Journal of Applied Research on Children: Informing Policy for Children at Risk

Volume 7
Issue 2 *The Critical Years: Research and Progress in Early Education and Early Brain Development*

Article 9

2016

A Development Evaluation Study of a Professional Development Initiative to Strengthen Organizational Conditions in Early Education Settings

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Acknowledgements
This research was supported supported by a grant awarded to the Ounce of Prevention Fund by the US Department of Education's Investing In Innovation program including a private match from the Stranahan Foundation. We thank our colleagues from The Ounce of Prevention Fund who provided insight and expertise that greatly assisted the research, although they may not agree with all of the interpretations/ conclusions of this paper. We thank Jaime Madison Vasquez, MEd for assistance with development of the implementation study database.

Introduction

Across education sectors in the United States, the drive to close chronic achievement gaps has piqued interest in school leadership as a cost-effective lever for implementing standards-based reforms. Similarly, the national consensus around early childhood education (ECE) has focused new attention on directors and supervisors as instructional leaders and critical collaborators in building center-based organizational capacity for continuous quality improvement. Little research, however, has examined the capacity of leaders in urban, community-based ECE centers to engage their staff in more ambitious, multi-modal job-embedded professional development (JEPD), the approach to PD gaining prevalence in K-12 educational settings. The present study reports findings from a 3-year development evaluation of a comprehensive ECE Professional Development Initiative (ECE PDI) in a large, Midwest urban center, funded through the federal Investing in Innovation (i3) grant program.

Job-Embedded Professional Development in Early Childhood Contexts

High-quality instruction is essential to producing developmental gains for young children and can mitigate risk factors such as family poverty and low parental education.[1] Even in ECE programs with highly qualified teachers, teacher-child interactions often do not provide the level of instructional support that children need to be well prepared for success in kindergarten.[2] In order to improve instructional quality, an emerging focus on early childhood professional development involves supporting leaders in creating a web of supports for teacher learning and child growth.[3,4] Three key factors are driving this renewed interest in the development of instructional leaders and JEPD for early childhood professionals.

First, Bryk et al's[5] synthesis of the research base on comprehensive school improvement places organization- and classroom-level constructs in dynamic interrelationship to better account for how the organization of a school interacts with work inside its classrooms by teachers to support student engagement and learning. Their framework emphasizes leadership as the "driver" for establishing the organizational capacities essential to success with an increasingly ambitious instructional agenda. Moreover, a convincing body of evidence from the K-12 sector now links principal leadership strategies to the improvement of student learning outcomes.[6,7] Highly effective principals influence student achievement primarily through learning how to transform working relations among adult professionals—toward high expectations for all, distributed leadership, inquiry-based collaboration, and the development of facilitative systems.[8]

Second, existing research in the early childhood education sector supports the positive impact of leadership investments upon both teacher efficacy and classroom practice.[9] Educational attainment and ongoing professional training among center administrators have been linked to several metrics of program quality, including teacher retention and job satisfaction, effective use of data for program improvement, and rates of center accreditation.[10] Improved instruction and program quality, in turn, is associated with enhanced learning environments for children as well as better child outcomes.[2(p1),11] As in the K-12 context, studies linking student outcomes to leadership practices pose significant methodological challenges and remain a frontier of research. But the consensus is clear, at least within major policy communities such as Head Start, that investment in leadership development is essential to transitioning the early childhood sector toward sustainable practices of evidence-driven improvement.[12]

Third, a clear paradigm shift has occurred in understandings of professional development as a vehicle for standards-based reform.[13] In contrast to traditional "one-off" modes of PD, the emerging JEPD paradigm is defined as "...long-term, school-based, collaborative, focused on students' learning, and linked to curricula.... In such programs, teachers examine student work, develop performance assessments and standards-based report cards, and jointly plan, teach, and revise lessons."[14(p3)] Such JEPD models are demanding in that they expose gaps in knowledge and competence, challenge personal dispositions, promote the distribution of leadership opportunities, and disrupt stable organizational patterns in favor of innovation.[15] Research indicates that job-embedded, comprehensive PD can be implemented with fidelity, yielding improvements in early childhood teachers' instructional capacity.[16-18] Other studies suggest that how leaders engage teachers has significant impact on whether teachers take up standards-based practices around instruction[19] and social and emotional supports.[20]

However, not all analyses of the merits of JEPD approaches are equally impressive or sanguine. Even convinced advocates of investment in JEPD designs acknowledge that they can be time-intensive for participants, expensive in terms of assets like on-site coaching, and demanding in terms of scheduling and the coordination of elements and resources.[21,22] Moreover, quality of implementation remains a fundamental challenge. While many teachers value opportunities to collaborate around lesson planning, peer-to-peer observation, and lesson study, they continue to associate "professional development" with externally imposed expectations of compliance.[23]

In many respects, the ECE PDI represents an ambitious synthesis of the most promising features of comprehensive JEPD as they emerged in

recent research. ECE PDI aligns both the content and methods of leader and teacher PD intensively over an extended period of time. In what follows, we first introduce the purpose of our study, followed by the model purveyor's theory of action and primary design features of the ECE PDI. We then detail our evaluation design and describe the characteristics of the teacher and leader sample that emerged from the model purveyor's center selection process. Then, we detail findings of the implementation and impact studies. Lastly, we conclude with a discussion of the findings.

Purpose of the Study

The purpose of the 3-year evaluation study was to assess the effectiveness of an Early Childhood Education Professional Development Initiative (ECE PDI) in advancing the knowledge, skills, and dispositions of community-based early childhood leaders and teachers in relation to creating the conditions for superior developmental outcomes for low-income students served by these community-based centers. Therefore, the evaluation pursued 3 broad goals. First, we intended to monitor and summarize patterns of implementation over the full span of the ECE PDI in order to assess fidelity and feasibility of implementation. Second, we aimed to assess impacts of implementation on the professional learning of teachers and leaders and, more distally, upon the growth and development of children in all intervention centers. Third, drawing on Improvement Science methodology, we planned to strike a productive balance between the roles of independent external summative evaluator and collaborative formative evaluator providing rich and timely data and feedback to the design development process.[24] The following research questions served as a guide to the external evaluation:

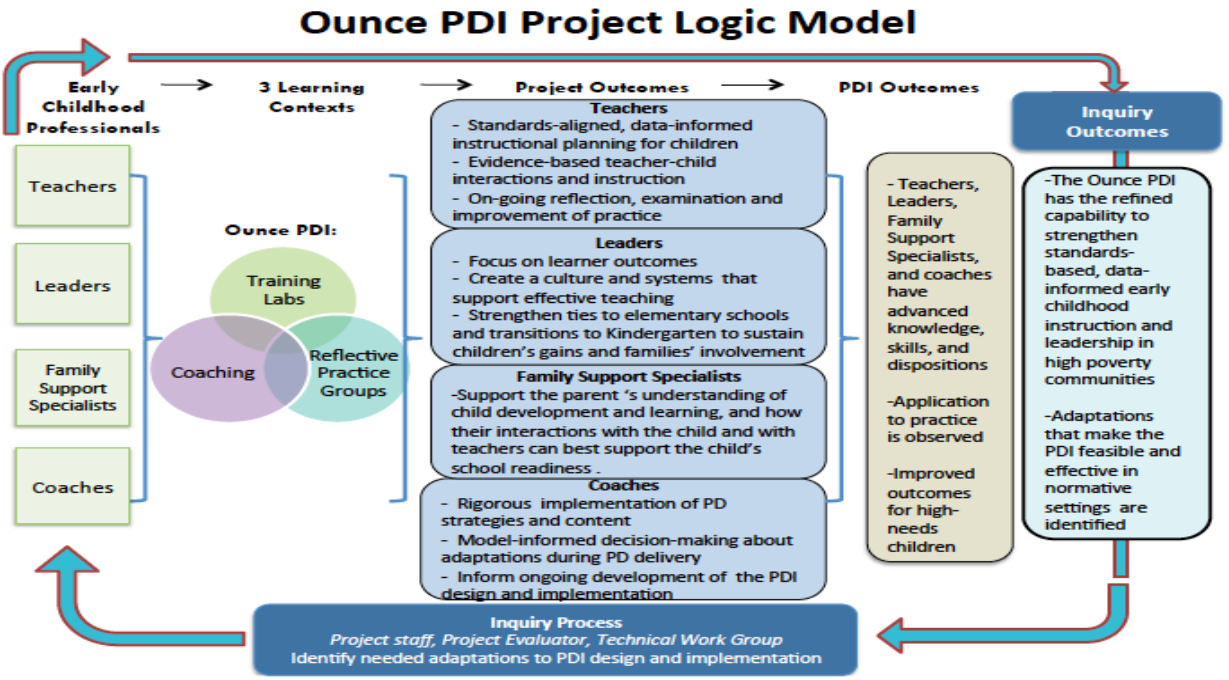
1. (Implementation fidelity) Overall, was the ECE PDI activity implemented with fidelity as the designers intended? Was the ECE PDI activity engaged and received by the participants as intended?
2. (Adult Learning Outcomes) What features of implementation are most critical to realizing targeted adult learning outcomes?
3. (Classroom Practice Outcomes) Does the ECE PDI produce evidence of improvement in classroom instructional practice in the intervention classrooms compared to classrooms in matched non-participating community-based centers?
4. (Student Learning Outcomes) Does the ECE PDI produce evidence of superior outcomes for high-needs, low-income students in participating provider settings compared to the

outcomes of children in matched non-participating community-based programs?

