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Does professional development reduce the influence of teacher stress on teacher–child interactions in pre-kindergarten classrooms?☆

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ABSTRACT

The present study examines the extent to which participation in a 14-week professional development course designed to improve teacher–child interactions in the classroom moderated the relation between teacher-reported job stress and gains in observed teacher–child interaction quality from the beginning to the end of the intervention. Participants were preschool teachers ($N = 427$; M age = 42) with an average of 11 years of experience teaching. Teachers reported how intensely they experienced different sources of stress at pre-test only (i.e., prior to being randomized into the treatment condition [course or control]). Teacher–child interactions were measured through classroom observations at pre and post intervention. Results demonstrated that control teachers reporting higher professional investment stress showed fewer gains in observed emotional support relative to control teachers experiencing less professional investment stress. These findings were not evident for teachers in the course condition. Interestingly, teachers with higher professional investment stress showed fewer gains in instructional support in the control condition and greater gains in the course condition, relative to teachers in their respective treatment groups who reported lower levels of professional investment stress. Findings suggest that participation in the professional development intervention had a buffering effect on the negative association between professional investment stress and emotional support. With regard to instructional support, it is possible that teachers' heightened awareness and anxiety over their need to develop professionally may have made them more responsive to an intervention designed to improve practice.

1. Introduction

Children's experiences in early learning environments are critical for developmental outcomes. A growing body of research on preschool settings indicates that high quality interactions between teachers and students foster children's academic and social-emotional readiness skills (Burchinal, Zaslow, & Tarullo, 2016; Raver et al., 2011; Yoshikawa et al., 2013). At the same time, literature reports that teachers' experience with stress can reduce the quality of these important interactions with students (Li-Grining et al., 2010; Yoon, 2002). As a result, many educational researchers have expended great effort to try to better understand teacher stress and identify ways in which teachers can be supported so that stress does not take a toll on their instruction and interactions (e.g., Chang, 2009; Kyriacou, 2001; Lambert, O'Donnell, Kusherman, & McCarthy, 2006; Zhai, Raver, & Li-Grining, 2011).

This study draws from Jennings and Greenberg's (2009) model of a *prosocial classroom,* which advances the importance of teacher emotional well-being. The model describes the impact of stress as a "burnout cascade" (p. 492). Stressed teachers without the emotional resources to meet the challenges of teaching have poorer quality interactions with their students. Consequently, students spend more time off task and show more problem behaviors, which in turn, produce a more stressful classroom climate. The stressful classroom climate leads to more challenge, stress, and exhaustion for the teacher and the cascade continues. Jennings and Greenberg indicate that in-service professional development may be one

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way to ameliorate feelings of job stress and boost the quality of teacher–child relationships. Yet, professional development opportunities take time, increase workload, and could even result in more feelings of stress and burnout, rather than less (Ozer & Beycioglu, 2010). Therefore, the current study bridges these two lines of research: teacher stress and professional development. Given that existing empirical and theoretical work indicates teacher stress is negatively associated with the quality of teacher–child interactions, the purpose of this study was to examine whether participation in a high quality professional development intervention targeting teachers' interactions and relationships with students moderates the relation between teachers' self-reported job stress and their observed teacher–child interactions.

1.1. Teacher–child interactions

Types of interactions that are beneficial to young students relate to the emotional and instructional supports provided by teachers, as well as teachers' management of the classroom (Pianta & Hamre, 2009). Teachers facilitate the development of students' social-emotional competence by creating warm and emotionally supportive environments infused with mutual respect and positive communication, providing opportunities for autonomy, and demonstrating sensitivity to students' emotions (Birch & Ladd, 1997; Brock & Curby, 2014; Denham, Bassett, & Zinsser, 2012; Pianta & Steinberg, 1992). Teachers establish productive and organized classrooms that support academic instruction and student learning behaviors by instituting consistent behavioral expectations and classroom routines, as well as maximizing instructional learning time (Choi et al., 2016; McLeod, Fisher, & Hoover, 2003). Relatedly, teachers provide high quality instruction by fostering a deeper understanding of academic concepts through open-ended questions, problem solving, and real-world application, and by encouraging language development through conversation, repetition, and elaboration (Hamre & Pianta, 2005; Torgesen, 2002).

