Early Childhood Research Quarterly 38 (2017) 1–14

Contents lists available at ScienceDirect

Early Childhood Research Quarterly

Improving teacher-child interactions: A randomized control trial of Making the Most of Classroom Interactions and My Teaching Partner professional development models☆

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ARTICLE INFO

Article history:
Received 21 December 2015
Received in revised form 15 August 2016
Accepted 21 August 2016

Keywords:
Pre-kindergarten
Professional development
Teacher-child interactions
Quality

ABSTRACT

The effectiveness of two professional development interventions, each designed to strengthen teacher-child interactions in preschool classrooms, was tested using a teacher-level randomized controlled trial. Georgia's Pre-K teachers (n = 486 in 336 schools/centers) were randomly selected from specified regions and randomly assigned to one of three conditions: 1) Making the Most of Classroom Interactions (MMCI), a cohort-model where small groups of teachers met for five days of instruction and support; 2) My Teaching Partner (MTP), in which teachers worked one-on-one with a coach using cycles of videotaped observations of teaching, review, and feedback; or 3) control. Each participating teacher received a Classroom Assessment Scoring System (CLASS; Pianta, La Paro, & Hamre, 2008) visit before and after the intervention from a trained, independent, blinded observer. Posttest scores were estimated as a linear function of condition and pretest score, using 2-level hierarchical linear models (HLMs). Findings indicated MMCI resulted in significantly higher posttest scores on Emotional Support and Instructional Support, and marginally higher posttest scores on Classroom Organization, as compared to controls. MTP resulted in significantly higher scores on Emotional Support. Findings are discussed in terms of implications for large-scale interventions to improve teacher-child interactions in early childhood programs.

1. Introduction

Improving quality in early childhood classrooms is a primary goal of many state and federal initiatives. For instance, the Race to the Top-Early Learning Challenge was designed to support "states in building statewide systems that raise the quality of Early Learning and Development Programs and increase access to high-quality programs for children with high needs, so that all children enter kindergarten ready to succeed" (Early Learning Challenge Technical Assistance Program, n.d.). Over 35 states have established Tiered Quality Rating and Improvement Systems (TQRIS) as a framework for defining quality and supporting improvement in early childhood classroom quality (QRIS Compendium, n.d.). This focus on improving quality comes from an ever-increasing understanding that quality is important for maximizing the benefits of early childhood programs in terms of children's early social and academic skills and that quality is, on average, lower than desirable (Love et al., 2003; Mashburn et al., 2008; Moiduddin, Aikens, Tarullo, West, & Xue, 2012; Yoshikawa et al., 2013). The current study used a randomized-controlled trial (RCT) to evaluate the effectiveness and feasibility of two professional development models for improving classroom quality (My Teaching Partner and Making the Most of Classroom Interactions) in Georgia's Pre-K program, a large, state-funded pre-kindergarten system. This study represents a collaboration between Bright from the Start: Georgia Department of Early Care and Learning (DECAL) and researchers who were independent of the model developers.

☆ This study was funded by Bright from the Start: Georgia Department of Early Care and Learning (DECAL). The opinions in this report do not necessarily reflect those of the funding agency. Portions of this manuscript have appeared in a publically available report and technical appendix available at: http://www.decal.ga.gov/BftS/EvaluationGAPreKProfDev.aspx.

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[1] Deceased. In memory of Dr. Yi Pan who cared deeply about the provision of quality early childhood education for disadvantaged children worldwide. The co-authors are greatly saddened by the loss of a friend and colleague.

http://dx.doi.org/10.1016/j.ecresq.2016.08.005

1.1. High-quality teacher-child interactions

Within the global construct of classroom quality, teacher-child interactions have emerged as a key aspect of quality in predicting children's outcomes. Teacher-child interactions are the "daily back-and-forth exchanges that teachers and children have with one another throughout each day, including those that are social and instructional in nature" (p. 89, Hamre et al., 2012). Increasingly strong evidence indicates that the quality of these interactions, more than other aspects of classroom quality, is critical for improving children's early academic and social-emotional skills. For instance, Howes et al. (2008) found that "effective teaching," defined as sensitive interactions with adults around instructional content within a positive climate, was a stronger predictor of children's language and literacy outcomes than materials or activities. Using the same data, Mashburn et al. (2008) found that instructional support—or the quality of teacher-child interactions specific to instruction—was a stronger predictor of children's academic outcomes at the end of pre-k than structural features of quality such as teacher education, class size, ratio, and provision of comprehensive services. Ponitz, Rimm-Kaufman, Grimm, and Curby (2009) found that teacher-child interactions were indirectly linked to children's reading skills through classroom engagement.

Turning to socio-emotional outcomes, efforts to help early childhood teachers build nurturing relationships with children have been linked to decreased externalizing and internalizing behavior in children (Perry, Allen, Brennan, & Bradley, 2010). Likewise, training teachers in foundational relationship skills has been linked to teacher-reports of increased positive and decreased negative child behavior among children who had below average social skills at baseline (Garbacz, Zychinski, Feuer, Carter, & Budd, 2014).

In a summary of the evidence base for the benefits of preschool education, Yoshikawa et al. (2013) underscored the importance of teacher-child interactions that are warm, responsive, and support learning. The important role of teachers' interactions is further reflected in the National Association for the Education of Young Children's (NAEYC) position statement, with explicit assertions such as, "Effective teachers are intentional in their use of a variety of approaches and strategies to support interest and ability in each learning domain" and "Curriculum is very important, but what the teacher does is paramount" (NAEYC, 2009).

1.2. Classroom Assessment Scoring System as a measure of teacher-child interactions

The most widely used measure of teacher-child interactions in early childhood classrooms is the Classroom Assessment Scoring System (CLASS; Pianta, La Paro, & Hamre, 2008). The CLASS has become part of the federal system for monitoring Head Start (Administration for Children and Families, U.S. Department of Health and Human Services, n.d.) and is increasingly included in states' TQRIS (QRIS Compendium, n.d.). The CLASS tool includes 10 dimensions of teacher-child interactions that are organized into three broad domains—Emotional Support, Classroom Organization, and Instructional Support—each of which has been linked to children's academic or social outcomes (Curby et al., 2009; Rimm-Kaufman, Curby, Grimm, Nathanson, & Brock, 2009).

Using a variety of measures, there is mounting evidence that quality in publically funded early childhood programs is low (Yoshikawa et al., 2013). Focusing specifically on the CLASS, research has documented the relatively low quality of teacher-child interactions, especially instructional support. An 11-state study of state funded pre-k found average instructional support was in the low range (*mean* = 2.1 out of 7; Mashburn et al., 2008), as did a national study of Head Start (*mean* = 2.3; Moiduddin et al., 2012). Research in Georgia's Pre-K programs found similar results (*mean* = 2.5; Peisner-Feinberg, Schaaf, Hildebrandt, & Pan, 2015).

1.3. Changing teacher behavior through effective professional development

Knowing that teacher-child interactions are crucial in supporting children's development and learning, the challenge is to *improve* teacher-child interactions. Research in early childhood education generally indicates that effective professional development combines specific training on novel skills, coupled with in-service coaching or consultation (Sheridan, Pope Edwards, Marvin, & Knoche, 2009). Such professional development has been shown to be effective in improving instruction and children's outcomes in targeted content areas such as literacy (Powell, Diamond, Burchinal, & Koehler, 2010; Wasik & Hindman, 2011; Landry, Swank, & Assel, 2010) and math (Clements, Sarama, Spitler, Lange, & Wolfe, 2011).

The current work focuses on teacher-child interactions more generally, rather than focusing on a content area. In this arena, there are several prominent approaches that combine skills training with coaching/consultation and have been linked to improved teacher-child interactions and children's outcomes. Early Childhood Mental Health Consultation (ECMHC) is one such approach in which mental health professionals work with early childhood teachers to improve classroom climate and classroom management, teach social skills, and address individual children's behavioral and mental health challenges (Duran et al., n.d). Although ECMCH is not a single, prescribed intervention, there are tools, resources, and modules available for teaching specific skills and all ECMCH models include one-on-one consultation. ECMCH has been linked to improved classroom climate (Brennan, Bradley, Allen, & Perry, 2008; Raver et al., 2008). Further, ECMHC has been consistently linked to reduced externalizing behavior and occasionally linked to reduced internalizing behavior and improved prosocial behavior (Perry et al., 2010).

Teacher-Child Interaction Training (TCIT) is another approach to improving classroom climate that pairs skills training and consultation. TCIT uses both didactic instruction and behavioral coaching with teachers in the classroom to improve communication, behavior management, and prevention strategies for children with difficult behaviors. Correlational data suggest that TCIT is linked to decreased behavioral concerns for all children and improved social skills for children whose social skills were low at baseline (Garbacz et al., 2014).