Description of the Intervention Model

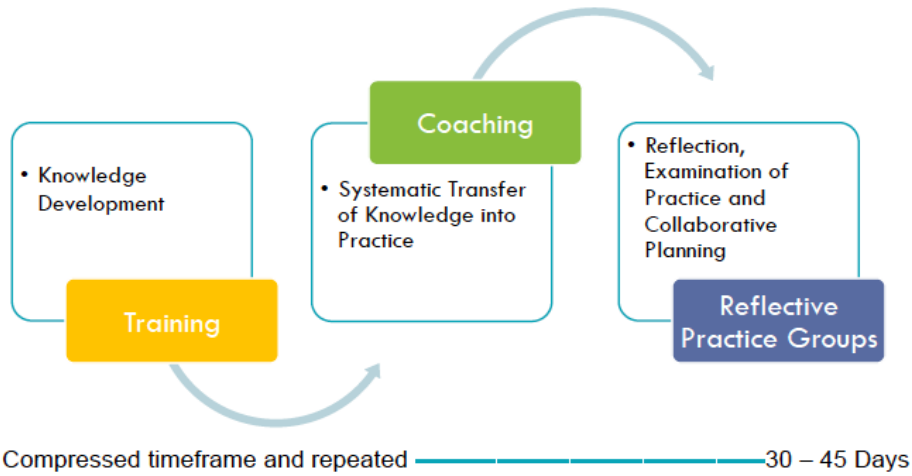
In Fall 2011, the Ounce of Prevention Fund (the Ounce) was awarded a 3-year Investing in Innovation (i3) development grant from the US Department of Education to develop, implement, refine, and study a job-embedded Early Childhood Education Professional Development Initiative (ECE PDI) for early childhood administrators and teachers. Through 3 core PD strategies or "contexts for learning" (i.e., learning Labs, coaching, and reflective practice groups [RPGs]), the ECE PDI supports ECE leaders' ability to provide organizational systems and cultures to support early learning teachers' instructional planning and implementation. To this end, the ECE PDI also supports the ECE PDI Coaches who are charged with rigorously implementing the model. By aligning the professional learning cycles of these 4 key stakeholders—center leaders, direct supervisors, teachers, and coaches—early learning settings are poised to realize significantly improved standards-aligned instruction in the classroom, leading to better results for young high-needs children over time. The theory of change guiding the ECE PDI model is illustrated in Figure 1.

Figure 1. PDI Theory of Change and Logic Model



The ECE PDI engages community-based ECE center leaders, teachers, and coaches in parallel learning cycles to simultaneously advance their knowledge, skills, and dispositions to improve organizational systems, instructional planning and implementation, fidelity in the delivery of PD, and children's early achievement. The ECE PDI configures the following tightly coupled PD strategies within a compressed time frame—training labs, on-site coaching, and reflective practice groups—to create varied learning contexts to promote different types of social interaction intended to promote adult learning as seen in Figure 2. Specifically, training labs build knowledge and deepen understanding. Coaching systematically supports the transfer of new and nuanced knowledge into practice as abstract pedagogical discussions become more meaningful when embedded in authentic work. Reflective practice groups build professional dispositions and a culture of reflection, lead to an examination of practice and problem-solving that consolidates the learning in the proceeding training labs and coaching cycles, and help sustain efforts at improvement over time.

Figure 2. Engagement in 3 Contexts for Professional Development and Learning



Conceptually, the ECE PDI incorporates 6 key frameworks that delineate evidenced-based practice goals and a final framework to motivate leaders and teachers to adopt these practices.

1. The Five Essential Supports for School Improvement Framework[5(p1)] is used to advance the leaders' understanding

and application of organizational systems for continuous improvement.
2. The Ounce developed the *Inclusive-Inquiry and Decision-Making Cycle* for leaders to employ cycles of staff-inclusive and collaborative research intended to assist in problem solving.
3. The Classroom Assessment Scoring System (CLASS) framework[25] is used to outline evidence-based and age-specific teacher-child interactions.
4. The Teaching Strategies GOLD™ Creative Curriculum and Assessment framework is used to help teachers advance their understanding of appropriate child development goals and application of these goals to their lesson planning and instructional practice.
5. The Ounce developed the *Focused Teaching Cycle* in order to encourage teachers to engage in a structured and collaborative lesson planning practice when "out of the action" and when "in the action" engage in structured reflection when interacting with children to increase the deliberate application of emotionally supportive, organized, instructionally meaningful practices.
6. The coaches used Motivational Interviewing[26] micro-skills to evoke reflection on personal and organizational change processes and to galvanize leader and teacher motivation to change mindsets and practices.

Drawing upon these frameworks, the ECE PDI learning cycle for leaders intends to increase the following instructional leadership knowledge, skills, and dispositions of administrators and supervisors: a) inclusive leadership practices to strengthen relational trust and cultivate a strong professional community by including staff in collective inquiry, problem-solving, and planning for practice improvement; and b) providing a system of coherent program- and job-embedded instructional guidance and supports for teachers' continuous professional learning, practice effectiveness, and improvement. The content of the ECE PDI modules for leaders is directly distilled from the Five Essential Supports framework.[5(p1)] By helping center leaders and direct supervisors become effective leaders strategically focused on teaching and learning, these early learning settings are poised to realize significantly improved standards-aligned instruction in the classroom, leading to better results for young high-needs children over time.[5(p1)]

The ECE PDI learning cycle for teachers intends to guide them in employing an approach that: (a) aligns their curriculum, instruction, and assessment practices to the Illinois Early Learning Standards and core

curriculum and development goals for infants, toddlers, and preschoolers; and (b) employs routines of collaboration that encourage reflection intended to improve decision-making related to evidence-based instructional practice. The content of the ECE PDI for teachers is grounded in "pedagogical content knowledge"[27] aligned to the CLASS framework.[25(p6)] Shulman's concept of pedagogical content knowledge can be summarized as knowledge about what is taught (curricular content), who is to be taught (children), and how to teach (teaching methods).[28] By focusing on pedagogical content knowledge, the ECE PDI supports teachers in synthesizing knowledge of content, students, and pedagogy in ways that lead to more effective planning and implementation of instructional practices.[29] Simultaneously, the ECE PDI encouraged teachers to consider not only knowledge about who is being taught (children) but also knowledge about whom they are teaching with (co-teachers). Helping teachers develop emotionally supportive classroom environments for children and with co-teachers alike is likely to increase student engagement and reduce children's stressed-out, off-task behavior, thereby setting the stage for greater academic success for underserved children.[30]

Through the implementation of an innovative JEPD design, the ECE PDI proposes to build leader capacities to provide teachers with 5 organizational supports empirically linked to improving teaching and learning.[5(p1)] Then through engagement in and modeling through 3 core learning contexts, the model intends to develop administrators' capacities to strengthen the frequency and coherency of instructional guidance and professional learning supports provided to teachers and, more distally, upon the growth and development of children in all intervention centers.

Research Design

We employed a mixed methods approach to the design of our evaluation study. For the implementation study, we measured fidelity for 6 key components of the ECE PDI model. Three criteria for measuring fidelity of implementation served as the framework[31]: (1) Adherence: whether the key components of the PD are implemented as designed; (2) Duration: the number, length, or frequency of the PD implemented; and (3) Participant responsiveness: the extent to which participants are engaged by PD activities. In sum, these criteria measure "fidelity to structure" of the ECE PDI.[32] For the impact study, we did not pursue an RCT design given the intention to significantly alter/improve the intervention design from baseline, along with budgetary limitations that precluded the recruitment and maintenance of a randomized design. Instead, a quasi-experimental, matched-sample design was used to test impacts for both classroom teachers and children for the intervention and comparison conditions,

allowing the project to make use of several categories of administrative outcome data.

Study Setting and Participants

Implementation occurred from January 2012 to November 2014 in 4 publicly funded, community-based, birth to 5 early learning centers in a large, urban Midwest city. The centers were selected through a competitive request for proposals, which required applicants to be birth to 5 Head Start sites. One intervention program maintained 2 site locations, which were sufficiently distinct demographically to be matched and analyzed separately in impact analyses.

Implementation study participants included 15 predominantly female administrators of color (i.e., center owners, directors, and direct supervisors) and 60 predominantly black and Latino infant, toddler, and preschool teachers in 21 classrooms serving over 500 low-income children and families of color. The extensive application process required center leaders to demonstrate the interest of leaders and teachers in undertaking a demanding JEPD process. Analyses indicated that the 4 centers selected for the study were demographically representative of Head Start centers located in high-needs communities in Chicago. Of the leaders, 65% hold a post-bachelor's degree, while 44% and 26% of teachers hold an associate's and bachelor's degree respectively, reflecting substantial educational asymmetry.

In order to establish the impact study sample, several criteria were applied to select a cadre of non-ECE PDI comparison centers for use in the classroom practice and student developmental impact analyses. A total of 40 early learning centers were matched to the 5 ECE PDI participating early learning sites based on the number of public funding streams comprising the program budget; percentage of free and reduced lunch status; child demographic composition including race, dual-language, and special education eligibility; and neighborhood census variables, including unemployment and violence. Tests of impacts for children examined change from baseline for the participating and comparison conditions, following establishment of baseline equivalence between treatment and comparison centers for each impact measure.

