$$\beta_{1tc} = \pi_{01c} + \pi_{11c}\,\text{Cohort}_{tc} + \pi_{20c}\,\text{Intervention}_{tc}$$

$$\text{Level 3: } \pi_{00c} = \pi_0 + E_c,$$

where X is a classroom-level outcome, t = 1–T teachers per center, c = 1–24 centers, j = 1–2 times, and the residuals at each level (E) are considered independent. The three-level HLM for the child outcomes, with random intercepts for children and teachers and a fixed effect for center, was

$$\text{Level 1: } Y_{ctij} = \beta_{0cti} + \beta_{1cti}\,\text{Time}_{ij} + \beta_{2cti}\,\text{Season}_{ctij} + E_{ctij}$$

$$\text{Level 2: } \beta_{0cti} = \pi_{00ct} + \pi_{10ct}\,\text{Race/Ethnicity}_{cti} + \pi_{20ct}\,\text{gender}_{cti} + E_{cti}$$

$$\beta_{1cti} = \pi_{01cti} + \pi_{11cti}\,\text{Race/Ethnicity}_{cti} + \pi_{21ct}\,\text{gender}_{cti}$$

$$\text{Level 3: } \pi_{00ct} = \pi_{0oc} + \pi_{10ct}\,\text{Cohort}_{ct} + \pi_{20ct}\,\text{Intervention}_{ct} + E_{ct}$$

$$\pi_{01ct} = \pi_{01c} + \pi_{11ct}\,\text{Cohort}_{ct} + \pi_{21ct}\,\text{Intervention}_{ct}$$

$$\pi_{0oc} = \pi_{0o},$$

where Y is a child outcome, i = 1–I children per teacher, t = 1–T teachers per center, c = 1–24 centers, j = 1–3 times, and the residuals at each level (E) are considered independent.

Group Equivalence

Using preliminary analyses, we examined the baseline equivalence of the intervention and control groups, and the on-site and remote coaching conditions (see Table 1). There were no statistically significant differences between intervention and control groups in teacher background characteristics, including possession of a 4-year degree or higher ($p = .11$) and median years of teaching experience ($p = .15$). There also were no significant differences between remote and on-site coaching condition groups (fall and spring combined) in teacher possession of a 4-year degree or higher ($p = .59$) and median years of teaching experience ($p = .94$). In addition, there were no significant differences in ECERS-R global classroom quality between intervention and control classrooms ($p = .18$) and between remote and on-site classrooms ($p = .20$). With regard to child background characteristics, there was a statistically significant difference between intervention and control groups in the percentage of racial–ethnic minority children (see Table 1), $\chi^2(1) = 15.42$, $p = .001$, but no intervention versus control differences in child gender ($p = .13$), home language ($p = .29$), or parental education ($p = 89$). There also were no significant differences between children in classrooms assigned to the on-site coaching condition or to the remote coaching condition with regard to gender ($p = .62$), race–ethnicity ($p = .22$), home language ($p = .27$), or parental education ($p = .10$).

Using preliminary analyses, we also employed HLM to test whether there were baseline differences between intervention and control groups in either teacher or child outcome variables. The teacher outcome model included intervention and cohort. This model did not reveal any significant baseline differences between either the intervention and control groups or between the on-site and remote coaching condition groups on the two ELLCO subscales and the four measures of teachers' instructional practices. The child outcome model included the child's sex and race–ethnicity as Level 1 covariates and intervention and cohort as Level 2 variables, and accounted for the nesting of children in classrooms as a random effect. This model did not reveal any significant baseline differences between intervention and control groups or between on-site and remote coaching condition groups on the seven child outcomes.

Intervention Versus Control Comparison

The first set of analyses compared classrooms randomly assigned to the intervention group or to the business-as-usual control group. Analyses were limited to fall semester only. Table 2 reports descriptive statistics for the 42 fall intervention and 31 fall control classrooms and for child variables for each group at pre- and postintervention data points. The intervention group represented classrooms randomly assigned to the on-site coaching condition or to the remote condition for fall semester; the control group comprised classrooms that were randomly assigned to receive the intervention in spring semester. As noted earlier, time was centered at the postintervention period. The main effect of time tested the pretest–posttest changes across the groups. The main effect of intervention tested whether the intervention group outscored the control group at the end of the intervention. The Intervention × Time interaction tested whether the intervention group showed larger pretest–posttest changes. A random intercept for each classroom accounted for the repeated assessments of classrooms, and a fixed effect accounted for the nesting of classrooms in centers. Effect sizes were computed as the difference between the intervention group and control group mean scores divided by the preintervention pooled standard deviation. A repeated measure logistic model tested for intervention and time differences on the categorical outcome (initial sound matching) using a generalized estimating equation. Results from these analyses are reported in Table 3.