The current study evaluates two professional development models that couple skills training with in-service coaching or consultation: My Teaching Partner (MTP) and Making the Most of Classroom Interactions (MMCI). Both were developed by the CLASS authors to support teachers in improving teacher-child interactions; however neither involves specific instruction on scoring the CLASS or improving CLASS scores. These approaches differ from ECMCH or TCIT in that they focus on instructional support, as well as classroom climate and management.

1.3.1. Making the Most of Classroom Interactions

MMCI is a face-to-face professional development model in which a group of teachers meets regularly with trained instructors to learn to identify and analyze effective interactions in classrooms and discuss ways to interact intentionally to increase children's learning. Enrolled teachers have access to print and web-based resources aligned with the CLASS measure. Between in-person sessions, teachers complete homework assignments that involve watching specific videos and practicing interactions in the classroom and have access to an online library of video clips demonstrating best practices in various aspects of teacher-child

interactions. MMCI was adapted from a 14-week college-level course that had been shown to be effective in improving teacher knowledge of high-quality teacher-child interactions, as well as observed emotional support and instructional support as measured by the CLASS (Hamre et al., 2012). The main adaptations were made by Teachstone, an organization founded by the CLASS authors to train individuals on the use of the CLASS and to support implementation of the professional development models. Adaptations included altering the "college-style" course into a cohort model in which teachers meet for 10 half-day sessions. With Teachstone's support, DECAL further adapted the model to be delivered in five full-day sessions. Each adaptation maintained the original content that had been previously evaluated; however, the current study is the first to evaluate the impact of MMCI using the current format.

1.3.2. My Teaching Partner

MTP is a one-to-one, remote coaching model that provides specific feedback to teachers about emotional climate, organizational structure, and instructional support using a standardized coaching cycle format. During each cycle, the participating pre-k teacher makes a video recording of her or himself interacting with children in the classroom and sends it to the coach, who then reviews the video and posts feedback and questions about the interactions with children to a secure website for the teacher to review. The coach's prompts provide detailed feedback and help teachers observe their classroom interactions more closely. After the teacher responds to the prompts, the teacher and coach have a one-to-one conference call to discuss the teacher's practice. The feedback and discussions focus on what the teacher is doing well and how the teacher could continue to develop in specific areas, using the CLASS as the framework. Shortly after the one-to-one conference call, the coach sends the teacher a brief summary of the main topics covered during the conference and the mutually agreed upon action plan for the next cycle. Additionally, teachers have access to the online library of video clips demonstrating best practice.

Pianta, Mashburn, Downer, Hamre, and Justice (2008) found that teachers who took part in MTP showed more growth in teacher-child interactions than teachers who had access to web-based materials only. Mashburn, Downer, Hamre, Justice, and Pianta (2010) found that children in MTP classrooms made greater language and literacy gains than children in comparison group classrooms.

Although there is some research pointing to the efficacy of these two professional development models, both the previous MTP evaluation and the evaluation of the college-level course that was the precursor of MMCI included only teachers who had volunteered to participate, were conducted by CLASS authors, and used coaches who were employed by the project. To better understand the feasibility and utility of these models within the context of a large early childhood system, an independent evaluation including randomly selected teachers and using employees of that system as instructors and coaches is warranted.

1.4. Improving teacher-child interactions in Georgia's Pre-K

Georgia's Pre-K, administered by DECAL, has incorporated CLASS into its on-going quality improvement efforts, making it an ideal system in which to further explore these models. Georgia's Pre-K aims to provide high-quality preschool experiences to four-year-olds to help prepare them for kindergarten. In the 2013-14 school year, Georgia's Pre-K was offered in all 159 counties across the state and served over 81,000 four-year-olds or approximately 60% of all four-year-olds in the state (Barnett, Carolan, Squires, Brown, & Horowitz, 2015). Georgia's Pre-K is universal, meaning that it is open to all four-year olds regardless of their family's income; however, roughly 55% of children served are from low-income families (Kids Count Data Center, n.d.). The program is offered in a variety of settings, including private child care, local schools, Head Start centers, military bases, and other not-for-profit programs. As part of the state monitoring and technical assistance system, each school/center is assigned a Georgia's Pre-K consultant, who ensures compliance with the program's standards while also providing training and technical assistance.

DECAL began preparing to use the CLASS to gauge the instructional practices in its pre-k classrooms and to provide a framework for its pre-k teachers' professional development in 2009. The decision to focus on the CLASS was based on the field's growing understanding of the importance of teacher-child interactions and findings from an evaluation of Georgia's Pre-K that indicated that it would benefit from focusing on key CLASS concepts, particularly Instructional Support (Maxwell et al., 2009). DECAL started by training Georgia's Pre-K consultants to use the CLASS in 2009-10 and gathering CLASS data in over 90% of classrooms in 2010-11. In the summer of 2011, observed classrooms were provided with a report that indicated if their score was in the low, medium, or high range on each of the ten dimensions and a link to the publically-available Teachstone website. No other training or support around the CLASS was provided to pre-k teachers by DECAL prior to the start of the current study, although some programs may have elected to purchase CLASS training, because DECAL was starting to emphasize use of the CLASS statewide.

DECAL's professional development efforts for pre-k teachers were expanded in 2010, when Georgia was awarded a federal K-12 Race to the Top (RT3) grant (Georgia Department of Education, n.d.). That grant included over 25 projects, one of which was specifically devoted to early learning. Through that project, DECAL implemented MMCI and MTP in their pre-k program. As noted above, MTP and a college-level course similar to MMCI had been evaluated previously by the CLASS authors, but DECAL's efforts were unique for several reasons. First, DECAL coupled implementation of these models with a rigorous RCT, conducted by an independent university-based research team. Pre-k teachers were randomly selected for participation and randomly assigned to one of the professional development models or a control group. Second, the interventions were implemented by Georgia's Pre-K consultants who were employed by DECAL, rather than being implemented by the model developers or their staff. DECAL's implementation was built into Georgia's Pre-K teacher professional development system. This was not something extra that participating teachers did; it was the annual professional development provided by the state for these pre-k teachers.

1.5. Outcomes of interest

The current study is primarily an efficacy trial of the models' impact on CLASS scores in a large-scale early childhood system under the types of real-world conditions we would anticipate if they were broadly adopted. In addition to CLASS scores; however, the study includes three outcomes that we hypothesized might be precursors or prerequisites to long-term improvements in teacher-child interactions. That is, change in any of these might signal that the intervention had value, even if CLASS scores remained unchanged. The first is knowledge of effective teacher-child interactions. Sometimes knowledge changes before practice (Hamre et al., 2012) or knowledge and practice change in an iterative fashion where increased knowledge leads to improved practice, which in turn leads to even greater knowledge (Sheridan et al., 2009). For that reason, in addition to observations of practice, the study tests the effects of MTP and MMCI on teachers' knowledge of effective teacher-child interactions. The second additional outcome of interest is perceived value of the intervention. Teachers are more likely to invest time and energy in professional development activities

Table 1
Teacher, Classroom, and Program Characteristics.

	Overall (n = 486)	MMCI (n = 175)	MTP (n = 151)	Control (n = 160)
Teacher Characteristics				
Educational attainment				
Less than BA/BS	8.7%	8.1%	9.3%	8.8%
BA/BS	65.2%	66.0%	67.6%	62.1%
Advanced degree (MA/MS, Ph.D.)	26.1%	25.8%	23.2%	29.1%
Mean (SD) years of education[2]	16.50 (1.23)	16.51 (1.22)	16.43 (1.23)	16.56 (1.23)
Mean (SD) years teaching in Georgia's Pre-K	6.11 (4.73)	5.97 (5.11)	6.30 (4.53)	6.08 (4.49)
Classroom Characteristics				
Mean (SD) observed class size	18.95 (2.34)	19.21 (2.16)	19.12 (2.20)	18.51 (2.60)
Mean (SD) observed children per adult	9.36 (1.57)	9.42 (1.51)	9.48 (1.53)	9.17 (1.67)
Mean (SD) proportion of children eligible for public assistance (standardized)[3]	0.07 (1.04)	0.04 (1.06)	−0.03 (1.02)	0.20 (1.03)
Program Characteristics				
Private setting/school-based	63%/37%	59%/41%	69%/31%	61%/39%
In Metro Atlanta/outside Metro Atlanta[4]	48%/52%	46%/54%	50%/50%	47%/53%

they think will benefit them in the long run (Abrami, Poulsen, & Chambers, 2004). The relationship with the coach/instructor is the final outcome addressed. Just as teacher-child relationships form the basis for effective early childhood education, the relationship between the coach/instructor and teacher is critical for meaningful change in practice (Peterson, 2012; Spino & Dinnebeil, 2013).