National trends in teacher–child interactions indicate that the quality of interactions often declines over the course of the year (National Center on Quality Teaching and Learning, 2013). To better understand how teachers can maintain high quality interactions with students throughout the school year, researchers need to consider the psychological and professional factors that influence the quality of teacher–child interactions (Rimm-Kaufman & Hamre, 2010). Teachers' emotional well-being contributes to their functioning in the classroom setting (Hamre & Pianta, 2004; Jennings & Greenberg, 2009; Sandilos et al., 2015). Teachers who experience high levels of stress face difficulty achieving and sustaining high quality interactions with their students (Li-Grining et al., 2010).

1.2. Teacher stress in early childhood settings

Early childhood teachers are under immense pressure to ensure that their young students are prepared for future success in school. These pressures have been compounded by the reality that early childhood professionals still tend to be underappreciated by society as evidenced by lack of mobility within the career track and disparities in pay between preschool teachers and teachers in grades K-12 (National Survey of Early Care and Education, 2013; USDH, 2016; Whitebook, Philips, & Howes, 2014). The high professional demands and low compensation make early childhood educators particularly vulnerable to stress (Gooze, 2014).

Teacher stress is broadly defined as a negative emotional experience associated with an individual's ability to cope with job stressors (Kyriacou, 2001). Teachers' experience with stress is related to a variety of negative outcomes, such as poor health, lower quality instruction, burnout, absenteeism, and turnover (e.g., Alkon, Ramler, & MacLennan, 2003; Curbow, Spratt, Ungaretti, & Breckler, 2000; Greenberg, Brown, & Abenavoli, 2016). Stress is also not unidimensional. Teachers' experience with job stress stems from various sources–both personal and environmental influences. Some teacher stress reflects investment in their professional career. Other stress stems from behavioral problems and low motivation on the part of their students. Yet another source of stress emanates from work issues such as high workload, unusually high numbers of students in their class, or too many professional responsibilities (Fimian & Fastenau, 1990; von der Embse, Kilguss, Solomon, Bowler, & Curtiss, 2015).

Prior research has described professional investment stress as the most prevalent source of stress among teachers. Teachers' feelings of stress related to professional investment included frustrations with lack of control over job-related decisions and limited access to professional growth opportunities, as well as a feeling of low intellectual or emotional stimulation (Fimian & Fastenau, 1990). Indeed, more recent data suggest that ongoing professional learning opportunities for teachers in the U.S. are limited compared to other high-achieving countries (Darling-Hammond, Wei, & Andree, 2010). Additionally, for preschool teachers, perceived lack of control over their job is regarded as a major contributor to job stress and has been shown to be detrimental to classroom practice (Curbow et al., 2000; Hagekull & Hammarberg, 2004; Raver, 2004).

Managing student behavior is another prominent and frequently studied source of stress for teachers, regardless of the grade level taught (Friedman-Krauss, Raver, Neuspiel, & Kinsel, 2014; Grayson & Alvarez, 2008). As one example, a study of teacher stress in the primary through secondary grades indicated that stressors related to student behavior had more detrimental effects on feelings of teaching efficacy than stress associated with overall teaching workload (Klassen & Chiu, 2010). Moreover, the concurrent relation between high teacher stress levels and increased behavioral issues or teacher-student conflict has been highlighted in the literature regarding teacher well-being (e.g., Jennings & Greenberg, 2009; Whitaker et al., 2015).

Structural features of early childhood education, such as large class size and limited planning time, have long been considered stressful aspects of the occupation (Raver, 2004). More recently, increased workload associated with documentation and paperwork has accompanied accountability reforms (Gooze, 2014; Stipek, 2006). In many early childhood settings these high work-related demands do not occur in tandem with adequate job supports, and for that reason, teachers experience high rates of burnout and turnover in the early childhood workforce (6; Maslach, Schaufeli, & Leiter, 2001; Whitebook et al., 2014).

Existing literature shows that teacher stress is complex and multifaceted. Not only is it important to consider the overall job stress a teacher is experiencing, but it is also valuable to examine sources of stress separately to disentangle key stressors that teachers face in their profession (Chang, 2009; Curbow et al., 2000; Klassen, Foster, Sajani, & Bowman, 2009). Furthermore, exploring the ways in which different sources of stress influence teachers' interactions with students has the potential to provide more specific levers for improving school-based professional development and other interventions targeting work-based stress.