Data Collection and Analysis

Based on our evaluation logic model (see Appendix A), the evaluation identified 6 key components to measure for fidelity of implementation. Each key component is comprised of indicators, which specify what is observable, and helps determine what is being implemented as planned. The components (labeled in the logic model) briefly

characterized include:

1. *Component 1—Coach Induction and Community of Practice Implemented by the Sponsor Organization*. Coaches carry the primary responsibility within ECE PDI both for rooting the embedded PD routines for leaders and teachers and for scaffolding the transition of PD responsibilities to each center's practice leaders over time. Component 1 captures how well the Ounce team delivered the PD associated with the introductory training of the coaches for their roles in the project. Includes 2 sub-indicators.
2. *Component 2—Professional Development Initiative Implementation*. The Ounce team committed to providing an ambitious schedule of PD experiences to teachers and leaders within a compressed time frame—typically 6 to 8 weeks, depending on the category of participants. Eight indicators focus on hours of PD delivered and percentage of PD sequences delivered within the specified timeframe.
3. *Component 3—Coach Professional Development*. Coaches continued to receive training within a general framework for building reflective practice similar to that of teachers and leaders. Two indicators focus on rates of attendance of coaches at initial induction trainings and subsequent continuing PD trainings.
4. *Component 4—Teacher Professional Development*. Creating the conditions for teacher learning required the Ounce team to assure adequate levels of teacher attendance as well as engagement with reflective learning exercises—most notably, the KWLH reflection format ("KWLH" denotes four questions: "What do you know?"; "What do you want to know?"; "What have you learned?"; "How can you learn more?"). Two indicators focus on rates of attendance by teachers and levels of completion of the KWLH reflection format.
5. *Component 5—Direct Supervisor Professional Development*. Direct supervisors of age-level classroom teams were expected to take on several skill sets modeled by ECE PDI coaches in the first half of the project. Four indicators focus on whether direct supervisors sustained high levels of attendance at leader PD sessions, completed most sections of KWLH reflection exercises, and attended the PD sessions of their assigned teachers.
6. *Component 6—Center Leader Professional Development*. Center owners and directors are critical to establishing the necessary climate, systems, and organizational conditions for

embedded PD. Three indicators focus on whether center owners and directors attended sufficient hours of PD and engaged KWLH reflection exercises thoroughly enough to shift their professional knowledge and mindsets.

Consistent with What Works Clearinghouse and i3 grant guidelines, we measured the indicators for each of the 6 key components related to the implementation of ECE PDI contexts for learning once per year for 3 years. Drawing on literature in the field, Head Start Performance Standards, and the Ounce's desire to hold themselves accountable to high-quality implementation, we determined threshold levels of fidelity for each key component. Developing the fidelity matrix included several months of conversation with the model purveyors in order to develop an authentic rating system that was also sensitive enough to accurately capture variance in implementation over time.

Several data sources were employed to analyze the extent to which the intended goal was being met. Sign-in sheets were collected to document the participant attendance to the ECE PDI contexts for learning. Instructional outlines and handouts from the learning contexts were collected to document the content of implementation. Teachers and leaders were asked to complete a formative assessment called the KWLH, which is a graphical organizer designed to support the learning process as well as assess conceptual learning over time. Rates of KWLH completion were calculated in order to measure the advancement of participant knowledge based on the theoretical premise that completion of such formative assessment in itself leads to metacognitive development. We designed a relational database to support highly accurate calculations of actual rates of attendance and other estimates of ECE PDI dosage (e.g., rates of completion of formative assessments) against intended rates of implementation. Table 1 displays specific time points in the intervention mapped onto the phases of implementation. Each implementation phase consists of differing intended hours of PD per participant group.

Table 1. Intended Hours of PD per Participant Group and Phase of ECE PDI Implementation

Time Point	Implementation Stage	Hours/ Coach	Hours/ Leader	Hours/ Teacher
1. April 2012 – August 2012	Program Installation	119	n/a	n/a
2. January 2013 – December 2013	Initial Implementation	181	32.5 - 42.5	67.5
3. January 2014 – November 2014	Implementation and Sustainability	181	32.5 - 42.5	67.5

The final fidelity ratings were based on point systems aligned to a predetermined benchmark. Certain indicators were assigned points to designate low, mid, and high levels of fidelity. Whereas a center would not earn any points for low levels of fidelity, several could earn points for mid levels of fidelity. Once calculated, the points were "rolled up" into a construct level score that determined one final dichotomous rating. This rating indicated whether the center met fidelity (yes/no). Three of the 4 ECE PDI centers (75% or more) had to meet fidelity in order to meet program fidelity overall. Dichotomous ratings were required by the Department of Education's implementation oversight process (i.e., National Evaluation of Investing in Innovation (NEi3) as an outcome criterion to be reported by all NEi3 implementation studies.

To assess change in classroom practice, classroom observations of teacher-child interactions were collected before and after the PDI intervention, in both treatment and comparison preschool classrooms using the Classroom Assessment Scoring System (CLASS-PreK). CLASS data were drawn from administrative data records collected and housed at the city's Department of Family and Support Services (CDFSS). Limitations in data availability restricted analyses to the center (rather than classroom) level. Three treatment centers and 7 comparison centers had baseline and Time 2 data available for analysis for the Emotional Supports and Classroom Organization measures. Four treatment centers and 10 comparison centers had baseline and Time 2 data available for the Instructional Supports measure.

Teacher ratings of children's learning and development were collected quarterly through administrative data sources contracted by the city's Department of Family and Support Services during the intervention in treatment and comparison programs using the GOLD™ assessment system (GOLD). The evaluation team was not involved directly in collecting or validating the GOLD data used for impact analyses. The Creative Curriculum GOLD™ assessment is an observation-based assessment system administered by classroom teachers that gathers information on 38 developmental objectives each arrayed along continua scored on a 10-point scale ("not yet" to level 9). Five well validated developmental factors derived from these objective scores—social-emotional, language, cognitive, literacy, and mathematics—were the primary measures used in this study. As a sixth measure, the study employed a specific GOLD assessment of English Language Acquisition to capture possible differential impacts of ECE PDI on the emerging English proficiency of students identified as "Dual Language Learners." We use administrative GOLD data collected by children's actual ECE teachers based on findings by Lambert and associates that classroom teachers provided adequate training could use

the instrument reliably and were better positioned than unfamiliar external assessors to observe their students with minimum impact on their affect or engagement with classroom materials.[33,34]

The impact study focused on early childhood students (N = 208) who entered their treatment centers in Fall 2012 (2 years of treatment) or Fall 2013 (1 year of treatment) and who were assessed at Time 2 in Spring 2014. Comparison students (N = 924) entered at the same time (Fall 2012 or Fall 2013) and were also present and assessed in Spring 2014. Specific student Ns varied somewhat by analysis according to whether students had baseline and Time 2 data for specific GOLD sub-scales.

Findings

Implementation Fidelity

More than 75% of centers implemented each component of the ECE PDI with fidelity, resulting in meeting the overall program fidelity benchmark by the end of Year 3 of implementation as seen in Table 2**.** Indicators related to coach development were consistently high in all years. Variation in implementation and attendance for leaders and teachers was evident, occurring primarily in the initial phases of implementation and resulting in fidelity for 2 of the 6 components not being met in Year 2. That is, treatment centers did not meet fidelity for Key Component 2, ECE PDI Implementation, with indicators measuring the number of expected hours of PD for each participant as well as implementation of those hours in a 2-month time frame; nor for Key Component 5, Direct Supervisor PD, with indicators measuring direct supervisor engagement with teacher PD.

Meeting expected levels of fidelity for Key Component 2 is challenging, because it requires centers to swiftly develop systems that embed routines for teacher collaboration into daily center operations. This can raise several questions for leaders, including how to coordinate these routines in relation to other required meetings and how to provide coverage for teachers to be able to meet together. The evidence suggests that once these factors of fit and feasibility with job-embedded methods were addressed, fidelity improved during full implementation in Year 3.

Table 2. Component Level Fidelity of Implementation Findings for Years 2 and 3

	Year 2		Year 3	
Key Component	*Component Score*	*Implemented with Fidelity**	*Component Score*	*Implemented with Fidelity**
1. Coach Community of Practice	100%	**Yes**	100%	**Yes**
2. ECE PDI Implementation	50%	No	75%	**Yes**
3. Coach Professional Development	100%	**Yes**	100%	**Yes**
4. Teacher Professional Development	100%	**Yes**	100%	**Yes**
5. Direct Supervisor Professional Development	0%	No	100%	**Yes**
6. Center Leader Professional Development	75%	**Yes**	100%	**Yes**

* More than 75% of centers implemented component with fidelity in order to meet overall program fidelity.

Additionally, the direct supervisors were the focus of additional fidelity measures as measured by indicators of Key Component 5, because the ECE PDI logic model expects direct supervisors to be most engaged in sustaining embedded PD for teachers beyond the grant period. Specifically, the ECE PDI expected direct supervisors to attend the lesson-planning meeting for 1 teaching team per month and the teacher RPG every other month in order to observe the way in which the ECE PDI coach facilitated such sessions. It is plausible that the presence of coaches in settings like lesson planning prompted a degree of role confusion for direct supervisors in relation to their supervised teachers. As one mentioned, “I didn’t understand why I was supposed to be there [in lesson planning meetings] when the coach was there.” However, when the expectations became clearer at the beginning of Year 3, the cadre of direct supervisors increased their fidelity to the model’s intended thresholds for engagement in the contexts for learning for teachers.

In sum, the evidence suggests that once these factors were addressed, fidelity to the model improved during full implementation in Year 3. As such, program-level fidelity rates this high indicate that the key components of the ECE PDI were implemented as intended and that leaders, teachers, and coaches successfully engaged its intensive, job-embedded methods.

Adult Learning Outcomes

We evaluated evidence regarding whether center directors and supervisors actually accomplished the kinds of conceptual growth intended by the ECE PDI design for leader learning. Our analysis on balance indicated that the ECE PDI leader learning cycles were successful in supporting the majority of center leaders to critically examine their current

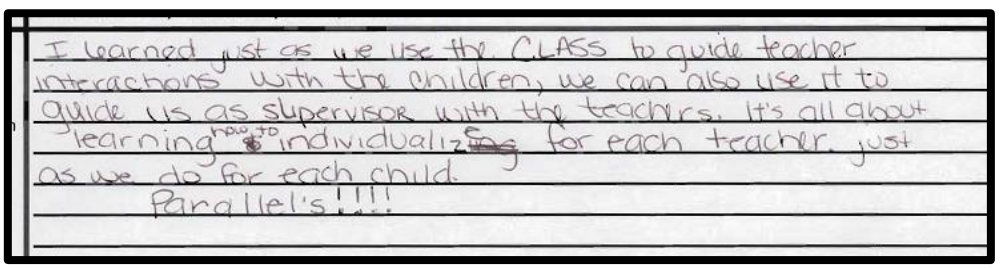
leadership conceptions and grapple authentically with a challenging set of new leadership principles. Three features of the ECE PDI design emerged as particularly catalytic for leader professional development.