1.6. Teacher and center/school characteristics as possible moderators

An original purpose of the current project was to help DECAL evaluate and improve its professional development efforts for Georgia's Pre-K teachers. In addition to the efficacy of MTP and MMCI, DECAL was interested in understanding if certain teachers, or teachers in certain types of centers/schools, benefited more or less from these efforts, as a means of better targeting future professional development efforts. For this reason, the current study tests a large number of potential moderators. The selection of moderators was based on a combination of previous research (e.g., teacher education, Early et al., 2007) and DECAL's specific policy questions (e.g., in/outside metro Atlanta). Additionally, we anticipated that teachers who take fuller advantage of the supports would demonstrate greater improvements in CLASS scores. Therefore, the current study tests dosage as a predictor of posttest scores.

1.7. Research questions

The project sought to answer four broad research questions: (1) did teacher-child interactions improve as a result of participation in MMCI or MTP?; (2) did teachers' knowledge of effective instruction, perceived value of the professional development, and/or teacher's relationships with their coach/instructor vary as a function of professional development model?; (3) did the effects of the models vary as a function of teacher characteristics and beliefs or as a function of center/school characteristics?; and (4) did the effects of the models vary as function of dose or the amount of exposure teachers received to the models? These questions were tested in a sample of 486 Georgia's Pre-K teachers who were in at least their second year of teaching.

2. Method

To evaluate the impact of the two professional development models on teacher-child interactions, teachers were randomly selected and randomly assigned to one of the professional development conditions or a control group. Data collection included pre- and posttest classroom observations, teacher questionnaires, coach/instructor questionnaires, and administrative information regarding participation in the professional development activities.

2.1. Teacher selection and random assignment

During this three-year study (2011-12, 2012-13, 2013-14), a new cohort of teachers was selected for participation at the start of each school year, and each teacher participated for one academic year. Across the three years, the final sample included 486 teachers (175 MMCI, 151 MTP, and 160 control) in 336 schools/centers at pretest, who had pre- and posttest CLASS observations. Effort was made to keep the three groups equal in size; however, the precise number of teachers selected into each condition depended, in part, on the Pre-K consultant's capacity to provide the services each year. Real-world considerations such as the distance from the consultants' homes to the sites and other work responsibilities played a small role in determining the number of teachers assigned to each condition each year.

As a first step in selecting teachers, each year DECAL selected counties for participation based on their consultants' capacity to serve various geographic areas. Eligible counties were those that were targeted for support by Georgia's RT3 initiative. Across the three years, 24 of the 26 counties targeted by RT3 were included. In Year 3, eight non-RT3 counties were also included. The 32 counties were spread throughout the state, including metropolitan Atlanta, smaller cities, and rural areas.

Once the counties were selected, DECAL sent a list of all Georgia's Pre-K classes in each county to the research team for random selection and assignment. In the first year, random assignment took place at the school/center level. That is, once selected, the school/center was randomly assigned to one of the professional development models (i.e., MTP, MMCI, or control) and all Georgia's Pre-K classrooms within that school/center were assigned to the same model. The participating counties were organized into five regions. During that first year, assignment was blocked at the region level so that an equal number of teachers from each of the five regions were assigned into each condition.

In the second and third years, a stronger approach was utilized. Random selection and assignment took place at the classroom level (rather than school/center-level), allowing some classrooms within a school/center to be selected for participation while others were not and allowing different classrooms within the same school/center to be in different models. In Years 2 and 3, no blocking took place: all classrooms in the participating counties/systems had an equal probability of selection and assignment to each condition. This change in selection procedures between the first and second year was made after consultation with the CLASS authors. Selecting at the classroom rather than school/center level

had two major advantages: (1) it diminished the nesting of data within school/center, and (2) it decreased the odds that a single event—such as a center/school closing—would strongly undermine the study. The model developers were confident that there was little threat of spillover—or control teachers improving simply by working in the same site as or hearing about intervention from teachers taking part—because the models are intensive, requiring significant time and support.

Classes, rather than teachers, were selected for participation because often teachers were not assigned to classrooms until very close to the start of the academic year and occasionally teachers were not assigned until after the school year had begun. Thus, the final step in the random selection and assignment process involved learning which teacher was assigned to the selected classroom, determining if she or he was eligible for participation, and replacing any classes where the teacher was ineligible. All teachers were eligible to participate except: (1) those who were in their first year as a Georgia's Pre-K teacher, or (2) those who would be absent most of the year, due to a medical condition or pregnancy, for example. First-year teachers were excluded because DECAL provides introductory professional development to all first-year Georgia's Pre-K teachers. DECAL thought it was important for all new teachers to experience that program, and participating in it and the current study would have been too time consuming and would have created a confound.

Teachers in all three conditions were given $100 in the fall and $100 in the spring as a 'thank you' for their time and effort. For those who were selected to participate, this project replaced the regular professional development required of all Georgia's Pre-K teachers, therefore teachers could not opt out. They did have the right to have their data excluded from the research component of this evaluation; however, none of the teachers took that option.

2.2. Attrition and teacher movement

Only 27 teachers, or 5.3% of the original sample, left the study between the pre- and posttest. Of these, 8 had been assigned to MMCI (4.4% of the original MMCI sample); 8 to MTP (5.0% of the original MTP sample), and 11 to control (6.4% of the original control sample). Thus, the differential attrition rate was 2.0% (6.4 minus 4.4). This level of overall and differential attrition meets the What Works Clearinghouse (2014) definition of low attrition, using the conservative boundary of 6.1%.

Most (24 of 27) of the teachers who did not receive a posttest observation stopped teaching in Georgia's Pre-K during the year; two were on maternity leave during the posttest period; the final one was in her second year of teaching but had not taken part in the introductory professional development, so was moved to that training at DECAL's request. In order to be sure that the loss of these teachers was not biasing the sample, pretest CLASS scores of these 27 teachers were compared to pretest CLASS scores of the 486 teachers who participated in both the pre- and posttests. No differences were found in any of the three CLASS domains. These 27 teachers have been excluded from all analyses.

Seven teachers moved to a different Georgia's Pre-K center/school between the pre- and posttest. Those teachers were retained in the sample. Posttest data were collected in the new school/center locations and they are included in all analyses.

2.3. Characteristics of participating teachers

Participating teachers were well-educated, with most having a Bachelor's degree or higher. On average, they had spent over six years teaching in Georgia's Pre-K. Average class size was about 19 students. More than half of the pre-k classrooms were in private settings (i.e., not public schools), and the sample was fairly evenly split within and outside the Atlanta metro area. See Table 1.

2.4. Measures of outcomes

Outcome measures are described below. See Table 2 for pre- and posttest descriptive statistics by condition.

2.4.1. CLASS

As described above, the CLASS is an observation measure of teacher-child interactions. It is made up of 10 dimensions. Each dimension is rated by a trained observer using a 7-point scale with 1 or 2 indicating the classroom is "low" on that dimension; 3, 4, or 5 indicating "mid-range"; and 6 or 7 indicating the classroom is "high" on that dimension. Observers rate the classrooms and teachers on the 10 dimensions roughly every 30 min throughout the observation morning. Scores are calculated by taking the average of all cycles.

The 10 dimensions are organized into three domains. The Emotional Support domain reflects the extent to which teachers support the emotional and social functioning of the classroom and includes respect and enjoyment demonstrated in the classroom, lack of anger or hostility, teachers' responsivity to children's concerns, and teachers' emphasis on children's interests. The Classroom Organization domain reflects processes related to student behavior, time, and attention. Teachers in classrooms that are high on Classroom Organization effectively set up and monitor appropriate behavior expectations and prevent and redirect problem behavior when it occurs, establish and maintain routines to maximize learning time, and organize learning activities that are varied and engaging. The Instructional Support domain refers to the extent teachers promote higher-order thinking as opposed to rote learning, extend learning by providing meaningful feedback to children, and facilitate children's use of language. In the current study, Cronbach's alpha for Emotional Support domain was 0.84, for Classroom Organization it was 0.86, and for Instructional Support it was 0.91.

2.4.2. Knowledge of effective teacher-child interactions (Hamre & LoCasale-Crouch, 2009)

We gathered information about teachers' knowledge of effective teacher-child interactions using a nine-item scale based on the CLASS framework. Each item presents respondents with a scenario that they might encounter in the classroom and asks them to select the best response from four alternatives. A sample of an item reads: "Before reading a story about autumn, the teacher wants to develop the children's understanding of autumn concepts by making connections to previous learning. One strategy she can use is: (1) having children share what they remember about the book they read yesterday; (2) sing a song that cues the class it is time for book reading, (3) review the letter sounds and parts of the word fall, and (4) remind them about their discussion of leaves falling off trees." Although validity data are lacking for this scale, using a slightly longer version of this tool, Hamre et al. (2012) found that teachers who participated in the precursor to MMCI scored higher than control-group teachers. This scale is scored as percent correct out of nine.