Intervention classrooms showed statistically significant larger gains than control classrooms on both of the ELLCO subscales, General Classroom Environment ($d = 0.99$) and Language, Liter-

Table 2
Descriptive Statistics for Classroom–Teacher and Child Outcome Variables: Intervention and Control Groups (Fall)

	Intervention group				Control group			
	Preintervention		Postintervention		Preintervention		Postintervention	
Outcome variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Classroom–teachers (*n*)	42		42		31		31	
General Classroom Environment (1–5)	3.31	0.79	3.78	0.64	3.21	0.67	2.90	0.56
Language, Literacy, and Curriculum (1–5)	3.06	0.87	3.61	0.62	2.88	0.74	2.66	0.79
Word definition instruction (0–9)	1.45	1.99	2.28	2.01	1.53	1.91	2.21	1.89
Code-focused instruction (0–6)	1.50	1.35	2.43	1.83	1.80	1.23	1.83	1.39
Language-eliciting prompts: Book reading (0–100)	55.65	27.69	63.82	27.40	49.97	26.74	53.24	27.82
Language-eliciting prompts: Free play (0–100)	34.25	17.83	42.36	16.97	34.11	17.49	35.60	20.04
Children (*n*)	345		310		265		258	
Receptive language	83.65	16.82	87.60	16.34	82.39	15.49	85.72	15.34
Letter-word identification	94.00	16.29	99.59	14.59	92.13	19.81	96.33	17.05
Letter knowledge (0–26)	5.90	8.24	10.80	9.72	5.74	8.19	8.49	9.15
Concepts about print (1–11)	1.97	1.93	2.75	2.32	1.92	1.72	2.28	1.77
Writing (1–9)	5.41	1.40	6.45	1.49	5.42	1.68	6.22	1.37
Blending (1–21)	10.21	5.40	12.41	4.99	9.69	4.99	10.79	5.11
Initial sound matching (1–20)	1.84	2.65	2.56	3.62	1.86	2.79	2.00	2.93

acy and Curriculum ($d = 0.92$), and also they were rated higher at the postintervention data point on each of these subscales (ds = 1.12 and 1.14, respectively). Teachers in the intervention condition demonstrated a trend toward larger gains in code-focused instruction ($d = 0.62$). There were no statistically significant gains in intervention teachers' practices to promote vocabulary knowledge or children's talk during large group time or free play time.

Examination of child outcomes included child race–ethnicity as a covariate because, as reported earlier, there were significant race–ethnicity differences between children in classrooms randomly assigned to the fall semester intervention group or to the control group. Through centering time at the postintervention data point, the same a priori contrasts tested for intervention differences at the postintervention, change over time, and intervention differences in gain scores over time.

As reported in Table 3, children in intervention classrooms showed larger gains and higher mean scores over time on four of seven outcome variables compared to children in control classrooms. Specifically, children in intervention classrooms had significant gains in letter knowledge ($d = 0.29$), concepts about print ($d = 0.22$), writing ($d = 0.17$) and blending ($d = 0.18$) but not receptive language, letter-word identification, or initial sound matching.

Table 3
Intervention Versus Control Group Comparisons of Classroom–Teacher and Child Outcomes (Fall)