1.3. Teacher stress and interaction quality

Teacher stress has consequences for the quality of interactions in the preschool classroom (Hamre & Pianta, 2004), which in turn influences the social, emotional, and academic skills of the young children (Raver, 2004). For instance, preschool teachers who report high levels of stress tend to be in classrooms rated lower in emotional support, classroom management, and instructional support (Collmann, 2012; Li-Grining et al., 2010). Conversely, reductions

in stress are linked to teachers' provision of higher quality environments and improved outcomes for students (Zinsser, Bailey, Curby, Denham, & Bassett, 2013). As one example, lower levels of overall teacher job stress and higher ratings of classroom management were related to increased ratings of learning motivation in preschoolers (Pakarinen et al., 2010). Although existing work establishes the link between higher stress and lower quality teacher–child interactions in early childhood classrooms, less is known about different sources of job stressors and their implications for preschool teachers' interactions with their students, which is an issue addressed in the present study.

1.4. Professional development

One potential way to buffer against the effects of teacher job stress is to provide teachers with additional supports and skills through professional development (Jennings & Greenberg, 2009). High quality professional development (PD) can result in positive changes in preschool teachers' instruction and improved outcomes for young children (Kinzie et al., 2014; Pianta, Mashburn, Downer, Hamre, & Justice, 2008). However, the PD experiences provided to teachers in schools and center-based settings vary widely in structure and quality (Sheridan, Edwards, Marvin, & Knoche, 2009). The variability and inconsistent quality of teacher PD spawned a large body of research exploring effective and systematic methods for providing additional training to teachers. Concurrently, the mounting evidence that teacher–child interactions are a vital aspect of early childhood programming has resulted in the creation of PD interventions that target interaction quality in preschools (e.g., Domitrovich et al., 2009; Pianta, Mashburn et al., 2008). Initial outcomes from PD interventions aimed to improve teacher–child relationships indicate that teachers can change the way they interact with students through the use of observations and feedback (Hamre, Downer, Jamil, & Pianta, 2012; Zan & Donegan-Ritter, 2014).

Despite the strong research on PD and teacher–child interactions in early childhood, somewhat less is known about the relation between preschool teachers' experience with stress and PD experiences. One possibility is that additional PD is not sufficient to influence the relation between stress and interaction quality. Yet another possibility is that participation in PD could provide teachers with new skills and strategies to utilize in the classroom, which may in turn render teachers' feelings of stress less influential on their interactions with students. International work on this topic has shown that teachers exhibit positive attitudes toward PD when they perceive a link between their accomplishments and the PD experience, and demonstrate negative attitudes toward PD when they feel the experience increased their feelings of burnout (Ozer & Beycioglu, 2010). Though not directly examined in this study, it is important to note that there are a variety of potential mechanisms influencing the relation between PD and teacher stress. For example, when administered effectively, PD experiences can increase teachers' feelings of self-efficacy in the targeted area of PD instruction (Goddard, Hoy, & Woolfolk Hoy, 2004; Rimm-Kaufman & Sawyer, 2004; Tschannen-Moran & McMaster, 2009), which, in turn, may mitigate any negative feelings of stress associated with that aspect of their job (Schwarzer & Hallum, 2008). Moreover, a characteristic of high quality PD is providing teachers with the opportunity to discuss new concepts or skills and to talk about problems that arise in the classroom (Garet, Porter, Desimone, Birman, & Yoon, 2001), the act of which may be stress-relieving. Thus, participation in PD targeted at improving teacher–child interactions may buffer the negative association between teachers' feelings of stress and interaction quality between teachers and students.

1.5. Present study

The present study examines the extent to which a 14-week professional development course designed to improve teacher–child interactions in the classroom moderated the relation between sources of teacher-reported job stress and gains in observed quality of teacher–child interactions from the beginning to the end of the intervention. The following research question was explored: Is the relation between teachers' ratings of different sources of stress and the quality of their interactions with preschool students moderated by participation in a PD intervention focused on improving teacher–child interactions?

The current study extends previous research by examining how different sources of job stress relate to preschool teachers' interaction quality. Three sources of stress (i.e., professional investment, discipline and motivation, and work-related stressors) and three types of interactional quality (i.e., emotional support, classroom organization, and instructional support) were examined separately to better understand how various sources of stress might be differentially associated with gains in different types of interactional quality. Moderation was tested by examining whether or not the relations between source of stress and change in interaction quality depended on assignment to the intervention (course) or control condition.