[2] Teachers were asked to indicate the highest level of education they had completed. All teachers had at least some college. Their responses were converted to years as follows: some college = 13, AA/AS Degree = 14, BA/BS degree = 16, some graduate coursework = 17, MA/MS = 18, Ed.D. or Ph.D. = 21

[3] Information about public assistance eligibility was obtained from DECAL. Their definition of public assistance changed over the course of the study, thus the values had to be standardized within year.

[4] Metropolitan Atlanta was defined as within the following 10 counties: Cherokee, Clayton, Cobb, DeKalb, Douglas, Fayette, Fulton, Gwinnett, Henry, and Rockdale.

Table 2
Descriptive Statistics for Outcome Variables by Professional Development Model.

	MMCI		MTP		Control	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
CLASS: Emotional Support						
Mean	5.63	5.87	5.53	5.73	5.57	5.58
SD	0.68	0.68	0.76	0.70	0.77	0.77
Range	2.79–6.83	2.50–6.96	2.88–6.92	3.38–6.88	2.83–6.92	2.21–6.75
CLASS: Classroom Organization						
Mean	5.25	5.50	5.11	5.39	5.19	5.30
SD	0.79	0.84	0.93	0.83	0.85	0.84
Range	2.22–6.89	2.44–6.89	1.50–6.83	2.56–6.83	2.33–6.67	2.72–6.72
CLASS: Instructional Support						
Mean	2.56	2.92	2.61	2.76	2.65	2.65
SD	0.80	0.91	0.91	0.92	0.91	0.83
Range	1.06–5.22	1.17–5.28	1.00–5.61	1.06–5.50	1.11–4.94	1.06–4.61
Teachers' Knowledge of Effective Teacher-Child Interactions						
Mean	NA	7.57	NA	7.20	NA	7.20
SD	NA	1.32	NA	1.22	NA	1.23
Range	NA	2–9	NA	3–9	NA	3–9
Teachers' Perceived Value of the Professional Development						
Mean	NA	4.27	NA	4.22	NA	3.95
SD	NA	0.63	NA	0.74	NA	0.66
Range	NA	1.63–5.00	NA	1.00–5.00	NA	1.00–5.00
Teachers' Relationship with the Coach/Instructor						
Mean	NA	4.54	NA	4.72	NA	NA
SD	NA	0.46	NA	0.52	NA	NA
Range	NA	3.40–5.00	NA	1.00–5.00	NA	NA

2.4.3. Perceived value of the professional development (LoCasale-Crouch, Downer, & Hamre, 2009a)

In the spring, all teachers were asked to respond to nine items regarding their perceptions of the professional development they had received that year. The items were first used by the National Center for Research on Early Childhood Education in evaluating MTP and the precursor to MMCI. A sample item reads "I feel more confident in my role as a teacher than I did before this professional development" and responses were on a 5-point Likert-type scale. MTP and MMCI teachers were asked specifically to think about that professional development model in answering the questions. As detailed below, in the first year, all control teachers participated in the same online professional development and were asked to think about it when answering these questions. In the second and third year, the control teachers were first asked to select the type of professional development they had received from a list provided by DECAL. They were then asked to respond to these Perceived Value questions while thinking about that professional development. Scores were derived by averaging the nine items together. Cronbach's alpha in the current sample was 0.95.

2.4.4. Relationship with the coach/instructor (LoCasale-Crouch et al., 2009a)

MMCI and MTP teachers were asked to respond to five items, using a 5-point Likert-type scale. These items were specific to the role and relationship with the coach/instructor and were not asked of control teachers because their professional development did not always involve a coach/instructor. A sample item reads: "The instructor/coach was enthusiastic about teaching/coaching." Scores are the simple mean of the items. Cronbach's alpha in the current sample was 0.88.

2.5. Measures of potential moderators

2.5.1. Teachers' adult-centered beliefs

Teachers' adult-centered beliefs were measured with a scale adapted from Schaefer and Edgerton's (1985) parental modernity scale. These items distinguish between "traditional" or adult-centered perspectives on interactions with children and more "modern or progressive" child-centered perspectives. Pianta et al. (2005) found that teachers' adult-centered beliefs were negatively correlated with several measures of classroom quality and argued that more child-centered beliefs reflect a better understanding of children's developmental needs and teachers' comfort and skill in interacting with young children. Teachers responded to the 16-items, using 5-point Likert-type scales. Scores were derived by computing the mean of all items, with items reverse scored as needed so the final score reflects more adult-centered beliefs. Cronbach's alpha in the current sample of teachers was 0.74.

2.5.2. Coach/instructors' knowledge of effective teacher-child interactions

Coaches/instructors responded to the same nine knowledge questions described above.

2.5.3. Coach/instructors' adult-centered beliefs

Coaches/instructors responded to same 16-item Adult-Centered Beliefs scale described above. Cronbach's alpha was 0.75 among coaches/instructors.

2.5.4. Coach/instructors' confidence

Coaches and instructors responded to questions regarding their confidence in their understanding of the CLASS tool and ability to be an effective coach/instructor, using five items written by LoCasale-Crouch, Downer, and Hamre (2009b). A sample item reads: "I am confident teachers will change their practice as a result of working with me." Coaches/instructors responded using a 5-point Likert-type scale. Scores are the simple mean of the items. Cronbach's alpha was 0.89.

2.6. Procedures

Independent data collectors conducted a CLASS observation in the classroom of each participating teacher at the start and the

end of the school year. A different data collector conducted the fall and spring observation. Each observation included six 30-min observation cycles. At the start of each of the six CLASS cycles, data collectors noted the number of children and staff present. Data collectors were unaware of the project's design, blind to the teachers' professional development condition, and entirely independent of DECAL. English was the only language used in most classes. There were seven classes in which a combination of English and Spanish were used and bilingual data collectors conducted the observations.

On average, there were 194 calendar days (*SD* = 29, *range* = 128 to 259) between the pre- and posttest observations. By design, implementing MTP professional development took more time than MMCI or control, necessitating that the pretest observation take place earlier in the school year and the posttest observation later in the year. For this reason, on average there were more days between pre- and posttest for MTP teachers (*mean* = 219, *SD* = 21) than for teachers in either the MMCI (*mean* = 187, *SD* = 19) or control (*mean* = 179, *SD* = 30) groups, and more days between pre- and posttest for MMCI than control.

In order to investigate possible associations between teacher characteristics and beliefs and changes in outcomes, questionnaire data were collected at the start and end of the teacher's participation, at the same time as the CLASS observations. The pretest questionnaire included information about teacher characteristics (e.g., education, experience) and the Adult-Centered Beliefs scale. The posttest questionnaire repeated the Adult-Centered Beliefs scale and included measures of Knowledge of Effective Teacher-Child Interactions, Perceived Value of the Professional Development, and Relationship with the Coach/Instructor (MMCI and MTP teachers only). Response rates were high, with 484 of 486 teachers (99.6%) completing the pretest questionnaire and 465 (95.7%) completing the posttest questionnaire.

Each spring, MTP coaches and MMCI instructors were asked to complete questionnaires that included items about educational background, years of experience as a consultant, and the Knowledge of Effective Teacher-Child Interactions, Adult-Centered Beliefs, and Confidence scales described above. Questionnaire data from 28 of the 30 (93%) coaches and instructors who took part in this project at any point are included in the current analyses. The remaining two declined to have their data included in the research component of the project. MMCI sessions were co-taught by pairs of Georgia's Pre-K consultants. All analyses reported here that include data from MMCI instructors are based on the average of the pair.

2.7. Data collector training and interrater-reliability

All data collectors completed a two-day small group training session taught by CLASS trainers who had been certified by Teachstone. At the end of this training, data collectors completed reliability testing in which they independently watched and coded five 20-min classroom segments posted on the Teachstone website. In order to be certified as reliable by Teachstone, they had to attain at least 80% agreement within one point of the master codes. That is, the data collector's score had to be within one point of the master code at least 40 out of 50 times (10 dimensions X 5 tapes). Additionally, in order to be sure that the data collectors were correctly scoring each dimension, Teachstone required their scores on each of the 10 dimensions to be within one point of the master code on two of the five tapes. The project added one reliability check in addition to those required by Teachstone: prior to collecting study data, newly certified data collectors observed in a classroom with an experienced certified CLASS observer and were required to have 80% of all codes within one point of the experienced observer for six CLASS cycles. In order to continue as a CLASS observer, this certification process was renewed annually.

During data collection, two data collectors were present for 112 (12%) of the CLASS observations to ensure all data collectors were continuing to score in the same manner. Data from only one of the two are included in this paper's main analyses. The two data collectors' scores were within one point of each other's 99% of the time on Emotional Support, 96% on Classroom Management, and 95% on Instructional Support. Cohen's weighted kappa was 0.63 for Emotional Support, 0.60 for Classroom Management, and 0.57 for Instructional Support.