First, there was an exceptional synergy between the curricular focus of the ECE PDI—and especially the transaction between the Five Essentials Framework and the CLASS assessment—and the 2-month cycle of learning labs, on-site consultations, and reflective practice groups. Both the Five Essential Supports and the CLASS assessment provided leaders with the kind of "optimal" cognitive stretch that was sufficient to initiate the deconstruction of older conceptual frames and mindsets. Second, embeddedness of leader learning within the teacher learning cycles created weekly opportunities for leaders to translate new principles into keener instructional observation, stretch their comfort zones in areas like generative questioning and data dialogue, and receive regular feedback regarding their efforts from their coaches. Third, for leaders whose daily professional experience is often limited to their center buildings, the cross-site learning labs and reflective practice sessions provided a welcome venue both for collaborative learning and professional encouragement. A supportive cross-site professional learning community did cohere with time to become both a safe zone and a stretch zone, in which directors and direct supervisors could remake their practices and their leader identities.

Specifically, the shift toward a more inclusive leadership mindset was accompanied by greater confidence among directors and supervisors in their own abilities to support more effective lesson planning and instruction. Through facilitation of lesson planning and reflective practice groups for teachers, the leaders more consistently integrated the CLASS "lens and language" into their supervisory interactions with teachers. This had 2 complementary and salutary effects.

First, it sharpened the leaders' own grasp of the emotional, organizational, and cognitive dimensions of excellent early childhood instruction, making them keener observers and analyzers of teacher-child interactions. Second, it illuminated the parallels between the challenges that teachers face with calibrating their interactions for children's learning and those faced by supervisors in calibrating their responses to support the learning of their assigned teachers—an insight that became known within the ECE PDI as "the parallel process," as seen in Figure 3.

Figure 3. An Excited PDI Supervisor Grasps the "Parallels"—Leader Module 4



For the majority of leaders, this insight into the applicability of the CLASS "lens and language" to their own supervisory work became a powerful influence toward adopting a "side-by-side, shoulder-to-shoulder" attitude with teaching colleagues. In effect, several of the leaders appreciated this new "way of being" as a leader. As one leader appreciatively expressed it:

> So knowing that the same practice that supervisors expect teachers to use with the children in relation to the CLASS, we should be doing the same thing, so yeah, instead of teacher sensitivity, I need to be like supervisor sensitivity. That was really important for me, because as a supervisor sometimes you can seem intimidating and you know so to them that may be a negative karma, to a teacher, like "I don't feel like I can go talk to Ms._____ …. So, make sure that I create a positive climate for them to come speak to me or what have you and then I think by knowing that, that changed the way I communicated with them and made sure that certain things…were evident in my interactions with them. So that was the really huge step for me to take.

As leaders applied the "parallel process" to their interactions with teachers in the phases of the learning cycle, a shift in leadership perspectives from narrow "transactional" concerns to more expansive "transformational" concerns—and particularly, the goal of fostering thoughtful practice and instruction—was observed.[35,36]

Evidence of Impacts on Instructional Practice

Change in teachers' classroom practice due to the ECE PDI was investigated through direct observations of classroom instruction using the age-appropriate Classroom Assessment Scoring System (CLASS) tool. Observations both at baseline and follow-up were conducted by CLASS assessors certified as reliable through the TeachStone certification process for specific age groups (i.e., infant, toddler, and PreK versions of the CLASS). Given the rigor of this certification process, we did not conduct an independent inter-rater reliability analysis. The teacher observation outcome measures in the impact study included the PreK CLASS Emotional Support, Classroom Organization, and Instructional Support domains in PreK classes based on available data. Data for each of the PreK CLASS domains were collected in the 2010-2011 and 2011-2012 academic calendar years with post-intervention data collected in 2015. Baseline and post-intervention data were collected from multiple classrooms within each center in the study.

PreK CLASS data from comparison centers (between 7 and 12, depending on the impact measure) were acquired from administrative datasets administered by the city's early childhood agency as well as the city's public school system. However, because no single classroom among the comparison centers had both baseline and post-intervention data between the baseline period (Spring 2012) and Time 2 (Spring 2015), the classroom-level data were aggregated at the center level in order to establish baseline equivalence and to measure the intervention effect for each PreK CLASS domain outcome at the center level.

QED Pre-Post Design to Test ECE PDI Impacts on PreK CLASS Measures

An ordinary least squares linear regression model was applied to the aggregated PreK CLASS domain data to establish baseline equivalence for the impact studies. The analytic sample size for each CLASS impact study varied based on available data. The center characteristic control variables included in the models to establish baseline equivalence and to measure the ECE PDI impact were: percentage of students in families living below the poverty line; percentage of families experiencing unemployment; the education level of parents (those with a bachelor's degree or higher) based on 2012 census data; and whether a center was funded through Early Head Start and/or the Preschool for All program.

Statistical Analyses to Measure Intervention Effects

Baseline equivalence was established by calculating the intervention center effect size in standardized standard deviation units (Hedge's g) in PreK CLASS domain scores between ECE PDI intervention and comparison centers and comparing the difference in intervention and comparison center effect sizes to the <.25 standard deviation unit standard established by the national evaluation requirements for the i3 grant program. Hedge's g, a variation of Cohen's d measure of effect size, corrects for small sample sizes. At baseline, the Emotional Support and Instructional Support measures were stronger in the intervention centers, and Classroom Organization measures were slightly lower than comparison centers. Each CLASS domain effect size fell below the national evaluation threshold of <.25 for establishing baseline equivalence as seen in Table 3. This means the ECE PDI centers and comparison centers' CLASS observation scores were not statistically different at the start of the intervention period. The regression models used to measure ECE PDI effects are listed in Appendix B. The baseline measures for each of the PreK CLASS domains under study were included in the impact models to adjust

for the differences among centers at baseline when measuring intervention center impact.

Table 3. Baseline Equivalence Estimates for the Pre-Kindergarten CLASS Measures

CLASS Measure	Intervention Centers (N)	Comparison Centers (N)	Baseline Unadjusted Intervention Mean (SD)	Baseline Unadjusted Comparison Mean (SD)	Standardized Baseline Difference*
Emotional Support	3	7	5.04(.64)	4.89(.56)	.19
Organizational Support	3	12	4.92(.52)	5.00(.92)	-.10
Instructional Support	4	8	3.43(.31)	3.41(.73)	.02

*Intervention and comparison center difference after adjusting for the baseline measure.

Results of QED Pre-Post Regression Analyses for PreK CLASS Measures

Whether a teacher received PD through an intervention center had a positive effect on CLASS Emotional Support (g = 1.15), Classroom Organization (g = .19), and Instructional Support (g = .83) after controlling for baseline measures and center characteristic covariates. However, the effects presented in Table 4 did not attain statistical significance at the p = .05 confidence level. Statistical power in these analyses was substantially reduced due to the small sample size.

Table 4. Pre-Kindergarten Post-Intervention Impact Results

CLASS Measure	Intervention Centers N	Comparison Centers N	Unadjusted Intervention Mean (SD)	Unadjusted Comparison Mean (SD)	Impact Effect Size (Hedge's g)	Impact Standard Error	p-value
Emotional Support	3	7	6.00(.17)	5.35(.73)	1.15	.71	.41
Organizational Support	3	12	5.75(.26)	4.92(1.16)	.19	1.02	.85
Instructional Support	4	8	3.13(1.36)	2.19(.79)	.83	.63	.26

Additional analyses were conducted to assess classroom growth in the Infant, Toddler, and PreK CLASS measures over a 3-year period. CLASS data were collected for intervention classrooms at the Infant, Toddler, and PreK levels at thr3ee time points: late fall/early winter 2012-2013; late fall/early winter 2013-2014; and winter/spring 2015. While we knew that the number of classrooms with 3 full years of CLASS data would be small, we deemed the numbers for Toddler classrooms (*N* = 11) and Pre-K classrooms (*N* = 8) to be sufficient for a preliminary assessment of effect sizes associated with 3-year trends. Only 2 classrooms at the Infant classroom level accrued 3 years of data, and thus they were not analyzed to detect effect sizes.

The unadjusted means for the Toddler CLASS Emotional and Behavioral Supports and Engaged Support for Learning domain measures increased over the 3-year period with varying rates of growth by domain and dimension measures (Appendix C). The PreK CLASS Emotional and Behavioral Supports and Classroom Organization domain measures increased over the 3-year period, and Instructional Supports measures remained the same. The dimension measures within each domain demonstrated variable growth over time (Appendix D).

Results of Repeated Measure Procedure for Toddler and PreK Classrooms

We employed a repeated measure analysis of variance procedure (RM_ANOVA) in order to examine the strength of improvement trends in Toddler and PreK CLASS assessment outcomes at the classroom level. The RM_ANOVA procedure tests whether the means of 3 or more metric variables are the same within the same cases (i.e., the null hypothesis), including variables measured across successive time points.[37]

The repeated measures ANOVA results indicate that the differences in mean scores were not statistically significant for any Toddler or PreK classroom domain or dimension measure across the 3 years. A limitation to this analysis is the small sample sizes for the CLASS measures. It is worth noting that 2 distinct trends are suggested in the bar graphs situated in Appendices E and F for both the Toddler and PreK classrooms.