2. Method

The data for this study were drawn from a large multi-site, randomized controlled trial (i.e., National Center for Research on Early Childhood Education [NCRECE] Professional Development Study; Downer et al., 2014; Hamre et al., 2012). The larger study evaluated two forms of professional development aimed to improve teachers' interactions with children over three phases of intervention. The first phase of the intervention (Phase 1) consisted of a 14-week college-level course, as described below. Data for this study were drawn from Phase 1 only.[1]

2.1. Participants

Participants were preschool teachers recruited from large community preschools and Head Start programs across ten sites (i.e., cities) in the United States (New York, NY; Hartford, CT; Chicago, IL (2 sites); Stockton, CA; Dayton, OH; Columbus, OH; Memphis, TN; Charlotte, NC; Providence, RI). Participants were eligible for NCRECE based on four criteria: (a) they were the lead teacher in a publicly-funded classroom in which the majority of children were eligible for kindergarten the following school year, (b) the majority of children did not have an IEP at the start of the current school year, (c) classroom instruction was primarily in English, and (d) high-speed internet access was available for teacher use at the program site. The research team extended invitations to the program administrators, established program agreements, and facilitated IRB approval at specific sites. Teacher recruitment was conducted after administrators confirmed that their site would participate in the study. After agreeing to take part in the study, teachers were then randomized into the course or control condition within site for the first phase of the study (Hamre et al., 2012). The number of teachers assigned to the course condition ranged from 37% to 56% across the ten sites. Incentives for participation in the study included the receipt of stipends as data collection materials were submitted as well as monthly books. Teachers' names were also

[1] Phase 2 included coaching and Phase 3 encompassed a post-intervention period of data collection. For more information regarding Phases 2 and 3, please see related NCRECE publications (e.g., Downer et al., 2014; Pianta et al., 2014).

Table 1
Items for teacher stress inventory composites.

Items
Work-Related Stress
There is little time to prepare lessons/responsibilities.
I have too much work to do.
The pace of the day is too fast.
My personal priorities are being shortchanged due to time demands.
There is too much administrative paperwork in my job.
My class is too big.
Professional Investment Stress
I lack opportunities for professional improvement.
My personal opinions are not sufficiently aired.
I am not emotionally/intellectually stimulated by my job.
I lack control over classroom decisions/matters.
Discipline and Motivation Stress
I feel frustrated because some students would do better if they tried harder.
I feel frustrated because of discipline problems in my classroom.
I feel frustrated when my authority is rejected by pupils/administration.
I feel frustrated having to monitor pupil behavior.
I feel frustrated attempting to teach students who are poorly motivated.
I feel frustrated because of inadequate/poorly defined discipline practices.

Note. Items are scored on a range of 1 (*not stressful*) to 5 (*highly stressful*).

entered into periodic drawings for gift certificates. At many of the sites, teachers received three college-level credits for their participation in the course.

Of the 427 teachers (*M* age = 42) who enrolled in Phase 1 of the study, 239 teachers had complete data at the end of the intervention year. The most common reason for missing data was that teachers dropped out of the study due to competing time commitments. In addition, several teachers were missing CLASS observational data because they took the course in the summer and they were not teaching at that time (Hamre et al., 2012). Little's MCAR test (conducted using SPSS Version 23) demonstrated that missing values for the key study variables were missing at random (MAR), X^2 (6) = 10.22, p = 0.12. Accordingly, full information maximum likelihood estimator (FIML) in M*plus*7 (Muthén & Muthén, 1998–2012) was used to handle missing data for the full sample (N = 427).

On average, teachers were approximately 42 years old, had 11 years of experience teaching, and made $30,000 to $34,999 a year. Teachers also had an average of 15 years of education and were diverse in terms of their educational background (high school or vocational degree = 10%; associate's degree = 22%; bachelor's degree = 47%; master's degree or higher = 21%). Half of the teachers had a degree in child development (5%) or early childhood education (45%). About one third had an education degree of some type (33%; e.g., elementary education, special education) and the remaining teachers (17%) did not have an education-related degree. Most of the teachers were African American (44%) or European American (30%). Relatively fewer participants were Latino American/Hispanic (16%) or Asian and other ethnicities (7%).

The majority (63%) of teachers worked in Head Start programs and the remaining teachers were employed in either public schools or private centers. Almost half of the children in teachers' classrooms were girls (48%). On average, classrooms were characterized by mostly African American (47%) and Latino American/Hispanic (32%) children. About 18% of students had limited English proficiency and 9% had IEPs. There were approximately 18 children in each classroom. Descriptive statistics are presented in Table 1 by treatment group. There were no significant differences in the demographic or work characteristics between teachers in the course and control groups. There were also no differences in the demographic make-up of their classrooms.