2.8. Implementation and dosage

MMCI consists of 10 two-and-a-half-hour workshops. For the current project, the 10 workshops were delivered over five training days, spread across five months. The MMCI sessions began in October or November and continued through February or March, with one training day per month. The group sizes ranged from 8 to 20 teachers, with an average of 11. Sessions were located in various regions throughout the state to minimize the travel time for teachers. The five training days were regular school days and DECAL provided funds to cover the costs of substitute teachers. Of the 175 teachers in the MMCI group, 170 (97%) attended all 10 MMCI sessions. Of the five remaining teachers, one attended eight sessions, one teacher attended two sessions, and three did not attend any sessions.

Coaching for MTP teachers began in September of each year and typically continued through April. Cycles of videotaping, sending the tape to the coach for review, and receiving feedback requires a minimum of two weeks, but can take longer. There was no predetermined goal for the number of MTP cycles teachers should complete and Pianta et al. (2014) found no evidence of a minimum number of cycles needed to demonstrate an impact. Instead, coaches and teachers were instructed to complete as many cycles as possible during the year, and when possible the data collectors waited until at least eight cycles had been completed before conducting the posttest CLASS observation. We elected to try to schedule visits after eight cycles because DECAL indicated that was a reasonable goal for most teachers during an academic year, while still leaving enough time to schedule and conduct posttest classroom visits. Forty-four teachers (29%) completed more than eight cycles; 40 (27%) completed exactly eight cycles; 59 (39%) completed five, six, or seven cycles, and eight teachers (5%) completed less than five. The average number of cycles completed was 7.57 (*SD* = 1.86, *range* = 2 to 13).

During each MTP coaching cycle, the coach provided three prompts: (1) "Nice Work," where the coach focused on what the teacher did well; (2) "Consider This," where the coach helped the teachers develop classroom observation skills, focusing specifically on how teachers' words and actions impact students; and (3) "Making the Most," focused on instructional support. For the first two prompts (i.e., Nice Work and Consider This), the coach would use a single dimension—such as positive climate, behavior management, or quality of feedback—as the focus. The selected dimension varied from cycle to cycle, but not within a cycle. The sequence of dimensions covered generally followed a pattern recommended by Teachstone, but there was flexibility to spend more or less time on any dimension depending on each teacher's needs and interests. Of the 7.57 cycles completed, on average, 2.39 (*SD* = 1.01, *range* = 1 to 7) focused on Emotional Support; 1.97 (*SD* = 1.05, *range* = 0 to 7) on Classroom Organization, and 2.08 (*SD* = 1.41, *range* = 0 to 5) on Instructional Support. (Note that the sum of these domain-specific prompts does not equal the total number of cycles because the first cycle was often used for introductions and the last cycle for wrap-up.)

Across the three years, 14 individuals served as both an MTP and MMCI coach, 12 as an MTP coach only, and 4 as an MMCI

instructor only. All coach/instructors had at least a Bachelor's degree in early childhood education. On average, they reported 5.93 years ($SD = 3.71$) of experience as a Georgia's Pre-K consultant. The pairs of MMCI instructors worked with an average of 14.42 ($SD = 3.96$) teachers each year. MTP coaches worked with an average of 3.43 ($SD = 1.02$) teachers each year. They were all reliable CLASS observers and most had attended additional training to become a CLASS trainer. Consultants received training and support from Teachstone throughout the project. Each received several days of training on the interventions by Teachstone prior to implementation and participated in regularly scheduled team calls and one-on-one sessions with Teachstone during implementation. Teachstone monitored the consultants to ensure a high degree of model fidelity.

2.9. Control group

In the first year of the study, teachers in the control group ($n = 51$) had access to the same online library of video clips demonstrating best practices in various aspects of teacher-child interactions as the MMCI and MTP teachers. No data are available regarding how much those teachers accessed the library, but anecdotal evidence suggested that it was used very little. In the second and third years, teachers in the control group ($n = 109$) participated in the same 15 h of professional development required of all Georgia's Pre-K teachers. Topics varied, but included behavior management, child assessment, outdoor learning, and others. Teachers in the control group did not receive direct training related to the CLASS, although some of the professional development opportunities may have been aligned with CLASS concepts.

2.10. Analysis plan

We start the analyses by comparing the three groups on various baseline characteristics to ensure that the random assignment process was successful in creating equivalent groups. Following those preliminary checks, we present the main impact analyses: a series of two-level hierarchical linear models (HLM) that account for the nesting of teachers within school/center. These models employ an intent-to-treat approach in which all 486 teachers with posttest data are included, regardless of actual participation in the supports. These first models compare the treatment groups on posttest CLASS scores, Knowledge of Effective Teacher-Child Interactions, Perceived Value of the Professional Development, and Relationship with Coach/Instructor, controlling pretest scores when available. In order to ensure that the change in randomization procedures between the first and second cohort did not alter the findings, we repeat the main CLASS analyses including only the second and third cohorts.

Another way to think about the effects of these models is to consider the proportion of teachers who reached a level of quality that we expect to improve children's outcomes. Some past research using a precursor to the current CLASS tool concluded that an Emotional Support score of 5.00 or more and an Instructional Support score of 3.25 or more is needed for pre-k programs to meaningfully contribute to children's social and academic outcomes (Burchinal, Vandergrift, Pianta, & Mashburn, 2010). Thus, the impact analyses are followed by logistic regression analyses that compare the odds of attaining this level of quality at posttest for teachers in each of the three groups.

Following those models, we use a two-step process to conduct exploratory analyses of between-group differences in the effects of MMCI and MTP. In the first step, we consider a number of teacher, classroom, and school/center characteristics that were of interest to DECAL as predictors of posttest MMCI and MTP scores, within condition. In the second step, we include interactions between condition and each of the teacher, classroom, and school/center characteristics that were significantly or marginally associated with any CLASS domain in the within-condition models. This two-step process allowed us to consider a large number of potentially important moderators that might help DECAL better target future interventions and improve professional development opportunities without creating overly complex models.

We conclude with three sets of treatment-on-the-treated analyses. First, we present analyses in which MTP and MMCI coach/instructor characteristics are used as predictors of posttest scores. These analyses could not include control teachers because they did not necessarily have a coach or instructor. Second we present analyses that compared posttest CLASS scores for teachers who took full advantage of the MMCI and MTP supports only. Finally, we end by investigating the possible association between MTP dosage (i.e., number of MTP cycles completed overall and number of cycles focused on a particular dimension) and changes in practices. (Parallel analyses were not possible with MMCI teachers because there was little variance in MMCI attendance.)

3. Results

3.1. Baseline comparisons and intraclass correlation coefficients

To ensure that there were no meaningful differences between the groups at the start of the study, teachers and classrooms in each condition were compared on all characteristics listed on Table 1, as well as pretest scores on Emotional Support, Classroom Organization, and Instructional Support. For most variables, comparisons were made using HLM to account for the nesting of teachers within schools/centers. For the educational attainment variable, a generalized estimating equation was used to analyze the 3-level categorical outcome, accounting for data clustering. No between-group differences were found, indicating that the randomization process was successful in creating comparable groups.

Intraclass correlation coefficients (ICC), a measure of the ratio of the variance that lies between school/center to the total variance, were 0.19 for Emotional Support, 0.21 for Classroom Organization, and 0.35 for Instructional Support.

3.2. Impact analyses

All impact analyses were conducted using two-level HLMs, accounting for the nesting of teachers within schools/centers, and controlling for pretest score (when available). The treatment variables were coded dichotomously, with the control group as the reference when comparing treatment to control (MMCI/MTP = 1, control = 0), and MMCI as the reference when comparing MTP to MMCI (MTP = 1, MMCI = 0); therefore, point estimates (PE) for between-group comparisons are equivalent to differences between adjusted posttest means of different groups. Effect sizes (ES) were calculated by dividing the difference between treatment group and control group means by the pooled standard deviation of the observed posttest. When available, impact analyses control for grand mean centered pretest scores on the outcome of interest. Results appear in Table 3.

3.2.1. Impact of MMCI and MTP on CLASS posttest scores

MMCI teachers had higher posttest scores than control-group teachers on Emotional Support ($ES = 0.36$; $p < 0.001$) and Instructional Support ($ES = 0.27$, $p < 0.05$), controlling pretest. Additionally, there was a trend that MMCI teachers had higher Classroom Organization posttest scores than control-group teachers ($ES = 0.20$, $p < 0.10$). MTP teachers had higher posttest scores compared to controls on Emotional Support ($ES = 0.22$, $p < 0.05$), controlling pretest.

Table 3
Results from HLMs of Posttest Scores.