		Time			Intervention vs. control			Intervention × Time		
Outcome variable	*dfe*	β	*SE*	*d*	β	*SE*	*d*	β	*SE*	*d*
Classroom–teacher outcomes										
General Classroom Environment	69	0.21**	0.07	0.29	0.82***	0.16	1.12	0.73***	0.15	0.99
Language, Literacy, and Curriculum	69	0.29***	0.09	0.35	0.93***	0.18	1.14	0.75***	0.17	0.92
Word definition instruction	61	0.83**	0.30	0.43	−0.02	0.49	0.01	0.13	0.59	0.07
Code-focused instruction	69	0.19*	0.08	0.44	0.17	0.12	0.39	0.27+	0.15	0.62
Language-eliciting prompts: Book reading	61	6.66	4.44	0.24	8.50	6.79	0.31	4.44	8.79	0.16
Language-eliciting prompts: Free play	63	6.32*	2.84	0.36	6.85	4.31	0.39	7.85	5.62	0.45
Child outcomes										
Receptive language	529	3.89***	0.49	0.24	−0.55	1.43	−0.03	−0.48	0.96	−0.03
Letter-word identification	516	5.02***	0.73	0.28	3.97*	1.44	0.22	1.74	1.45	0.10
Letter knowledge	533	8.93***	0.49	0.53	5.34***	1.46	0.32	4.82***	0.97	0.29
Concepts about print	532	0.65***	0.09	0.36	0.37*	0.17	0.20	0.40*	0.18	0.22
Writing	530	0.93***	0.06	0.61	0.33*	0.13	0.21	0.26*	0.12	0.17
Blending	530	1.88***	0.23	0.36	1.17**	0.43	0.22	0.93*	0.46	0.18
Initial sound matching[a]		0.22	0.13		0.19	0.18		0.15	0.26	

Note. Covariates were cohort in classroom–teacher outcome analyses and child race–ethnicity, gender, and cohort in child outcome analyses. *dfe* = degree of freedom for error; Time = postintervention data point.
[a] Binary outcome.
$^{+}.10 < p < .05$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

On-Site Versus Remote Coaching Condition Comparison

A second set of analyses examined classroom and child outcomes in a comparison of teachers assigned to the remote coaching condition or to the on-site coaching condition. These analyses combined fall and spring intervention semesters and involved two data points (preintervention, postintervention). This set of analyses did not include a control group condition. Descriptive statistics are reported in Table 4. Intervention, time, and Intervention × Time comparisons were conducted with repeated assessments of classrooms or children defining the second level of the model. Classrooms were entered as the third level in the HLM for child outcomes. As noted earlier, the season variable was included to adjust for differences in the fall–winter and winter–spring child assessment points. In addition, covariates included child race–ethnicity, child gender, and cohort. All analyses included the repeated measures associated with multiple classrooms per center as a fixed effect. A priori contrasts tested for intervention differences at the postintervention data point, as well as gain scores from pre- to postintervention. Longitudinal logistic regressions examined the categorical initial sound-matching outcome.

Results of the a priori contrasts for classroom–teacher and child outcome variables are reported in Table 5. No consistent pattern emerged. Teachers who received on-site coaching demonstrated significantly larger gains than teachers in the remote coaching condition in code-focused instruction ($d = 0.71$) and had higher scores on code-focused instruction at postintervention ($d = 0.67$). However, children whose teachers received remote coaching showed larger gains on the PPVT-III ($d = 0.13$) and were more likely to exhibit initial sound-matching skills (odds ratio = 1.85) than children whose teachers participated in on-site coaching.

Discussion

The study is among a small number of experimental investigations of effects of a literacy-focused PD intervention on prekindergarten children's outcomes. It also is among the first random assignment study of a PD intervention that provided teachers with information about early literacy paired with individualized coaching on effectively incorporating evidence-based practices into existing instructional practices. This approach to PD, mostly studied to date with quasiexperimental designs, is in contrast to PD interventions that involve implementation of new curriculum resources, a strategy that has been examined with experimental designs. Moreover, the study appears to be the first to examine effects of technologically mediated delivery of literacy coaching in comparison to conventional delivery of coaching via visits to the classroom. Classrooms in the current study were similar to classrooms involved in other Head Start studies. In comparison to classrooms serving 4-year-olds in the Head Start FACES study (Zill, Sorongon, Kim, Clark, & Woolverton, 2006), in our sample the overall ECERS-R global classroom quality score was somewhat lower (4.65 vs. 4.81, respectively) and the mean standard score on the PPVT-III was slightly lower (83.12 vs. 85.6, respectively) at the beginning of the school year. The research employed random assignment and investigated intervention effects on both teacher–classroom and child outcomes. Analyses included all teachers, regardless of level of engagement in the intervention. The study achieved a good level of fidelity in implementation of the intervention design. We speculate that coaching feedback remained focused primarily on literacy content due to the generally good quality of classrooms and the availability of another resource, Second Step, for teachers to address children's problem behaviors.