2.2. Intervention description

Of the 427 teachers, 218 (51%) were randomly assigned to the professional development intervention; a 14-week course designed to increase teachers' knowledge about the vital role that teacher–child interactions play in learning and skill acquisition. The PD was constructed to build specific skills for observing teacher–child interactions that contribute to language and literacy skills. The intervention targeted language and literacy because observational evidence suggests that preschool teachers focus more on these skills than other academic content areas (Early et al., 2010).

The course provided very specific knowledge about effective interactions and used the Classroom Assessment Scoring System (CLASS; Pianta, La Paro et al., 2008), a validated observational measure, as the framework for this knowledge. Teachers were taught to make explicit links between teachers' behavioral actions and intended consequences for children. For example, when learning about behavior management, teachers were encouraged to watch and analyze videos that highlighted the ways in which specific teacher actions led to more or less positive behaviors among students in the classrooms. The course also targeted teachers' skills in detecting effective teacher–child interactions through video analysis.

The course was delivered in 14, 3-h-long sessions through collaborations with local colleges and universities in each site. On average, teachers had good attendance rates (M = 82%, SD = 0.25). There were a range of 5–15 teachers in each course section. The first three sessions provided teachers with information on the framework for the course and covered materials such as why preschool experiences are important for long-term development, the importance of teacher–child interactions and relationships for promoting children's development, and introduction to the three broad domains of the CLASS: Emotional Support, Classroom Organization, and Instructional Support. Following this introduction, 1–2 sessions focused more deeply on each of the CLASS domains. Each session introduced teachers to types of effective interactions and presented videos in which teachers analyzed the extent to which these interactions were present or absent. Homework included readings and analyzing videos online. The next series of sessions focused on language and literacy development and instruction. In the final session, teachers were asked to film themselves delivering a language and literacy activity and to share their video with fellow teachers while highlighting examples of effective (or ineffective) interactions throughout.

The course was delivered by instructors who were required to have a master's degree or higher in early childhood education or a related field, experience in early childhood education and in teaching college-level students from diverse backgrounds, and proficiency with technology. Each course section was taught in person by an individual instructor. To prepare for the course, the instructors attended a week-long training and received on-going implementation support from NCRECE staff (e.g., weekly phone calls from course developers). To monitor the fidelity of implementation, course sessions were videotaped and coded by the NCRECE staff and instructors received feedback on their implementation. Videotaped coding as well as reports provided by the participating teachers and course instructors indicated that the course was administered with high levels of fidelity with instructors covering 95% of course material and using high quality instructional methods (Hamre et al., 2012; LoCasale-Crouch et al., 2011).

Teachers in the control condition received business-as-usual supports and were not exposed to the intervention coursework, though they may have been taking other courses at the time (Hamre et al., 2012).

2.3. Procedures and measures

Teachers completed an online questionnaire prior to beginning the course that included demographic information and a self-report measure of job stress. The self-report measure of job stress was collected only at the start of Phase 1 of the study. Teacher use of effective teacher–child interactions was coded from videotapes teachers submitted to the research team. All teachers were provided with a digital video camera and were asked to submit four 30-min videos during the course phase of the study. Teachers were provided with specific instructions regarding the types of lessons to tape. Each videotape was required to meet the following criteria: (a) at least 30 consecutive minutes of instruction, (b) a language or literacy lesson/activity is taking place that is reflective of a typical day in the classroom, (c) the teacher is interacting with students, and (d) the teacher is visible throughout the taping. Two 15-min segments were CLASS coded from each 30-min video. The segments selected for this study were gathered at two time points: a) time 1, corresponding to the time period before the start of the course through the first two weeks of the course, and b) time 2, corresponding to the time period between the mid-point of the course to within 2 weeks after the last day of class.

Coding was randomly assigned to raters at the segment level. Each segment was double-coded. Coders attended a 2-day CLASS training and had to pass the CLASS reliability

test, which requires scoring five segments and demonstrating consistency with master codes (80% of codes within 1 point of master code). Average reliability for the Reliability I test was 84%, with a range of 60% to 100%. Coders who did not pass this initial test were provided with feedback and given a second test. Coders who did not pass this second test were assigned to other responsibilities. Throughout the coding period, all coders attended weekly meetings that focused on assessing progress and reliability, as well as addressing issues of potential drift. During these meetings 89% of codes were within 1 point of the master code.