Predictor	*PE*	*SE*	*t*	*p*	*ES*
Class: Emotional Support					
Intercept	3.79	0.24	15.86	<0.001	
Pretest	0.32	0.04	7.71	<0.001	0.33
MMCI vs. Control	0.26	0.07	3.44	<0.001	0.36
MTP vs. Control	0.16	0.08	2.02	0.046	0.22
MTP vs. MMCI	−0.10	0.08	−1.34	0.184	0.14
CLASS: Classroom Organization					
Intercept	3.84	0.23	16.56	<0.001	
Pretest	0.28	0.04	6.56	<0.001	0.29
MMCI vs. Control	0.17	0.09	1.85	0.066	0.20
MTP vs. Control	0.11	0.09	1.18	0.240	0.13
MTP vs. MMCI	−0.06	0.09	−0.62	0.535	−0.07
CLASS: Instructional Support					
Intercept	1.91	0.14	13.95	<0.001	
Pretest	0.28	0.04	6.27	<0.001	0.27
MMCI vs. Control	0.24	0.09	2.57	0.011	0.27
MTP vs. Control	0.11	0.10	1.17	0.243	0.13
MTP vs. MMCI	−0.13	0.09	−1.34	0.183	0.14
Knowledge of Effective Teacher-Child Interactions					
Intercept	7.20	0.1	68.77	<0.001	
MMCI vs. Control	0.37	0.15	2.52	0.013	0.29
MTP vs. Control	0.00	0.15	0.02	0.987	0.00
MTP vs MMCI	−0.36	0.15	−2.49	0.014	−0.28
Perceived Value of the Professional Development					
Intercept	3.95	0.06	69.00	<0.001	
MMCI vs. Control	0.32	0.08	4.17	<0.001	0.46
MTP vs. Control	0.30	0.08	3.77	<0.001	0.43
MTP vs MMCI	−0.02	0.08	−0.26	0.792	−0.03
Teachers' Perception of the Coach/Instructor					
Intercept	4.52	0.04	111.96	<0.001	
MTP vs MMCI	0.20	0.06	3.56	<0.001	0.40

Notes: PE = point estimate, SE = standard error, ES = effect size.

There were no differences between MTP and control on Classroom Organization or Instructional Support and there were no differences between MTP and MMCI on any of the posttest CLASS domains.

As noted in the Method section, in the first year of the project, random assignment took place at the center-level. In the second and third years it took place at the teacher-level. In order to ensure that this change was not affecting the findings, we conducted a sensitivity check in which the main impact analyses were repeated including only the teachers in the second and third year of the project. The pattern of significance remained the same for MMCI versus control and the effect sizes were similar (Emotional Support: $ES = 0.34$, $p < 0.01$; Instructional Support: $ES = 0.26$, $p < 0.05$). For the MTP versus control comparison, the direction of the effect on Emotional Support remained the same, although the difference became non-significant and the effect size decreased ($ES = 0.12$; $p > 0.05$).

3.2.2. Impact of MMCI and MTP on teachers' knowledge of effective teacher-child interactions

The models testing the effect of the treatment on teachers' Knowledge of Effective Teacher-Child Interactions were identical to the models testing the effect of the treatment on CLASS scores, except pretest score was not controlled because it had not been measured at pretest. Findings indicated that MMCI teachers' posttest Knowledge scores were higher than those of MTP ($ES = -0.28$, $p < 0.05$) or control-group teachers ($ES = 0.29$, $p < 0.05$). There was no difference between MTP and control.

3.2.3. Between-group differences in perceived value of the professional development

The models comparing the groups on Perceived Value of the Professional Development were identical to the models testing the effect of the treatment on teachers' Knowledge of Effective Teacher-Child Interactions. Findings indicated that both MMCI and MTP teachers perceived their professional development as more valuable than control-group teachers (MMCI: $ES = 0.46$, $p < 0.001$; MTP: $ES = 0.43$, $p < 0.001$).

3.2.4. Between-group differences in relationship with coach/instructor

Parallel analyses were conducted using Relationship with the Coach/Instructor as the outcome; however, this model included MMCI and MTP teachers only because control group teachers did not necessarily have a coach/instructor. Findings indicated that MTP teachers had more positive views of the coach/instructor than did the MMCI teachers ($ES = 0.40$, $p < 0.001$).

3.3. Odds of achieving adequate posttest CLASS scores

At pretest, 20% of MMCI teachers, 19% of MTP teachers, and 23% of control teachers attained an Emotional Support score of 5.0 or higher and an Instructional Support score of 3.25 or higher, as previous research had indicated were needed to meaningfully influence children's development (Burchinal et al., 2010). After the year of professional development, 34% of MMCI teachers, 30% of MTP teachers, and 23% of control teachers attained that level.

Two-level logistic regression was used to test if there was a between group difference (MMCI, MTP, control) in the likelihood of attaining both cutpoints, controlling for a corresponding baseline dichotomous variable created using the same cutpoints on the pretest data. The estimated odds of reaching both of these cutpoints was 0.56 (exp(−0.58)) for MTP teachers, 0.64 (exp(−0.45)) for MMCI teachers, and 0.37 (exp(-1)) for control teachers. As seen in Table 4, participation in MMCI increased a teacher's probability

Table 4
Two-level Logistic Regression Models Predicting Odds of Reaching both Cutpoints at Posttest.

Effect	*Est*	*SE*	*DF*	*t*	*p*
Intercept	−1.47	0.21	335	−6.86	<0.0001
Baseline	0.94	0.25	147	3.76	0.000
MTP vs. control	0.42	0.28	147	1.54	0.127
MMCI vs. control	0.55	0.26	147	2.08	0.039
MMCI vs. MTP	0.12	0.26	147	0.49	0.628

of attaining this level of teacher child-interactions, as compared to control teachers (*estimated odds ratio* = 1.73, $e^{0.55}$; $p < 0.05$). There was no statistically significant difference between MTP and control or between MTP and MMCI in the odds of attaining this level of interaction.

3.4. Teacher, class, and school/center characteristics as moderators

A two-step exploratory process was used to select and test potential moderators of the associations between treatment conditions and CLASS posttest scores. As a first step, all characteristics under consideration were included in separate HLMs for MMCI and MTP teachers to identify which might be associated with posttest scores, when controlling pretest scores. These characteristics were selected in conjunction with DECAL because they might provide insight into how future intervention efforts could be more effectively targeted. The second step involved testing all variables that demonstrated significant or marginal associations with CLASS scores in the within-model analyses as moderators in overall models.

The characteristics tested included:

- Teachers' Adult-Centered Beliefs, as measured on the pretest teacher questionnaire
- Teachers' years of experience as a Georgia's Pre-K teacher, as measured on the pretest teacher questionnaire
- Teachers' years of education, as measured on the pretest teacher questionnaire
- Class size, as observed during the pretest CLASS, averaged across the six cycles
- Child-to-staff ratio, as observed during the pretest CLASS, averaged across cycles
- Proportion of children in the classroom whose families reported receiving public assistance, as reported by DECAL
- Center vs. school
- Inside vs. outside metropolitan Atlanta area

Among MMCI teachers, those with fewer years of education and those in metropolitan Atlanta had higher Emotional Support scores at posttest, controlling for pretest and the other teacher, classroom, and school/center characteristics (education: $PE = -0.10$, $p < 0.05$, $ES = -0.18$, metro: $PE = 0.26$, $p < 0.05$, $ES = 0.38$). MMCI teachers with less Adult-Centered Beliefs, those with fewer years of education, and those in metropolitan Atlanta had higher Classroom Organization scores at posttest (beliefs: $PE = -0.25$, $p < 0.05$, $ES = -0.15$; education: $PE = -0.13$, $p < 0.05$, $ES = -0.10$; metro: $PE = 0.39$, $p < 0.01$, $ES = 0.46$). MMCI teachers in metropolitan Atlanta had higher Instructional Support scores at posttest ($PE = 0.54$, $p < 0.001$, $ES = 0.60$).

Among MTP teachers, there was a marginal trend toward teachers with less adult-centered beliefs, with more favorable child-to-staff ratios, and inside metropolitan Atlanta having higher posttest Emotional Support scores, controlling for pretest and the other teacher, classroom, and school/center characteristics (beliefs: $PE = -0.18$, $p = 0.08$, $ES = -0.15$; ratio: $PE = -0.10$, $p = 0.07$, $ES = -0.22$; metro: $PE = 0.22$, $p = 0.07$, $ES = 0.31$). Those in metropolitan Atlanta had significantly higher posttest scores on Classroom Organization than those outside Atlanta, ($PE = 0.32$, $p < 0.05$, $ES = 0.39$), and when there were fewer children per adult in the classroom, MTP teachers' posttest Instructional Support scores were higher ($PE = -0.21$, $p < 0.05$, $ES = -0.35$).

As the second step in considering differential associations between treatment and outcomes, all variables that were significantly or marginally associated with any of the CLASS posttest scores in any of the above models were included in a single model, along with their interaction with professional development condition. Thus, these models included: (1) teacher's Adult-Centered Beliefs, (2) teacher's education, (3) child-to-staff ratio, and (4) inside vs. outside metropolitan Atlanta, along with the interaction of each of these with MTP and MMCI (using Control as a reference group). Pretest CLASS score was controlled in all models.