In the dimensions associated with the Emotional Supports and Organizational Support domains, the general 3-year trend is noticeably positive and ascending. For the 7 PreK classrooms, for example, the trajectory in the “Teacher Sensitivity” dimension rises steadily from early 2013 (5.3) to early 2014 (5.7) to early 2015 (5.9). In addition, the trajectories for the dimensions “Behavioral Management” and “Productivity” move solidly into a range of high-quality interactions between preschool teachers and children. Second, in the dimensions associated with the instructional

supports domain, progress is evident in the first half of the initiative (2013-2014) followed by a "slide back" in the second half of the initiative (2014-2015). This "slide back" pattern in instructional supports is relatively uniform across all ECE PDI classrooms and does not comport with analyses of additional data sources that indicate the teachers were in fact advancing in their understanding of how to intentionally plan for high-quality teacher-child interactions. It is plausible, for example, that the apparent decline derives from one or both of the following:

- *The delayed emphasis of instructional supports in the core curriculum of the ECE PDI cycles for learning*. Specific content related to two Toddler CLASS dimensions, "Quality of Feedback" and "Language Modeling," and three PreK CLASS dimensions, "Concept Development," "Quality of Feedback," and "Language Modeling," is most apparent in the coaches' instructional outlines during the final year of implementation.
- *The transition from coach-facilitated to direct-supervisor-facilitated teacher learnings cycles when the direct supervisors were still working to develop and improve their supervisory skills.* Key to the sustainability of essential features of the ECE PDI model was to prepare direct supervisors for the role of JEPD facilitator. One could expect the quality of the direct supervisors' facilitation to be lower during the second year of implementation when they were still learning how to support teacher learning.

Child Development Impacts

Baseline measures were collected in fall 2012, quarterly progress checkpoints occurred between winter 2012 and winter 2014, and the final impact measures were collected in spring 2014. A quasi-experimental pre/post design using hierarchical linear models was applied to measure the ECE PDI model impact effect for both 1-year and 2-year child cohorts (N = 1,162) to determine if there was a significant difference in adjusted mean scores at the end of the intervention period accounting for the children's age-standardized baseline measures, child-level characteristics, and center-level characteristics.

An important preliminary step in implementing a pre/post quasi-experimental design was to assure that the intervention and comparison samples were equivalent on the target measures before the intervention was administered. A 2-level HLM model was used to establish baseline equivalence between ECE PDI centers and comparison centers on the GOLD™ Teaching Strategies sub-scales. Baseline measures were standardized based on students' age in months at the time of the baseline assessment. The models used for this analysis can be found in Appendix G

and H. Baseline equivalence was established by calculating effect sizes in standardized standard deviation units (Hedge's g) in the children's levels of development at baseline between intervention and comparison centers and comparing the difference in intervention and comparison center effect sizes to the <.25 standard deviation unit standard set by the National Evaluation Investing in Innovation Fund (NEi3). For each of the baseline measures, children in intervention centers had lower scores on average than their peers in comparison centers. The difference in the children's average pretest baseline scores between intervention and comparison centers meant that the sample of children were closely matched in their expected development at baseline as seen in Table 5.

Table 5. Baseline Equivalence for GOLD™ Teaching Strategies Measures

Measure Name	Baseline Intervention Group N	Baseline Comparison Group N	Baseline Unadjusted Intervention Group Mean (SD)	Baseline Unadjusted Comparison Group Mean (SD)	Standardized Baseline Difference (Hedge's g)*
GOLD Social Emotional	199	907	489.75(91.95)	506.12(88.70)	-0.14
GOLD Language	198	908	484.63(89.14)	507.31(85.81)	-0.16
GOLD Cognitive	195	897	486.03(87.19)	511.08(85.26)	-0.25**
GOLD Literacy	192	863	506.35(77.70)	524.98(79.44)	-0.06
GOLD Mathematics	194	852	509.13(85.62)	533.02(79.06)	-0.17
GOLD ELA	35	87	3.33(1.93)	3.69(1.97)	-0.08

* Intervention and comparison center difference after adjusting for student age (in months) at the time of their baseline measure. The standardized baseline difference is calculated by dividing the parameter estimate by the pooled standard deviation for the pretest measure. Consistent with What Works Clearinghouse standards, baseline equivalence is established if the standardized baseline difference is <0.25 standard deviations.[38] Hedge's g, a variation of Cohen's d, corrects for small sample sizes.

** Standardized baseline difference is g = -.248 < .250.

Children enrolled in intervention centers for either one or two academic years were included in the sample to assess if there was an incremental intervention effect if children were enrolled in ECE PDI intervention centers for a longer period of time. The results for the GOLD domain measures and the GOLD English Language Acquisition composite scale indicated that the ECE PDI model did not have a significant effect on the children's learning and development. We did not detect any significant interaction effects of the ECE PDI on post-intervention scores for children enrolled in ECE PDI centers for 2 years versus 1 year.

However, as seen in Figure 4, a comparative time-series analysis

aimed at assessing the impact of the ECE PDI model on children with greater exposure to the ECE PDI yielded a statistically significant ECE PDI effect in average growth rates in children's Social Emotional Learning and Development. Specifically, longitudinal hierarchical linear growth models were applied to determine if there was a significant difference between the rates of learning and development on the GOLD Social Emotional, Language, Cognitive, Literacy, and Mathematics learning between children in ECE PDI centers and comparison center peers with 2 full years of ECE enrollment. Children's GOLD ELA was not included in our growth model due to the small sample size of this sub-group in the 2-year intervention period. The ECE PDI model intervention lessened the gap in child social emotional development between the intervention and comparison center children with a medium effect size ($\delta = .60$, $p < .05$), shown in Table 6. This impact does comport with the intervention's focus on improving the quality of social and emotional interactions between teachers and students as the base for realizing further student development in the cognitive and academic learning domains.

Figure 4. GOLD Social Emotional Unadjusted Mean Growth Trajectory

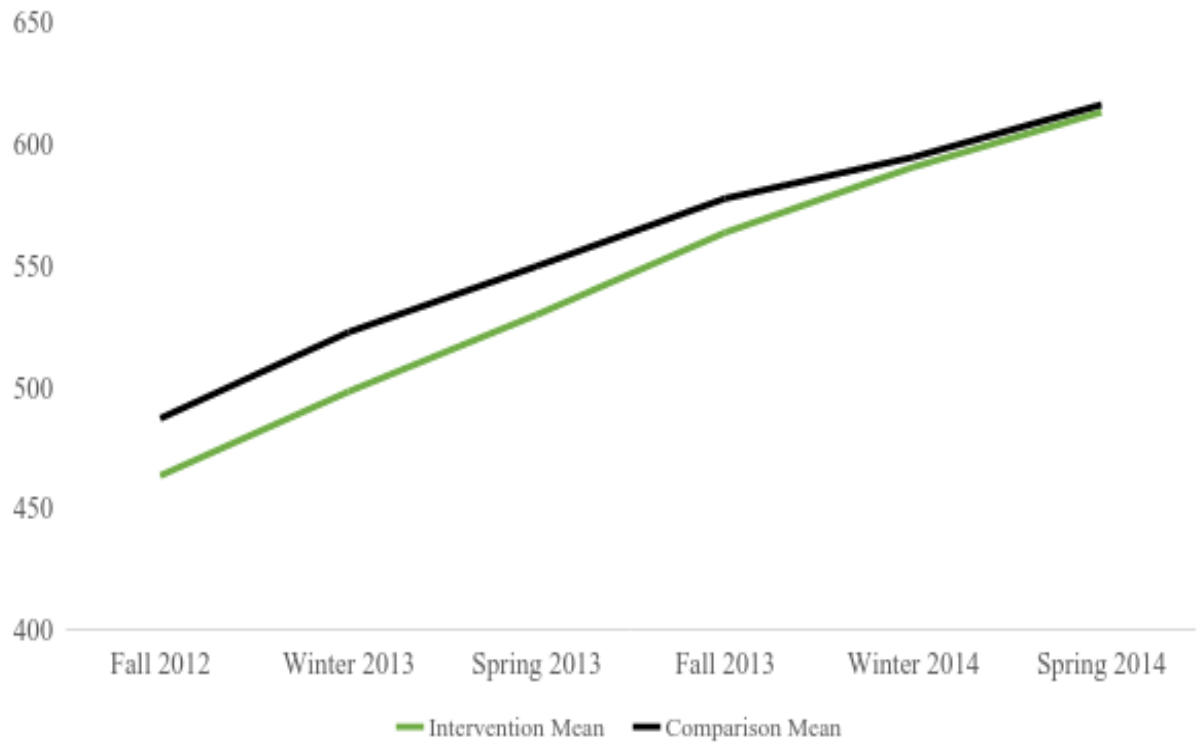


Table 6. ECE PDI Model Effect Sizes on Student Growth Fall 2012 Through Spring 2014

Measure Name	N PDI	N Comparison	Y_{000} Mean Initial Status	Y_{001} PDI Initial Status**	Y_{100} Mean Growth Rate	Y_{101} PDI Growth Rate**	Y_{101} Standard Error	δ Effect Size	p-value
Social Emotional	55	301	554.55	-47.44	24.62	9.23	4.16	0.60*	0.03
Language	55	301	552.66	-50.04	26.69	7.51	4.15	0.43	0.08
Cognitive	55	299	558.53	-54.18	28.41	4.66	3.85	0.24	0.23
Literacy	55	295	567.51	-40.22	24.7	1.12	2.97	0.07	0.71
Mathematics	54	299	573.48	-36.62	24.63	3.2	3.38	0.20	0.35

*p <.05, **Intervention versus the comparison reference group

The sample used for this model consisted of children who were in the intervention study for 2 full academic years of the intervention period (n = 358) versus the sample used in the first set of models, where children were exposed to the intervention for 1 or 2 years (N = 1,162). The ECE PDI model was designed for continuous improvement with changes occurring in model delivery over the intervention period. Children who were there for 2 full years were exposed to teachers involved in reflecting on their own practice for the purpose of fostering strong teacher-child interactions in a classroom environment cultivated to improve the children's social emotional learning and development as the precursor for cognitive and academic development. Modeling the children's growth trajectories over the 2-year period yielded a statistically significant intervention effect on the children's rate of learning and development in the Social Emotional domain, with a near significant effect in the children's language development based on GOLD™ Teaching Strategies assessments over the intervention period.