2.3.1. Teacher–child interactions

Teacher–child interactions were measured using the Classroom Assessment Scoring System – Pre-Kindergarten (CLASS Pre-K; Pianta, La Paro et al., 2008). The CLASS Pre-K includes10 dimensions assessing teacher–child interactions. Each dimension is rated on a 7-point scale with behavioral indicators and anchor point descriptions provided for low (1–2), medium (3–5), and high (6–7) levels of that dimension. The dimensions are aggregated to create three primary domains. *Emotional support* consisted of positive climate, negative climate (reversed), regard for student perspectives, and teacher sensitivity. *Classroom organization* consisted of behavior management, instructional learning formats, and productivity. *Instructional support* consisted of concept development, quality of feedback, and language modeling.

2.3.2. Teacher job stress

Teachers' reported job stress was collected only at the pretest time point using the Teacher Stress Inventory (TSI; Fimian & Fastenau, 1990). In this inventory, teachers reported how intensely they experienced stress, by responding to a series of statements (e.g., my class is too big) using a Likert-type response scale ranging from 1 (*not stressful*) to 5 (*highly stressful*). A full list of items is presented in Table 1. Sixteen items make up the three subscales of the inventory (subscales had adequate reliability [α] in the current sample): *Work-related stressors* (e.g., workload, size of classes, professional responsibilities; $\alpha = 0.80$); *professional investment* (e.g., opportunities for professional improvement, emotional/intellectual stimulation; $\alpha = 0.75$); and *discipline and motivation* (e.g., student behavior problems, student motivation; $\alpha = 0.80$).

2.3.3. Covariates

A number of covariates were included either because they were determined to be conceptually important in this sample or because they had appeared in prior studies of teacher–child interactions (Cabell et al., 2013; Hamre et al., 2012; Mashburn et al., 2008; Pianta, Mashburn et al., 2008). The full list of covariates included: teacher race/ethnicity, annual income, years of education, years of teaching experience, teaching efficacy/beliefs,[2] and Head Start affiliation (e.g., teaching in a Head Start center). Additionally, to examine change in teacher–child interactions using residualized change scores, the time 1 (fall) CLASS domain was entered into the model as a predictor and the corresponding time 2 (spring) CLASS domain was used as the outcome in each model.

2.4. Analytic approach

Correlation coefficients showed associations among the stress subscales (work-related stressors, professional investment, and discipline and motivation) with coefficients ranging from 0.56 to 0.67. Including all three subscales in a single model raised multicollinearity concerns. However, analyzing each separately meant that findings in models for each source of stress also contain information about the portion of variance shared across subscales. Resolution involved a two-part approach: first, analyzing each source of stress alone in separate models (keeping all the other covariates the same), and second, computing models with all three subscales entered simultaneously. Results revealed significant moderation regardless of the analytic approach. In models examining each source of stress separately, simple slopes for specific sources of stress were significant; whereas, in the model with all subscales entered simultaneously, the simple slopes of the moderation analyses exhibited similar trends but were non-significant (for both groups). Careful examination of the results from both models speaks to the potential suppression effects at play in the model containing the three correlated predictors. Thus, results are reported from models that included each source of stress separately and findings are interpreted in ways that acknowledge this decision.

The current study had 10 data collection sites. Programs/centers within sites were not recorded as part of the data collection procedure. To correct for the non-independence of teachers within site, we used the M*plus* TYPE = COMPLEX option, which provides scaled standard errors robust to non-independence and non-normality.

3. Results

Preliminary analyses were conducted using SPSS Version 23 to examine the descriptive statistics of all study variables. The means and standard deviations of all variables used in the final models are listed by condition in Table 2. *T*-tests were conducted to examine differences in all variables due to treatment condition (course vs. control; see Table 2). Results indicated significant differences on all three teacher–child interaction outcome variables (emotional support, classroom organization, instructional support) at time 2. Teachers in the course condition outperformed teachers in the control condition on all teacher–child interaction outcomes at time 2. However, there were no differences between teachers on these variables at time 1. There were no differences by condition for teacher race/ethnicity, annual income, years of education, years

[2] Details regarding Teaching Efficacy/Beliefs (Tschannen-Moran & Woolfolk Hoy, 2001) can be obtained from the primary author.

Table 2
Descriptive statistics for covariates by treatment condition.