Findings from these final models indicated that the effect of MMCI on both Emotional Support and Classroom Organization was stronger for teachers who had less education (ES: $PE = -0.14$, $p < 0.05$, $ES = -0.24$; CO: $PE = -0.18$, $p < 0.05$, $ES = -0.26$). The effect of MMCI on Instructional Support was stronger for teachers in the metropolitan Atlanta area than those outside the metropolitan area ($PE = 0.42$, $p < 0.05$, $ES = 0.47$). The effect of MTP on Instructional Support was stronger for teachers in classes with fewer children per adult ($PE = -0.14$, $p < 0.05$, $ES = -0.25$). There were no other statistically significant or marginal associations between any of the interaction terms and the post-intervention CLASS scores. Thus, of the 24 interactions tested (4 moderators X 2 professional development models X 3 outcomes), four (17%) were statistically significant.

3.5. Treatment-on-the-treated analyses

3.5.1. Coach/instructor characteristics

Coach/instructor characteristics could not be included in the moderator analyses because teachers in the control condition did not necessarily have a coach or instructor so the items about the coach/instructor were not asked of that group. Thus, separate HLMs were conducted for MTP and MMCI teachers predicting posttest scores in the three domains, controlling for pretest score, using the coach/instructor characteristics of: Adult-Centered Beliefs, Knowledge of Effective Teacher-Child Interactions, Confidence, and years of experience as Georgia's Pre-K Consultant. All variables were measured toward the end of the school-year on the spring questionnaire.

Among MMCI teachers, those whose instructors had more years of experience as a Georgia's Pre-K consultant had marginally higher Classroom Organization scores ($PE = 0.08$, $p = 0.07$, $ES = 0.21$) and significantly higher Instructional Support posttest scores ($PE = 0.10$, $p < 0.05$, $ES = 0.25$), controlling for pretest score and the other coach/instructor characteristics. None of the other associations were marginally or statistically significant. Among MTP teachers, no associations were found between coach characteristics and posttest score.

3.5.2. Full participation

As another check on the findings, the first set of HLMs that compared the three treatment groups on posttest CLASS scores, controlling for pretest CLASS scores, were re-estimated using only the teachers who took full advantage of the supports. Thus, we eliminated five MMCI teachers who did not attend all 10 MMCI sessions and 31 MTP teachers who completed fewer than eight MTP cycles. This resulted in an MMCI sample of 170 and an MTP sample of 84. The control group remained 160. The patterns of significance were identical to those seen in the intent-to-treat analyses, and the effect sizes were in the same general range. On Emotional

Support, MMCI and MTP teachers both scored higher at posttest than control teachers (MMCI: $PE = 0.25$, $p < 0.01$, $ES = 0.35$; MTP: $PE = 0.20$, $p < 0.05$, $ES = 0.28$). On Classroom Organization, there was a marginally significant difference between MMCI and control ($PE = 0.16$, $p < 0.10$, $ES = 0.19$). On Instructional Support, the only significant between group differences was between MMCI and control ($PE = 0.25$, $p < 0.05$, $ES = 0.28$).

3.5.3. MTP cycles

Finally, to assess the association of number of MTP cycles completed and classroom quality we conducted HLMs on each of the three post-intervention CLASS domain scores, controlling for pre-intervention CLASS score in that same domain, limiting the sample to only MTP teachers. No statistically significant or marginal associations were found.

Next we tested the number of cycles in which the prompts (i.e., Nice Work and Consider This) were focused on a specific domain as a predictor of posttest score in that same domain, controlling for pretest. Findings indicated that the number of cycles in which the prompts focused on Emotional Support was significantly associated with posttest score on Emotional Support ($PE = 0.12$, $p < 0.05$, $ES = 0.36$). No such association was found for Classroom Organization or Instructional Support.

4. Discussion

This study makes a substantial contribution by providing an independent test of two promising professional development models, using a large randomly selected and assigned sample of teachers in a real-world context. MMCI, which used an in-person, cohort model to improve teacher-child interactions, was an effective means of increasing Emotional and Instructional Support in Georgia's Pre-K classrooms, compared with control-group teachers. Teachers in this group also demonstrated marginally significant improvement in Classroom Organization. Further, teachers who took part in MMCI had greater knowledge of effective teacher-child interactions after participation than did their peers in the MTP or control groups and thought their professional development was more valuable than did their peers in the control group. Their relationships with their instructors were positive, but somewhat less positive than those reported by MTP teachers.

Teacher-child interactions among teachers in the MTP group, which involved one-to-one, remote coaching, also showed improvement. Emotional Support increased as a result of participation, although Classroom Organization, Instructional Support, and Knowledge of Effective Teacher-Child Interactions did not improve. There were no differences between MTP and MMCI teachers at the end of the study on any of the three CLASS domains. MTP teachers saw their professional development activities as more valuable than control-group teachers, and MTP teachers reported more positive relationships with their coaches than did MMCI teachers with their instructor.

4.1. Strengths of the study design

This study has three particular strengths in evaluating the professional development models: teachers were randomly selected for participation, teachers were randomly assigned to a professional development group, and professional development activities were led by Georgia's Pre-K consultants. Most similar studies of professional development strategies, including those by Pianta and colleagues investigating the efficacy of MTP and the predecessor of MMCI, rely on teachers who have elected to participate (Hamre et al., 2012; Pianta, Mashburn et al., 2008). That type of research tells us about the benefits we might see if teachers are invested in changing their practice. The current study is more broadly applicable to large systems such as Georgia's Pre-K because it tells us about the benefits of these models for all teachers, not just those who elect to participate.

Due to the random assignment of teachers to a professional development group, we can be confident that the changes we saw were caused by participation in the professional development activities. If teachers had been allowed to select their own professional development model, there might be systematic differences between groups that led them to choose a particular model and also led them to change (or not) during the course of the year. By randomly assigning teachers to a professional development group, we can be fairly certain that the only difference between groups is the professional development they received and that changes are therefore due to that experience.

The fact that the MMCI and MTP supports were provided by Georgia's Pre-K consultants adds to the applicability of these results in real-world settings. In past research on these strategies, the coaches and instructors have been Teachstone or university employees who are very experienced in delivering CLASS-based professional development. To be cost-effective, feasible, and sustainable, systems that are interested in employing such professional development models on a large scale would need to use their own consultants or technical support staff. This study demonstrates that improvements in teacher-child interactions are possible when program staff deliver a well-defined intervention. Relying on DECAL consultants to deliver the intervention has a further benefit: the consultants can continue to use MMCI and MTP strategies and methods in their regular consulting work after this project.

Additionally, this is the first test of MMCI in its current format. Much of the curriculum had been tested by Hamre et al. (2012) as part of a college-level course, but MMCI represents a substantial modification to that course. In this study, MMCI was delivered during five full-day sessions to cohorts of teachers. The format tested in this study was more feasible for DECAL and is likely more feasible for other early childhood agencies.

4.2. Teacher, classroom/site, and coach/instructor characteristics

There was correlational evidence that some groups of teachers benefited more from the professional development models than others. MMCI teachers with fewer years of education showed greater improvements in Emotional Support and Classroom Organization, and the effect of MMCI on Instructional Support was stronger for teachers in the metropolitan Atlanta area than those outside the metropolitan area. MTP teachers in classrooms with fewer children per adult showed greater improvements in Instructional Support. These findings make some intuitive sense. The content delivered in MMCI might have more influence on the practice of less educated teachers because it is more novel for those with less education and those teachers might be more open to change than their more educated counterparts. Teachers in the metropolitan area may have other supports available in the form of colleagues and universities, allowing them to take fuller advantage of the professional development. Likewise, the teaching environment is less stressful when there are more favorable child-to-teacher ratios, and this lower stress may allow teachers to focus more on improving their interactions.

Additionally, teachers in the MMCI group demonstrated more improvements in Instructional Support (and marginally more in Classroom Organization) when the instructor delivering the MMCI content had more years of experience as a pre-k consultant. It is possible that MMCI instructors with more years of experience were better able to support teachers in changing the instructional aspects of their interactions with children (e.g., provided more real-world

examples, were more knowledgeable of how to embed instruction into daily interactions).

These conditional findings, however, must be interpreted with caution. The set of moderators tested was based on DECAL's practical and policy needs, rather than relying solely on theory and past research, and a relatively large number of interactions were tested. Further, causal inferences cannot be drawn because these variables cannot be assigned at random. It is possible, for instance, that teachers with certain pre-existing skills and dispositions—like commitment to high quality early care and education—are more likely to benefit from the professional development and find employment in settings with more favorable teacher to child ratios. Additionally, previous research by Pianta, Mashburn et al. (2008) has not identified child-to-teacher ratios or teacher education as factors associated with change in practice. These findings need replication.