Results indicate that the *Classroom Links to Early Literacy* intervention, a one-semester PD program comprising a two-day workshop followed by literacy coaching with Head Start teachers, had positive effects on general classroom environment and classroom supports for early literacy and language development. In addition to these proximal outcomes, the PD intervention had positive effects on children's letter knowledge, blending skills, writing, and concepts about print. Accordingly, the PD intervention strengthened four important prekindergarten precursors of

Table 4
Descriptive Statistics for Classroom–Teacher and Child Outcome Variables: On-Site and Remote Coaching Conditions (Fall and Spring)

	Onsite condition				Remote condition			
	Preintervention		Postintervention		Preintervention		Postintervention	
Outcome variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Classroom–teachers (*n*)	43		41		45		41	
General Classroom Environment (1–5)	3.16	0.82	3.67	0.79	3.19	0.68	3.59	0.68
Language, Literacy, and Curriculum (1–5)	2.89	0.93	3.65	0.75	2.96	0.74	3.45	0.79
Word definition instruction (0–9)	1.54	1.83	2.28	2.06	1.52	2.00	2.19	2.33
Code-focused instruction (0–6)	1.56	1.35	2.78	1.82	1.59	1.53	1.92	1.95
Language-eliciting prompts: Book reading (0–100)	50.21	27.02	59.03	25.06	52.21	28.03	62.30	29.47
Language-eliciting prompts: Free play (0–100)	36.85	19.09	36.54	18.16	31.87	18.50	38.67	16.37
Children (*n*)	350		303		368		306	
Receptive language	84.25	17.05	87.81	15.89	83.91	16.13	88.50	16.17
Letter-word identification	93.93	16.60	99.40	14.39	95.41	16.38	99.99	13.88
Letter knowledge (0–26)	6.89	8.71	11.81	10.08	7.10	8.59	12.67	9.74
Concepts about print (1–11)	2.11	1.85	3.55	2.59	1.99	1.74	3.39	2.59
Writing (1–9)	5.77	1.48	6.55	1.48	5.85	1.41	6.78	1.59
Blending (1–21)	10.68	5.56	13.59	5.04	10.14	5.29	13.75	4.52
Initial sound matching (1–20)	2.09	2.79	3.06	3.91	1.62	2.62	2.84	3.90

Table 5
Differences in On-Site Versus Remote Coaching Outcomes (Fall and Spring)

Outcome variable	*dfe*	Time			Intervention Condition × Time		
		β	*SE*	*d*	β	*SE*	*d*
Classroom–teacher outcomes							
General Classroom Environment	144	0.08	0.16	0.11	0.12	0.14	0.16
Language, Literacy, and Curriculum	144	0.19	0.17	0.23	0.26	0.18	0.32
Word definition instruction	127	0.06	0.49	0.03	0.07	0.62	0.04
Code-focused instruction	145	0.29*	0.12	0.67	0.31*	0.14	0.71
Language-eliciting: Book reading	127	−3.92	7.70	−0.14	−1.68	8.65	−0.06
Language-eliciting: Free play	140	−2.25	3.84	−0.13	−7.57	4.81	−0.43
Child outcomes							
Receptive language	877	−1.33	1.18	−0.08	2.19***	0.81	0.13
Letter-word identification	861	−0.45	1.20	−0.03	−0.91	1.03	−0.05
Letter knowledge	879	−0.35	0.29	−0.02	0.29	0.20	−0.02
Concepts about print	879	0.18	0.18	0.10	−0.04	0.20	−0.02
Writing	807	−0.24	0.12	−0.16	0.16	0.12	0.10
Blending	879	−0.15	0.39	−0.03	0.75+	0.40	0.14
Initial sound matching[a]	722	0.07	0.18		0.54*	0.23	

Note. Covariates were cohort and season in classroom–teacher outcome analyses and child race–ethnicity, gender, cohort, and season in child outcome analyses. *dfe* = degree of freedom for error; Time = postintervention data point.
[a] Binary outcome.
+ $.10 < p < .05$. * $p < .05$. ** $p < .01$. *** $p < .001$.

later literacy competence. Placed in the context of the National Early Literacy Panel's (2008) recent meta-analyses, three of the positive intervention effects on children in the current study (letter knowledge, blending, writing) are among the literacy-related variables moderately to strongly predictive of later conventional literacy outcomes, and one (concepts about print) is among a small set of variables moderately correlated with at least one later conventional literacy skill.