	Condition					
	Course (N = 218)			Control (N = 209)		
	%	M	SD	%	M	SD
Covariates						
Teacher Characteristics						
Race (African-American)	43			46		
Ethnicity (Hispanic)	17			15		
Annual Income		$32,531	$10,870		$33,174	$11,775
Years of Education		15.51	1.54		15.71	1.65
Years of Experience		13.80	8.64		14.39	9.48
Teaching Efficacy/Beliefs		7.44	1.01		7.59	0.97
Classroom Characteristics						
Head Start affiliation	61			35		
Teacher-child Interactions						
Emotional Support (pre)		5.30	0.48		5.26	0.50
Classroom Organization (pre)		2.50	0.68		2.36	0.69
Intructional Support (pre)		5.17	0.64		5.22	0.65
Teacher Stress Inventory						
Work-related Stressors		2.11	0.67		2.14	0.79
Professional Investment		1.61	0.65		1.56	0.58
Discipline and Motivation		1.77	0.62		1.71	0.63
Teacher-child Interactions						
Emotional Support (post)		5.42 $_a$	0.49		5.17 $_a$	0.58
Classroom Organization (post)		2.96 $_b$	0.64		2.51 $_b$	0.65
Intructional Support (post)		5.46 $_c$	0.59		5.27 $_c$	0.65

Note. Pre = pre-midterm. Post = post-midterm. Items with the same subscript significantly differ between course and control condition at $p < 0.05$. df for *t*-tests ranged from 237 to 345.

of teaching experience, teaching efficacy/beliefs, and Head Start affiliation. Correlations between the study controls, predictors, and outcomes are presented by condition in Table 3.

Moderation analyses were run in M*plus*7 (Muthén & Muthén, 1998–2012) because the program supports the use of a full information maximum likelihood estimator (FIML) to handle missing data and appropriately adjusts standard errors when clustering is present. All main effects were tested in an initial set of regression models (Model 1, Table 4). As can be seen in Table 4, teachers who participated in the PD intervention made significantly greater gains in the quality of their interactions with children across all domains (i.e., emotional support, classroom organization, instructional support) than teachers in the control condition.

To explore the moderation effect of participation in the PD intervention on the relation between sources of stress and residualized change in interactional quality, interaction effects were tested in a second set of regression models (Model 2, Table 4). Significant moderation was found for the course condition (receipt of PD course) in the relations between two types of teacher-reported job stress, professional investment and discipline and motivation, and residualized change in all three types of interactional quality. Specifically, the interaction between treatment condition and teacher-reported stress in professional investment was significantly related to change in emotional support ($\beta = 0.27$, $p < 0.01$), classroom organization ($\beta = 0.15$, $p < 0.05$), and instructional support ($\beta = 0.26$, $p < 0.001$). Additionally, the interaction between treatment condition and teacher-reported stress in discipline and motivation was significantly related to change in instructional support ($\beta = 0.16$, $p < 0.05$).

Table 3
Correlations between study variables and spring teacher-child interactions by treatment condition

	Condition					
	Course			Control		
	ES	CO	IS	ES	CO	IS
Covariates						
Teacher Race (Black)	0.02	0.17	0.12	−0.10	0.07	−0.03
Teacher Ethnicity (Hispanic)	0.05	0.10	0.16	−0.03	−0.18	−0.08
Teacher Annual Income	0.07	0.19 *	−0.06	0.00	0.12	0.25 **
Teacher Years of Education	−0.04	0.10	0.05	0.09	0.18 *	0.10
Teacher Years of Experience	0.12	−0.15	0.19 *	0.05	0.02	−0.01
Teaching Efficacy/Beliefs	0.11	0.16	0.05	0.10	0.23 *	9.00
Head Start Affiliation	−0.02	0.00	−0.16	0.08	−0.03	0.02
Teacher-child Interactions (pre)	0.19 *	0.21 *	0.28 ***	0.37 ***	0.22 *	0.49 ***
Teacher Stress Inventory						
Teacher-child InteractionsTeacher-child InteractionsWork-related Stressors	−0.13	0.00	−0.23 **	0.04	−0.06	−0.02
Professional Investment	0.01	0.07	−0.07	−0.24 **	−0.23 **	−0.14
Discipline and Motivation	−0.13	−0.01	−0.16	−0.16	−0.19 *	−0.21 *

Note. ES = Emotional Support. CO = Classroom Organization. IS = Instructional Support. Teacher-child Interactions (pre) = corresponding Teacher-child Interactions (Emotional Support, Classroom Organization, Instructional Support) observed pre-midterm. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 4
Main effects of sources of stress and moderation effects of intervention to predict change in teacher-child interaction quality.