4.3. Interpreting effect sizes

The effect sizes found here are all in the small range (0.20–0.49) according to Cohen (1992), but most reach the level of "substantive" (0.25 or greater) as defined by What Works Clearinghouse (2014). Further, they are meaningful when put in the context of other research on these and other strategies for improving teacher-child interactions. For instance, the effect sizes reported in a randomized control trial of an ECMHC approach, a different type of professional development intended to strengthen teacher-child interaction, Raver et al. (2008) reported effect sizes between 0.19 and 0.29 on the positive climate, negative climate, teacher sensitivity, and behavior management dimensions of the of the CLASS. Those effect sizes are smaller than the effect size of 0.36 for MMCI on Emotional Support in this study.

In the original study of a course similar to MMCI, Hamre et al. (2012) reported effects sizes of 0.41 for Emotional Support, 0.28 for Classroom Organization, and 0.66 for Instructional Support. The MMCI effect sizes in the current study were 0.36, 0.20, and 0.27 respectively. Thus, using randomly selected teachers and state-employed consultants as coaches/instructors, the current study found effect sizes that were roughly comparable to those found by Hamre and colleagues for Emotional Support and Classroom Organization, but somewhat smaller impacts on Instructional Support. It is unclear why the effect sizes for Instructional Support in this study are smaller than those seen by Hamre and colleagues. One possibility is that Instructional Support may be more novel content for many early childhood professionals. The importance of the classroom's emotional climate and organization have been long accepted by early childhood educators, but the importance of instruction is relatively new (NAEYC, 2009). This novelty might have made the content more difficult for Georgia's Pre-K consultants, who were new to MMCI. Further, these randomly selected teachers, whose motivation to change likely varied, may have been the least motivated by these novel ideas.

Another way to consider the magnitude of the effects is to consider the proportion of teachers whose interactions reached an adequate level to improve children's outcomes. The findings from the logistic regressions indicate that MMCI did significantly increase a teacher's odds of reaching that level of interaction, but the majority of MMCI teachers still fell below that threshold. All in all, these findings indicate that MMCI, and to a lesser extent MTP, are valuable ways to improve quality of pre-k in a large-scale, real-world setting, but more work is needed to ensure that all teachers are providing interactions that maximize pre-k's benefits.

4.4. Treatment on the treated

It is surprising that findings did not change when we limited the sample to teachers who got the full dose of MMCI or MTP, defined as all 10 MMCI sessions or at least eight MTP cycles. We would anticipate that more exposure to an effective intervention would yield stronger results. Likewise, it is surprising that there was no linear association between total number of MTP cycles and posttest scores in any of the three domains, and only number of cycles focused on Emotional Support was associated with posttest scores in Emotional Support.

These findings contradict those seen in an early evaluation of MTP. Pianta et al. (2014) found that more cycles were generally beneficial for teachers. Their findings indicated that for Emotional Support each additional cycle was linked to increased posttest scores. In the other two domains, there was an inverse U-shaped pattern in which additional cycles were beneficial up to a point and then the benefits tapered off. For Classroom Organization, that point was 7.52; for Instruction Support it was 13.17. They found no evidence of a minimum number of cycles needed to demonstrate an impact.

Despite null findings for number of cycles completed, it is nonetheless possible that teachers in the current study did not complete sufficient number of cycles to see MTP's full benefits. In the Pianta et al. (2014) study, teachers completed more cycles on average (*mean* = 10.11, *SD* = 4.15) than in the current study (*mean* = 7.57, *SD* = 1.86). Discussions with DECAL staff, as well as a separate study component that included semi-structured interviews with MTP coaches and MMCI instructors provided some clues as to why the MTP cycles might have been low (Early et al., 2014). Those reasons included low enthusiasm on the part of some teachers, technical difficulties in using video and web-systems, and other demands on coaches' time, making it difficult to complete all necessary work, especially when MTP was new to them. Thus, the current study may not be a sufficient test of MTP's ability to change teachers' interactions with children. Nonetheless, this study provides important information about the likely attainable dosage for a large-scale implementation. More work is needed to understand the range of supports teachers and coaches need to ensure that MTP is implemented in a way that provides maximum benefit. Further, future research that considers the nesting of teachers within coaches, and includes additional information about coach-level implementation, would provide a more complete picture of when and how MTP is effective.

4.5. Study limitations

It is important to note that the study had several limitations. The single day of observation by a single observer in the fall and spring means that the ratings of teacher-child interactions are not exact. Teacher-child interactions vary from day-to-day, and it is always possible that an observation took place on a particularly good or bad day. Additionally, although the observers were well-trained and monitored, it is impossible for independent observers to be entirely accurate and consistent in their ratings.

As noted earlier, there is a confound between condition and days between pre- and posttest observation. MMCI is a shorter intervention than MTP, and we decided it was more important to keep the window between the end of the intervention and the posttest observation constant than to keep the window between the pre- and posttest constant because the effect of the intervention may change during the weeks or months after it ends. However, there is some indication that teacher-child interactions become less positive toward the end of the school year (National Center on Quality Teaching and Learning, 2013), so this decision may have favored MMCI, where posttest were earlier, and could partially explain MTP's limited impact.

The change in randomization procedure between the first and second year of the study is another limitation. The sensitivity check that omitted the data from the first year indicated that the

MMCI findings were not affected by this change; however, while the direction of the effect remained the same, the impact of MTP on Emotional Support became non-significant and the effect size diminished. It could be that the analyses including all three years are artificially increasing the power of the analyses by not accounting for the change in level of randomization between the first and second years. We think it is more likely, however, that removing the first year data diminished the power to detect the effect.

The fact that the main outcome tested in this study—CLASS scores—is the same as the outcome targeted by the models themselves, and that the study did not measure children's outcomes, are additional limitations. It is possible that these models simply 'teach to the test,' helping teachers improve CLASS scores during an observation, without truly affecting change in every day practice or children's outcomes. Future work on these professional development models should include other ways of measuring classroom quality, as well as measures of children's academic and socio-emotional skills.

It is also important to remember that all studies take place within a context, and we cannot know exactly how these findings would generalize to other contexts, like non-pre-k classrooms in childcare or Head Start. Some characteristics that might differentiate this context from others include: the high education level of Georgia's Pre-K teachers, the low attrition in this study indicating low teacher turnover, and the fact that Georgia was working to build awareness of the CLASS and of the importance of rich teacher-child interactions statewide during the project, which would include teachers in the control group. This familiarity and "culture of CLASS" across the entire state may not be present in other pre-kindergarten systems. The control group's possible familiarity with the CLASS may have made it even harder to find statistically significant differences between the intervention and control groups. Though this could, in a sense, be viewed as a tougher test of the effectiveness of the interventions, we recognize that it also limits the generalizability of the findings.

5. Conclusions

Georgia's Pre-K teachers benefited from and liked both the MMCI and MTP interventions. This study purposefully sought to test MMCI and MTP as possible ways to improve teacher-child interactions in large-scale, real-world conditions, such as delivery of the intervention by program staff, inclusion of a large number of teachers, and randomly selecting teachers rather than asking for volunteers. When compared to teachers in the control group, MMCI resulted in significant or marginal improvements in all three domains; MTP resulted in improvements in one domain. Pre-k teachers rated both interventions more favorably than did teachers in the control group.

MMCI appears to be a feasible intervention for large-scale adoption. MMCI requires fewer staff members and less time to implement than MTP, which makes it more practicable and sustainable for large-scale implementation. DECAL put a great deal of effort into implementing both models with a high level of fidelity. That effort resulted in almost all MMCI teachers attending all 10 sessions; however, only 56% of MTP teachers completed eight or more cycles of coaching. This difference illustrates the challenges associated with MTP implementation.

Additional research is needed to understand better the circumstances under which MMCI and MTP are most likely to support meaningful improvements in teacher-child interactions. The findings from this evaluation add to the literature about the MMCI and MTP interventions and provide some hints about the factors (e.g., teacher education, ratios) that may influence the effectiveness of the interventions. There are many important questions still to answer about these interventions. For instance, how best to engage a wide range of teachers (not just the few who are especially motivated) in improving classroom practices? Are there ways of identifying which teachers are likely to benefit most from the one-on-one, intensive supports provided by MTP and which would find the group-comradery and support of MMCI more useful? What threshold of intervention is needed to meaningfully change Instructional Support? And what supports do coaches or instructors require to maximize their influence on teacher practice?

Advancements in early childhood professional development are still needed. Using these well-defined, evidence-based professional development models, statistically significant findings emerged. The improvements, however, were small and Instructional Support in all three groups remained in the low-to-middle range. Thus, additional work is needed, including refinement of existing models and creation of new approaches to professional development, to best support all pre-k teachers in engaging in high-quality interactions with their students.

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