It is notable that the study found positive intervention effects on children's skills in blending but not initial sound matching. Although the measure of blending (Lonigan et al., 2007) used in the current study includes items pertaining to initial sounds and phonemes (in addition to compound words), the initial sound-matching measure was challenging for most children and, as reported earlier, a pattern of highly skewed responses led us to create a dichotomous measure. Positive intervention effects on children's blending but not initial sound-matching skills may reflect children's status on a developmental continuum of phonological awareness that proceeds from awareness of large units of sound (e.g., words) to awareness of phonemes and smaller abstract units of sound (Phillips, Clancy-Menchetti, & Lonigan, 2008). It may be, as well, that teachers focused more instructional time on blending than on sound matching, as Cassady, Smith, and Putnam (2008) found in a study of kindergarten children and their teachers.

Children's language skills and teachers' vocabulary instruction and use of language-eliciting prompts during free play significantly improved over time in the entire sample (see Table 3), but the intervention apparently did not change teachers' business-as-usual approaches to supporting language development. The study found no intervention effects on teachers' instructional practices aimed at promoting children's vocabulary knowledge and use of language during large group time and, as a likely consequence, no effects on children's receptive vocabulary. Dominant approaches to language use in prekindergarten classrooms, including limited attention to novel words (e.g., Neuman & Dwyer, 2009) and a general pattern of teachers offering mostly statements and directives (e.g., Gest, Holland-Coviello, Welsh, Eichter-Catt, & Gill, 2006), are difficult to change (Justice et al., 2008; Landry et al., 2009). Helping teachers learn and practice the nuances of extending children's talk and supporting the use of new words may require a more focused intervention than offered in a PD program with relatively broad content boundaries. Across the one semester of intervention in the current study, each coaching feedback to a teacher typically pertained to a new topic within one of the major outcome areas targeted by the intervention, as reported earlier. We wonder if teachers may have benefited from revisiting a particular practice through repeated attention in consecutive coaching contacts. The Wasik et al. (2006) PD intervention, focused exclusively on teachers' book reading and conversation strategies for an entire school year, yielded strong positive effects on children's receptive and expressive language skills (*d*s = 0.73 and 0.44, respectively).

Effect size results from prior studies of similar interventions and target populations provide a benchmark for interpreting the current study's effect sizes for significant intervention effects (Hill, Bloom, Black, & Lipsey, 2008). The range of effect sizes for the four child outcomes (.17–.29) for which there were statistically significant positive intervention effects in the current one-semester intervention compares favorably to the range of effect sizes for the three literacy and language child outcomes (.15–.39) for which there were significant positive effects in the Bierman et al. (2008) intervention, which spanned a school year and involved implementation of new curricula for promoting both academic and social–emotional indicators of school readiness in a Head Start population. At the classroom level, effect sizes for the current study's general classroom environment subscale and literacy, language, and curriculum subscale of the ELLCO (.99 and .92, respectively) were stronger than effect sizes for these subscales (.60 and .48, respectively) in the one-semester PD intervention investigated by

Dickinson and Caswell (2007) in a Head Start sample. The ELLCO effect sizes also were stronger than the overall effect size (.77) in the Neuman and Cunningham (2009) study of early language and literacy coursework combined with coaching with teachers in child care centers. The Landry et al. (2009) PD intervention, which included an intervention component (systematic feedback on children's progress) not included in the current study, found stronger effects for teacher behavior outcomes (range: 0.46–1.40) but no effects on oral language instruction and small effects for child outcomes that generally varied by site.

Results of the current study point to technologically mediated (remote) delivery of literacy coaching as a promising alternative to the common coaching practice of in-person visits. Technological innovations used in the remote condition paired coach feedback with segments of a teacher-submitted videotape and included embedded links to pertinent video exemplars and text in the hypermedia resource. Coaching supports to teachers in the remote condition, then, approximated the supports provided to teachers in the on-site condition.

Limitations

Two study limitations are notable. First, random assignment at the teacher level heightened the possibility of second-hand exposure of teachers in the control group to the intervention during fall semester and intervention contamination involving the two coaching conditions (e.g., a teacher in the remote condition sharing the hypermedia resource with a teacher in the on-site condition). Two factors that potentially facilitate intervention contamination, team teaching and an intervention that entails collaborative work among lead teachers (Wayne et al., 2008), were not present in the current study. In addition, the intervention did not involve highly visible indicators of participation that might trigger the curiosities of teachers in the wait-listed control group or one of the two coaching conditions. Workshops were held during teachers' vacation times at locations other than the program site, teachers in the remote condition used the laptop computer during nonwork hours, and coach visits to classrooms of teachers in the on-site condition were not an anomaly in a program where a range of specialists (not affiliated with the current study) regularly visited classrooms. Also, teachers in the on-site coaching condition had access to video exemplars and articles included in the hypermedia resource via their coach.