These results reflect the ECE PDI model focus on building teacher and child social emotional learning as the foundation for further development in the areas of cognitive and academic learning and development. These results are also in line with similar studies measuring ECE center program effectiveness on child-level outcomes, which all yielded small to medium effect sizes. For example, the 2010 Head Start Impact Study tracked and compared child outcome data of 3- and 4-year-old children's point of entry into an ECE center program through the spring of their first grade year. Head Start program effect sizes ranged from *d* = .09 to .35 in language, literacy, and pre-writing outcomes for 3- and 4-year-old children. A more targeted Head Start intervention to impact student

outcomes was the Research-based Developmentally Informed (REDI) program, which focused on developing children's language and emergent literacy as well as social emotional skills. The REDI program effect sizes ranged from *d* = .28 to .40 in social emotional skills at the end of a 1-year intervention period in PreK classes.[39] The Chicago School Readiness Project intervention study showed positive effect sizes of *d* = .34 and .63 for vocabulary, letter naming, and early mathematics skills and effect sizes between *d* = .37 and .43 for emotional regulation subscales.[40]

Limitations of Impact Estimates

Limitations of impact analyses around classroom practice were the small sample sizes for the CLASS measures, which substantially reduced statistical power. In the first analysis, there was insufficient data to measure the ECE PDI effect sizes for the Infant and Toddler CLASS data. The data used in the PreK class were aggregated at the center level because there were no pretest and posttest measures for a single classroom across any of the centers. In the second analysis, there were 2 centers with Infant CLASS observation data for the 3-year period; this limited our ability to assess whether improvements in scores over time were significant. A larger classroom level sample size for CLASS data would have raised the statistical power of the classroom-level studies and allowed more statistical procedure options to measure ECE PDI effect sizes.

Regarding the analyses of child development outcomes, the center-level sample sizes for the child-level impact studies were 20 centers in the GOLD ELA study and a range of 40 to 42 centers in the GOLD Social Emotional, Language, Cognitive, Literacy, and Mathematics impact studies. Based on their simulation study, Maas and Hox[41] suggest that a sample size of at least 100 group-level units (the center level in the current study) would be needed to obtain precise standard errors of model parameters when using maximum likelihood estimation. When there are 30 to 50 group-level units, regression coefficients used to calculate effect sizes are unbiased, but the standard errors of the variance components may be low. Thus, the results obtained in the current study may be moderately biased due to the small number of center-level units.

Discussion

The ECE PDI outcome findings support the theory that best learning occurs within a context of supportive relationships that makes learning engaging, meaningful, and challenging.[42] In particular, the closing of the gap in the area of social emotional learning and development for the children in participating centers can be related to the multiple layers of emotional support intended by the ECE PDI model. For instance, the use of the

CLASS as a "lens and language" to provide feedback was first modeled by the ECE PDI coaches who then assisted the direct supervisors in embracing such an approach in their feedback to staff. Center staff, in turn, made progress in creating a positive, emotionally supportive context for learning for the children in their classrooms as measured by the CLASS. Thus, in each learning context, learners engaged in "parallel processes"[43] by which the methods used in PD sessions such as collaboration, language modeling, and protocol-based supports closely aligned with what leaders were being asked to do with their staff and, in turn, what their teachers were being asked to do with children in their classrooms.

Employing emotionally supportive parallel processes in a JEPD model has the benefit of cultivating the emotional conditions that support teacher well-being.[44] In turn, addressing teacher well-being is a way to address the stressors that are often linked to teacher burnout and teacher turnover.[44] However, the evidence from this study also suggests that the parallel process requires extensive modeling of high-quality instructional supports between instructional leader and teacher so that the teachers can in turn improve their quality of feedback and concept development with the children with whom they interact. Providing consistent instructional supports that extend learning remains one of the hardest ECE practices to master[2(p1)] and thus is continually a work in progress.

Conclusion

The present work illustrates one approach to developing instructional leadership capacities of community-based early education administrators with internally driving continuous professional learning, implementation, and improvement. When considering all the work involved in reorganizing a center to start up teacher collaboration and data inquiry, the ability to meet fidelity for the majority of the indicators is a significant outcome and suggests that the model is feasible in community-based centers with administrators willing and able to overcome challenges that arise with this transition.

Unfortunately, limitations in the availability of CLASS classroom practice measures from baseline to follow-up required the aggregation of these measures at the center level and prevented comparisons of impact at the classroom level. Thus, we were not able to link CLASS classroom impact levels with child development outcomes as captured by the GOLD. Acknowledging this limitation, a comparative time-series analysis for children who were exposed to teaching impacted by the ECE PDI intervention for the full 2-year period did have a positive impact on closing the gap in the area of social emotional learning and development. Given that the ECE PDI was designed to advance ECE teachers' pedagogical

knowledge of social emotional development, these results suggest the model's potential effectiveness in supporting instructional practice within a context of supportive relationships that makes learning engaging, meaningful, and challenging.[41(p23)]

In terms of ECE PDI's impacts on ECE leaders and supervisors, the framework of the Five Essential Supports facilitated more inclusive and effective navigation of the constraints that early education administrators commonly experience and developed their capacity to strengthen organizational routines. These routines in turn supported staff with delivery of a more ambitious and impactful early education experience for children and families, although the degree of these impacts varied across centers and classrooms. This said, the data generally suggest a positive association between the transformation of leader-to-teacher relationships over 2 years and improvements in the socio-emotional features of teacher-to-teacher and teacher-to-student relationships over the course of the intervention.

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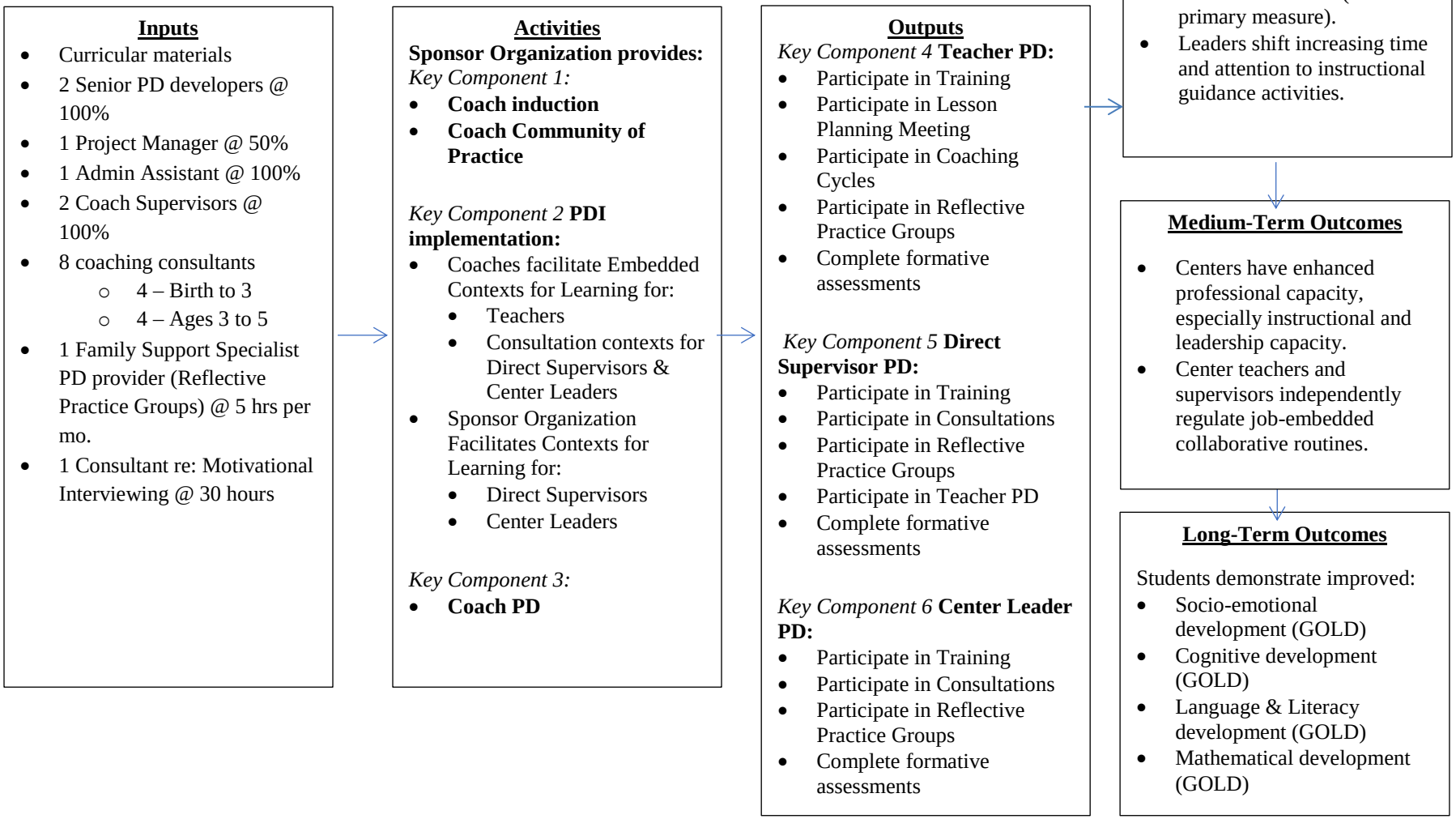
Appendix A: ECE PDI Evaluation Logic Model

Goal: To build birth-to-5 teachers' capacity to design and deliver standards-aligned, data-driven instruction and to close developmental and learning gaps among high-needs students to support their kindergarten readiness through simultaneous job-embedded PD for teachers, leaders, and their coaches.