A second limitation is that results of our study, which involved university-based coaches working at arm's length from teachers' supervisors, may not be applicable to PD interventions in which coaches are employed by the program that also employs the teachers. Also, similar to other PD studies, results of intervention research with teachers who volunteer to participate in the intervention may not generalize to PD programs with required teacher participation.

Implications and Future Directions

Results of the current study add experimental evidence to a fledgling research literature on the benefits of employing an intensive PD program to significantly improve at-risk children's early literacy skills. Findings also point to two research avenues for further development of PD as a tool for bolstering preschool foundations of later literacy outcomes.

One potentially productive research direction is to systematically compare effects of contrasting PD approaches to promoting change in teaching practices. It would be useful to know the relative effects of PD interventions that seek to improve teacher quality via implementation of a new curriculum and PD interventions that provide structured guidance to teachers in formulating and implementing changes in existing instructional practices in the context of information about evidence-based practices. One critically important question is whether PD approaches differ in the sustainability of PD-initiated improvements in instructional practices beyond the period of PD support. For example, teachers discontinued use of dialogic reading strategies at the conclusion of the intervention phase of a dialogic reading study (Whitehurst et al., 1994). We do not know whether teacher understanding, ownership, and extensions of new teaching practices are enhanced in an alternative PD strategy of supporting teachers in planning and implementing instructional improvements in their on-going curriculum. A related question is whether the ease with which teachers effectively implement instructional improvements varies by PD approach. PD programs centered on adoption of a new curriculum presumably provide a shortcut to classroom improvements with a ready-to-go plan of activities, but this efficiency may be offset by time needed for determining how existing practices can accommodate a new curriculum with sufficient integrity.

A second research direction pertains to uses of technology to deliver PD. Because the current study appears to be the first random assignment comparison of in-person and technologically mediated coaching with teachers, a replication of our research would be informative. It would be beneficial for future research on comparisons of web-mediated and in-person coaching to examine the nature of teacher participation in these two delivery systems, including the quality of teacher–coach relationships and specific ways in which teachers contribute to the content focus of the coaching process. Examination of coach time use from a cost–benefit perspective also is needed.

In sum, findings of the current study add empirical support to the use of intensive PD with prekindergarten teachers for significantly improving at-risk children's literacy outcomes. Results also point to promising research directions in further development of PD methods regarding technologically mediated delivery of expert coaching, approach to changing existing instructional practices, and the content scope of PD interventions.

References

Adams, M. J., Foorman, B. R., Lundberg, I., & Beeler, T. (1998). *Phonemic awareness in young children.* Baltimore, MD: Brookes.

Bierman, K. L., Domitrovich, C. E., Nix, R. L., Gest, S. D., Welsh, J. A., Greenberg, M. T., . . . Gill, S. (2008). Promoting academic and social–emotional school readiness: The Head Start REDI program. *Child Development, 79,* 1802–1817.

Cassady, J. C., Smith, L. L., & Putman, S. M. (2008). Phonological awareness development as a discrete process: Evidence for an integrative model. *Reading Psychology, 29,* 508–533.

Center for Early Education and Development, University of Minnesota. (2005). *Get it got it go!* Minneapolis, MN: Author.

Clay, M. M. (1979). *The early detection of reading difficulties.* Portsmouth, NH: Heinemann.

Clay, M. M. (1985). *Concepts about print: Sand and stones*. Westport, CT: Heinemann.

Committee for Children. (2002). *Second step: Violence prevention curriculum. Preschool/kindergarten-grade 9 trainer's manual* (3rd ed.). Seattle, WA: Author.

Community Opportunities, Accountability, and Training and Educational Services Act of 1998, Pub. L. No. 105–285, 112 Stat. 2702.

Connor, C. M., Morrison, F. J., & Slominski, L. (2006). Preschool instruction and children's emergent literacy growth. *Journal of Educational Psychology, 98,* 665–689.

Diamond, K. E., Gerde, H. K., & Powell, D. R. (2008). Development in early literacy skills during the prekindergarten year in Head Start: Relations between growth in children's writing and understanding of letters. *Early Childhood Research Quarterly, 23,* 467–478.

Dickinson, D. K., & Caswell, L. (2007). Building support for language and early literacy in preschool classrooms through in-service professional development: Effects of the Literacy Environment Enrichment Program (LEEP). *Early Childhood Research Quarterly, 22,* 243–260.

Dodge, D. T., Colker, L. J., & Heroman, C. (2002). *The creative curriculum for preschool* (4th ed.). Washington, DC: Teaching Strategies.

Domitrovich, C. E., Gest, S. D., Gill, S., Bierman, K. L., Welsh, J. A., & Jones, D. (2009). Fostering high-quality teaching with an enriched curriculum and professional development support: The Head Start REDI program. *American Educational Research Journal, 46,* 567–597.

Dunn, L., & Dunn, L. (1997). *Peabody Picture Vocabulary Test—Third Edition.* Circle Pines, MN: American Guidance Service.

Gest, S. D., Holland-Coviello, R., Welsh, J. A., Eicher-Catt, D., & Gill, S. (2006). Language development subcontexts in Head Start classrooms: Distinctive patterns of teacher talk during free play, mealtime and book reading. *Early Education and Development, 17,* 293–315.

Harms, T., Clifford, R. M., & Cryer, D. (1998). *Early Childhood Environment Rating Scale: Revised Edition.* New York, NY: Teachers College Press.

Hill, C. J., Bloom, H. S., Black, A. R., & Lipsey, M. W. (2008). Empirical benchmarks for interpreting effect sizes in research. *Child Development Perspectives, 2,* 172–177.

Improving Head Start for School Readiness Act of 2007, Pub. L. No. 110–134, 121 Stat. 1363.

International Reading Association. (2004). *The role and qualifications of the reading coach in the United States.* Newark, DE: Author.

Jackson, B., Larzelere, R., St. Clair, L., Corr, M., Fichter, C., & Egertson, H. (2006). The impact of *HeadsUp! Reading* on early childhood educators' literacy practices and preschool children's literacy skills. *Early Childhood Research Quarterly, 21,* 213–226.

Jackson, R., McCoy, A., Pistorino, C., Wilkinson, A., Burghardt, J., Clark, M., . . . Schmidt, S. R. (2007). *National evaluation of Early Reading First: Final report to Congress.* Washington, DC: Institute of Education Sciences, U.S. Department of Education.

Jacobson-Chernoff, J., Flanagan, K. D., McPhee, C., & Park, J. (2007). *Preschool: First findings from the preschool follow-up of the Early Childhood Longitudinal Study, Birth Cohort (ECLS-B)* [NCES Report No. 2008-025]. Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

Justice, L. M., Mashburn, A., Hamre, B., & Pianta, R. (2008). Quality of language and literacy instruction in preschool classrooms serving at-risk pupils. *Early Childhood Research Quarterly, 23,* 51–68.

Koehler, M. J. (2002). Designing case-based hypermedia for developing understanding of children's mathematical reasoning. *Cognition and Instruction, 20,* 151–195.

Landry, S. H., Anthony, J. L., Swank, P. R., & Monseque-Bailey, P. (2009). Effectiveness of comprehensive professional development for teachers of at-risk preschoolers. *Journal of Educational Psychology, 101,* 448–465.

Landry, S. H., Swank, P. R., Smith, K. E., Assel, M. A., & Gunnewig, S. B. (2006). Enhancing early literacy skills for preschool children: Bringing a professional development model to scale. *Journal of Learning Disabilities, 39,* 306–324.

Lee, J., Grigg, W. S., & Donahue, P. L. (2008). *The nation's report card: Reading 2007.* Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Retrieved January 30, 2009 from http://nces.ed.gov/nationsreportcard/pdf/main2007/2007496.pdf

Lonigan, C. J., Wagner, R., & Torgesen, J. (2007). *Test of Preschool Early Literacy.* Austin, TX: Pro-Ed.

Lonigan, C. J., Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (2002). *Preschool Comprehensive Test of Phonological and Print Processing.* Tallahassee, FL: Florida State University.

McGrew, K. S., & Woodcock, R. W. (2001). *Woodcock–Johnson Achievement Test—Third Edition technical manual.* Itasca, IL: Riverside.