Appendix B: CLASS PreK Impact Models

$$ES15_j = \beta_0 + \beta_1*(TREAT) + \beta_2*(ESBL_2) + \beta_3*(CFPOV_3) + \beta_4*(CFWORK_4) + \beta_5*(CFEDU_5) + \beta_6*(CEHS12_6) + \beta_7*(CPFA12_7) + e_j$$

$$CO15_j = \beta_0 + \beta_1*(TREAT) + \beta_2*(COBL_2) + \beta_3*(CFPOV_3) + \beta_4*(CFWORK_4) + \beta_5*(CFEDU_5) + \beta_6*(CEHS12_6) + \beta_7*(CPFA12_7) + e_j$$

$$IS15_j = \beta_0 + \beta_1*(TREAT) + \beta_2*(ISBL_2) + \beta_3*(CFPOV_3) + \beta_4*(CFWORK_4) + \beta_5*(CFEDU_5) + \beta_6*(CEHS12_6) + \beta_7*(CPFA12_7) + e_j$$

Variables
ES15 = CLASS Emotional Support post-intervention measure 2015
CO15 = CLASS Classroom Organization post-intervention measure 2015
IS15 = CLASS Instructional Support post-intervention measure 2015
ESBL = CLASS Emotional Support baseline measure
COBL = CLASS Classroom Organization baseline measure
ISBL = CLASS Instructional Support baseline measure
TREAT = Intervention center versus comparison center
CFPOV = 2012 Percent families below the poverty line with related children under 18
CFWORK = 2012 Percent unemployed 2012
CFEDU = 2012 Percent with bachelor's degree or higher
CEHS12 = 2012 EHS Center-based
CPHA12 = 2012 State PreK Preschool for All Funding
e_j = error term

Appendix C: Toddler CLASS Domain and Dimension Score Means and Standard Deviations, 2013-2015

Domain Score: Emotional and Behavioral Supports (EBS)

	Mean	Std. Deviation	N
2013	4.850	.7321	6
2014	6.125	.6571	6
2015	6.217	.5307	6

EBS Dimension: Positive Climate

	Mean	Std. Deviation	N
2013	4.967	.4967	6
2014	6.600	.4733	6
2015	6.400	.6419	6

EBS Dimension: (Lack of) Negative Climate

	Mean	Std. Deviation	N
2013	6.100	.9099	6
2014	6.9667	.08165	6
2015	7.000	0.0000	6

EBS Dimension: Teacher Sensitivity

	Mean	Std. Deviation	N
2013	4.533	.7866	6
2014	5.850	.9894	6
2015	6.067	.8116	6

EBS Dimension: Regard for Child Perspectives

	Mean	Std. Deviation	N
2013	4.767	.5715	6
2014	5.850	.7609	6
2015	5.900	1.0159	6

EBS Dimension: Behavioral Guidance

	Mean	Std. Deviation	N
2013	3.933	1.1978	6
2014	5.383	1.4006	6
2015	5.833	.7230	6

Domain Score: Engaged Support for Learning (ESL)

	Mean	Std. Deviation	N
2013	2.912	.8901	6
2014	4.008	1.2612	6
2015	3.388	.2344	6

ESL Dimension: Facilitation of Learning and Development

	Mean	Std. Deviation	N
2013	3.100	1.0100	6
2014	5.150	1.0330	6
2015	4.450	.3146	6

ESL Dimension: Quality of Feedback

	Mean	Std. Deviation	N
2013	2.767	.6121	6
2014	3.700	1.5633	6
2015	2.883	.3764	6

ESL Dimension: Language Modeling

	Mean	Std. Deviation	N
2013	2.867	1.1501	6
2014	3.333	1.4445	6
2015	2.950	.3728	6

Appendix D: PreK CLASS Domain and Dimension Score Means and Standard Deviations, 2013-2015

PreK Domain: Emotional Supports (ES)

	Mean	Std. Deviation	N
2013	5.714	.3010	7
2014	6.071	.8528	7
2015	6.250	.3434	7

ES Dimension: Positive Climate

	Mean	Std. Deviation	N
2013	5.571	.6448	7
2014	6.343	.8561	7
2015	6.343	.4995	7

ES Dimension: (Lack of) Negative Climate

	Mean	Std. Deviation	N
2013	7.000	0.0000	7
2014	7.000	0.0000	7
2015	7.000	0.0000	7

ES Dimension: Teacher Sensitivity

	Mean	Std. Deviation	N
2013	5.300	.4282	7
2014	5.686	1.0527	7
2015	5.943	.6268	7

ES Dimension: Regard for Student Perspective

	Mean	Std. Deviation	N
2013	4.914	.4598	7
2014	5.600	.9781	7
2015	5.743	.6705	7

PreK Domain: Classroom Organization (CO)

	Mean	Std. Deviation	N
2013	4.657	.5315	7
2014	5.619	.8769	7
2015	6.060	.3167	7

CO Dimension: Behavioral Management

	Mean	Std. Deviation	N
2013	4.900	.4796	7
2014	5.986	1.1305	7
2015	6.043	.2149	7

CO Dimension: Productivity

	Mean	Std. Deviation	N
2013	4.771	.9123	7
2014	5.743	.7635	7
2015	6.371	.4680	7

CO Dimension: Instructional Learning Formats

	Mean	Std. Deviation	N
2013	4.329	.5619	7
2014	5.200	.9165	7
2015	5.771	.3988	7

PreK Domain: Instructional Supports (IS)

	Mean	Std. Deviation	N
2013	3.220	.9336	7
2014	3.389	1.1825	7
2015	2.703	1.7394	7

IS Dimension: Concept Development

	Mean	Std. Deviation	N
2013	3.071	1.0531	7
2014	3.200	1.3748	7
2015	2.586	1.6446	7

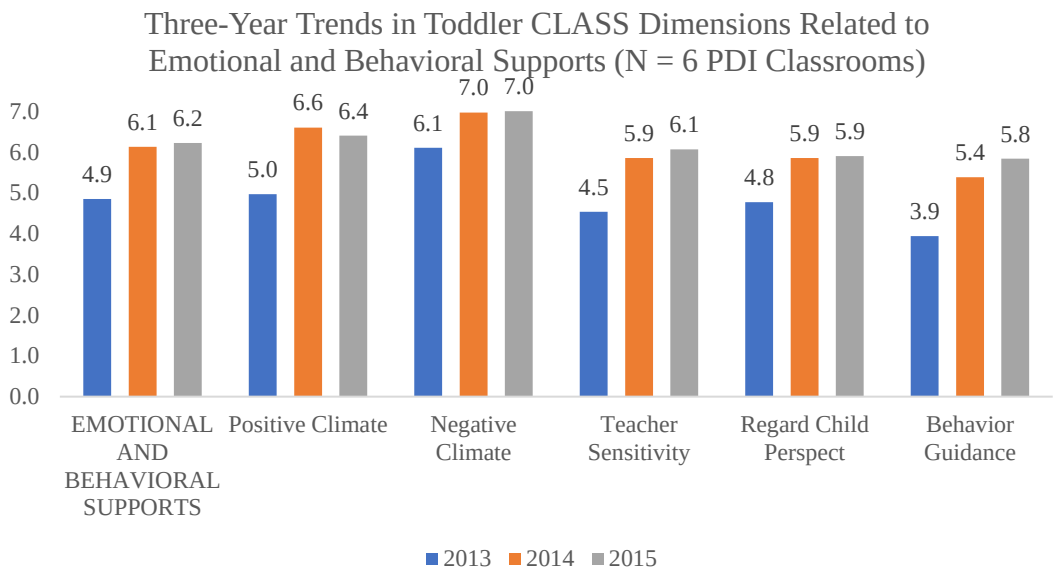
IS Dimension: Quality of Feedback

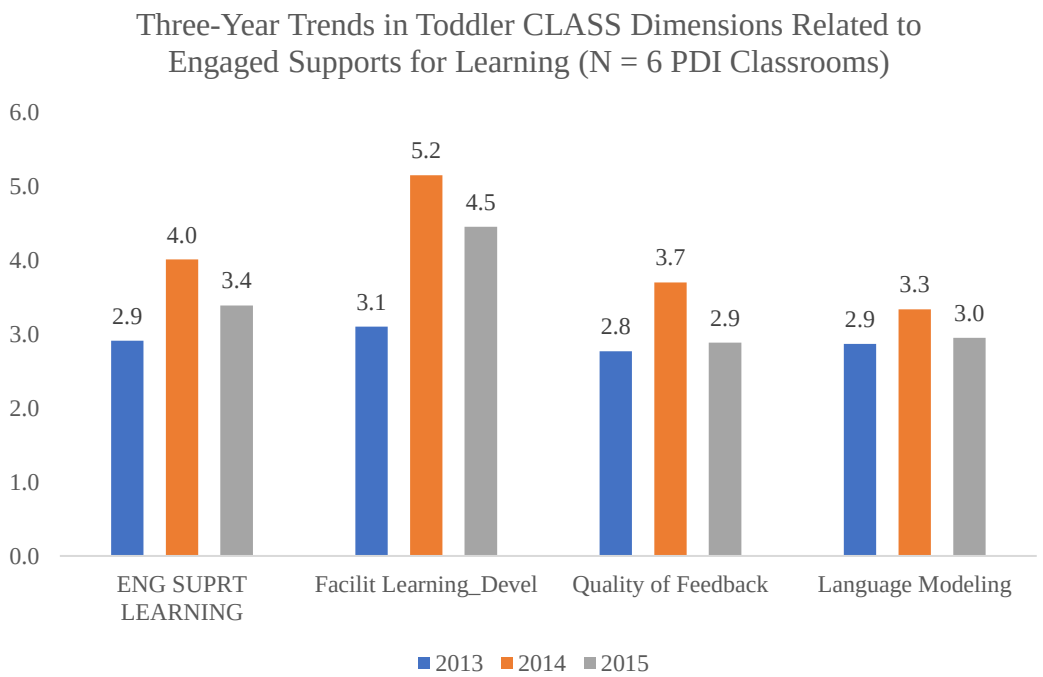
	Mean	Std. Deviation	N
2013	3.400	.9000	7
2014	3.557	1.3100	7
2015	2.814	1.7257	7

IS Dimension: Language Modeling

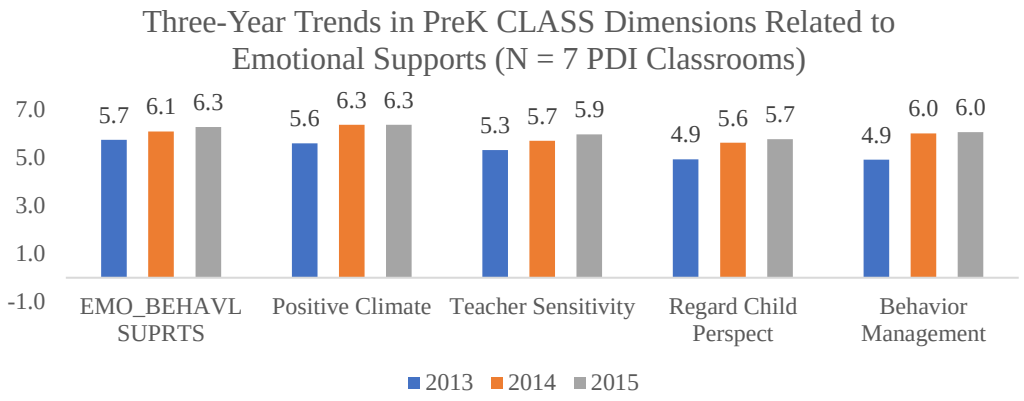
	Mean	Std. Deviation	N
2013	3.200	.9574	7
2014	3.414	1.1596	7
2015	2.786	1.9030	7

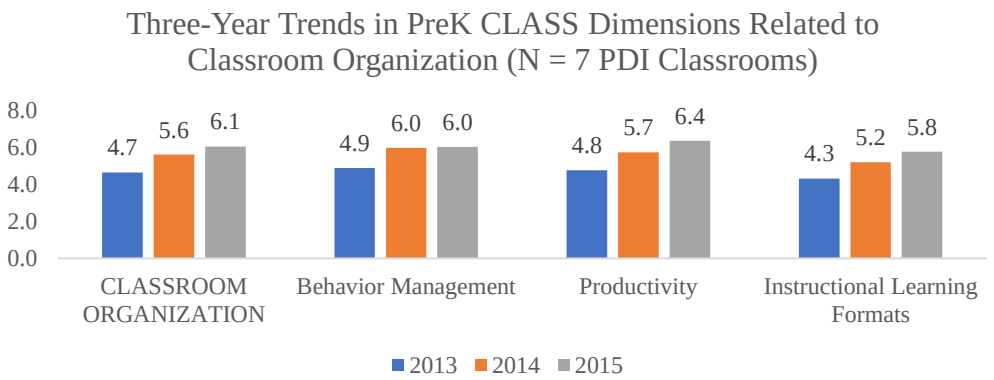
Appendix E: Comparing Extent of Change within Toddler CLASS Dimensions within Domain

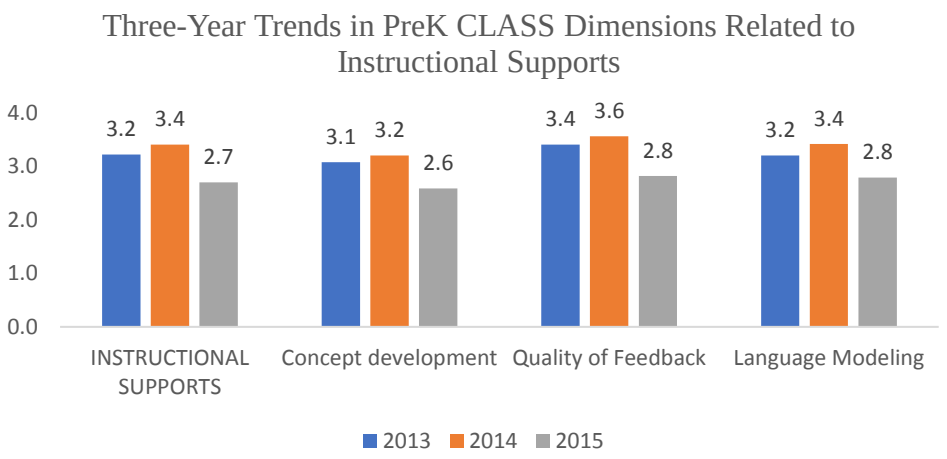




Appendix F: Comparing Extent of Change within PreK CLASS Dimensions within Domain







Appendix G: Baseline Model

$Y_{ij} = \gamma_{00} + \gamma_{01}*TREAT_j + u_{0j} + r_{ij}$

where,

Y_{ij} = the age-standardized GOLD subscale development outcome for child i in early childhood center j at baseline
γ_{00} = the average GOLD subscale development score (intercept) across centers
γ_{01} = the slope coefficient for the intervention center covariate
u_{0j} = the random effect for the center-level intercept, normally distributed with a mean of 0 and homogenous variance $u_{0j} \sim N(0,T)$
r_{ij} = the random effect for the student level, normally distributed with a mean of 0 and homogenous variance rij ~ N(0,σ2)

Appendix H: Three-Level Linear Growth Model

Level 1 Model

$Y_{tij} = \pi_{0ij} + \pi_{1ij}*(TIME_{tij}) + e_{tij}$

Y_{tij} = GOLD domain outcome variable at time point t for student i in center j
π_{0ij} = mean initial status of student i in center j
π_{1ij} = the developmental growth rate for student i in center j between Fall 2012 and Spring 2014
e_{tij} = the within person residual term

Level 2 Model

$\pi_{0ij} = \beta_{00j} + \beta_{01j}*(F12I_{ij}) + \beta_{02j}*(F12T_{ij}) + \beta_{03j}*(W13I_{ij}) + \beta_{04j}*(W13T_{ij}) + \beta_{05j}*(S13I_{ij}) + \beta_{06j}*(S13T_{ij}) + \beta_{07j}*(SU13I_{ij}) + \beta_{08j}*(SU13T_{ij}) + \beta_{09j}*(F13T_{ij}) + \beta_{010j}*(W14T_{ij}) + \beta_{011j}*(S14T_{ij}) + r_{0ij}$

$\pi_{1ij} = \beta_{10j} + \beta_{11j}*(F12I_{ij}) + \beta_{12j}*(F12T_{ij}) + \beta_{13j}*(W13I_{ij}) + \beta_{14j}*(W13T_{ij}) + \beta_{15j}*(S13I_{ij}) + \beta_{16j}*(S13T_{ij}) + \beta_{17j}*(SU13I_{ij}) + \beta_{18j}*(SU13T_{ij}) + \beta_{19j}*(F13T_{ij}) + \beta_{110j}*(W14T_{ij}) + \beta_{111j}*(S14T_{ij})$

π_{0ij} = the initial status of student i in center j as a function of β_{pq}*(student age group)
π_{1ij} = the developmental growth rate for student i in center j as a function of β_{pq}*(student age group)
The $\beta_{pij's}$ represent the student-level effects for the age categories included in the level 2 model for each checkpoint period
r_{0ij} = level 2 random effect

Level 3 Model

$\beta_{00j} = \gamma_{000} + \gamma_{001}(TREAT_j) + \gamma_{002}(Site\ 2\ Group_j) + \gamma_{003}(Site\ 3\ Group_j) + \gamma_{004}(Site\ 4\ Group_j) + \gamma_{005}(Site\ 5\ Group_j) + u_{00j}$
$\beta_{01j} = \gamma_{010}$
$\beta_{02j} = \gamma_{020}$
$\beta_{03j} = \gamma_{030}$
$\beta_{04j} = \gamma_{040}$
$\beta_{05j} = \gamma_{050}$
$\beta_{06j} = \gamma_{060}$
$\beta_{07j} = \gamma_{070}$
$\beta_{08j} = \gamma_{080}$
$\beta_{09j} = \gamma_{090}$
$\beta_{010j} = \gamma_{0100}$
$\beta_{011j} = \gamma_{0110}$
$\beta_{10j} = \gamma_{100} + \gamma_{101}(TREAT_j) + \gamma_{102}(Site\ 1\ Group_j) + \gamma_{103}(Site\ 2\ Group_j) + \gamma_{104}(Site\ 3\ Group_j) + \gamma_{105}(Site\ 4\ Group_j)$
$\beta_{11j} = \gamma_{110}$
$\beta_{12j} = \gamma_{120}$

$\beta_{13j} = \gamma_{130}$
$\beta_{14j} = \gamma_{140}$
$\beta_{15j} = \gamma_{150}$
$\beta_{16j} = \gamma_{160}$
$\beta_{17j} = \gamma_{170}$
$\beta_{18j} = \gamma_{180}$
$\beta_{19j} = \gamma_{190}$
$\beta_{110j} = \gamma_{1100}$
$\beta_{111j} = \gamma_{1110}$

γ_{000} = the mean for the initial status across centers
γ_{001} = the intervention center effect on the mean initial status across centers
γ_{100} = the average student developmental growth trajectory (TIME) across centers
γ_{101} = the intervention center effect on the grand mean on TIME
β_{00j} = the initial status of center j
β_{10j} = the average growth rate within centers for the 6 time points (TIME)
β_{pqj} = the fixed effects for student age categories
u_{00j} = level 3 random effect