Missall, K. N., & McConnell, S. R. (2004). *Psychometric characteristics of individual growth and development indicators: Picture naming, rhyming, and alliteration* (Tech. Report No. 8). Minneapolis, MN: Center for Early Education and Development.

Missall, K. N., Reschly, A., Betts, J., McConnell, S. R., Heistad, D., Pickart, M., . . . Marston, D. (2007). Examination of the predictive validity of preschool early literacy skills. *School Psychology Review, 36,* 433–452.

National Early Literacy Panel. (2008). *Developing early literacy: Report of the National Early Literacy Panel.* Washington, DC: National Institute for Literacy.

Neuman, S. B., & Cunningham, L. (2009). The impact of professional development and coaching on early language and literacy instructional practices. *American Educational Research Journal, 46,* 532–566.

Neuman, S. B., & Dwyer, J. (2009). Missing in action: Vocabulary instruction in pre-k. *Reading Teacher, 62,* 384–392.

Perlman, M., Zellman, G. L., & Le, V. (2004). Examining the psychometric properties of the Early Childhood Environment Rating Scale—Revised. *Early Childhood Research Quarterly, 19,* 398–412.

Phillips, B. M., Clancy-Menchetti, J., & Lonigan, C. J. (2008). Successful phonological awareness instruction with preschool children: Lessons from the classroom. *Topics in Early Childhood Special Education, 28,* 3–17.

Pianta, R. C., Mashburn, A. J., Downer, J. T., Hamre, B. K., & Justice, L. (2008). Effects of web-mediated PD resources on teacher–child interactions in pre-kindergarten classrooms. *Early Childhood Research Quarterly, 23,* 431–451.

Powell, D. R., Diamond, K. E., Bojczyk, K. E., & Gerde, H. K. (2008). Head Start teachers' perspectives on early literacy. *Journal of Literacy Research, 40,* 422–460.

Powell, D. R., Diamond, K. E., & Koehler, M. J. (in press). Use of a case-based hypermedia resource in an early literacy coaching intervention with pre-kindergarten teachers. *Topics in Early Childhood Special Education.*

Puma, M., Bell, S., Cook, R., Heid, C., Lopez, M., Zill, N., . . . Bernstein, H. (2005, May). *Head Start impact study: First year findings.* Washington, DC: U.S. Department of Health and Human Services, Administration for Children and Families.

Raudenbush, S., & Bryk, A. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Thousand Oaks, CA: Sage.

Sherin, M. G., & van Es, E. (2005). Using video to support teachers' ability to notice classroom interactions. *Journal of Technology and Teacher Education, 13,* 475–491.

Smith, M. W., Dickinson, D. K., Sangeorge, A., & Anasatopoulos, A. (2002). *Toolkit for assessing early literacy in classrooms.* Baltimore, MD: Brookes.

Snow, C. E., Burns, M. S., & Griffin, P. (Eds.). (1998). *Preventing reading difficulties in young children.* Washington, DC: National Academy Press.

Wasik, B. A., Bond, M. A., & Hindman, A. (2006). The effects of a

language and literacy intervention on Head Start children and teachers. *Journal of Educational Psychology, 98,* 63–74.

Wayne, A. J., Yoon, K. S., Cronen, S., Zhu, P., & Garet, M. S. (2008). Experimenting with teacher professional development: Motives and methods. *Educational Researcher, 37,* 469–479.

Whitehurst, G. J., Arnold, D. S., Epstein, J. N., Angell, A. L., Smith, M., & Fischel, J. E. (1994). A picture book reading intervention in day care and home for children from low-income families. *Developmental Psychology, 30,* 679–689.

Whitehurst, G. J., & Lonigan, C. J. (1998). Child development and emergent literacy. *Child Development, 69,* 848–872.

Zill, N., & Resnick, G. (2006). Emergent literacy of low-income children in Head Start: Relationships with child and family characteristics, program factors, and classroom quality. In D. K. Dickinson & S. B. Neuman (Eds.), *Handbook of early literacy research* (Vol. 2, pp. 347–371). New York, NY: Guilford Press.

Zill, N., Sorongon, A., Kim, K., Clark, C., & Woolverton, M. (2006). *FACES 2003 research brief: Children's outcomes and program quality in Head Start.* Retrieved from http://www.acf.hhs.gov/programs/opre/hs/faces/reports/research_2003/research_2003.pdf

Received February 12, 2009
Revision received September 9, 2009
Accepted September 23, 2009 ■