		Emotional Support		Classroom Organization		Instructional Support	
		Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
	Teacher Race (Black)	−0.05 (0.06)		0.06 (0.08)		0.11 (0.08)	
	Teacher Ethnicity (Hispanic)	0.01 (0.06)		0.06 (0.07)		0.02 (0.07)	
	Teacher Annual Income	0.01 (0.06)		0.09 (0.06)		0.03 (0.10)	
	Teacher Years of Education	0.05 (0.14)		0.00 (0.09)		0.08 (0.12)	
	Teacher Years of Experience	0.08 (0.06)		0.05 (0.05)		−0.05 (0.05)	
	Teaching Efficacy/Beliefs	0.06 (0.09)		0.15 (0.09)		0.05 (0.06)	
	Head Start Affiliation	0.07 (0.07)		0.00 (0.08)		0.00 (0.05)	
	Teacher-child Interactions (pre)	0.31 (0.06)***		0.38 (0.09)***		0.28 (0.05)***	
Set 1		R^2 = 0.16*	R^2 = 0.16*	R^2 = 0.23***	R^2 = 0.23***	R^2 = 0.20***	R^2 = 0.21***
	Intervention Condition (Course)	0.23 (0.06)***	0.23 (0.06)***	0.20 (0.06)**	0.20 (0.07)**	0.31 (0.07)***	0.32 (0.07)***
	Work-related Stressors	0.00 (0.07)	0.00 (0.09)	0.00 (0.09)	0.00 (0.10)	0.02 (0.06)	−0.04 (0.11)
	Work-related Stressors x Condition		−0.01 (0.09)		−0.01 (0.08)		0.08 (0.09)
Set 2		R^2 = 0.16*	R^2 = 0.21**	R^2 = 0.24***	R^2 = 0.26***	R^2 = 0.20***	R^2 = 0.25***
	Intervention Condition (Course)	0.24 (0.06)***	0.25 (0.05)***	0.20 (0.07)**	0.21 (0.06)***	0.32 (0.07)***	0.33 (0.06)***
	Professional Investment	−0.06 (0.07)	−0.30 (0.10)**	−0.04 (0.09)	−0.17 (0.13)	−0.01 (0.05)	−0.24 (0.10)*
	Professional Investment x Condition		0.27 (0.06)**		0.15 (0.07)*		0.26 (0.06)***
Set 3		R^2 = 0.17**	R^2 = 0.17*	R^2 = 0.24***	R^2 = 0.24***	R^2 = 0.20***	R^2 = 0.22***
	Intervention Condition (Course)	0.24 (0.05)***	0.24 (0.05)***	0.20 (0.06)***	0.20 (0.06)***	0.32 (0.07)***	0.32 (0.06)***
	Discipline and Motivation	−0.10 (0.06)	−0.15 (0.10)	−0.07 (0.07)	−0.12 (0.08)	−0.04 (0.08)	−0.17 (0.11)
	Discipline and Motivation x Condition		0.06 (0.08)		0.05 (0.07)		0.16 (0.07)*

Note. Model 1 = Main effects model. Model 2 = Moderation model. Teacher-child Interactions (pre) = corresponding Teacher-child Interactions (Emotional Support, Classroom Organization, Instructional Support) observed pre-midterm. Covariate estimates are presented from a model excluding all treatment condition, teacher stress, and interaction predictors.Standardized estimates are reported with standard errors in parenthesis. *p < 0.05. **p < 0.01. ***p < 0.001.

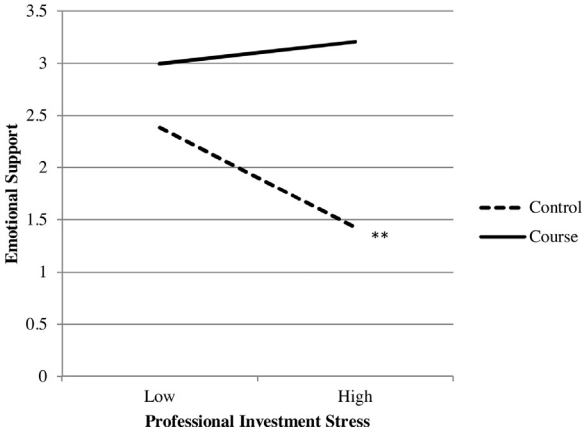

Fig. 1. Interaction between Professional Investment Stress and Treatment Condition to Predict Change in Emotional Support.
*p < 0.05. **p < 0.01. *p < 0.001.

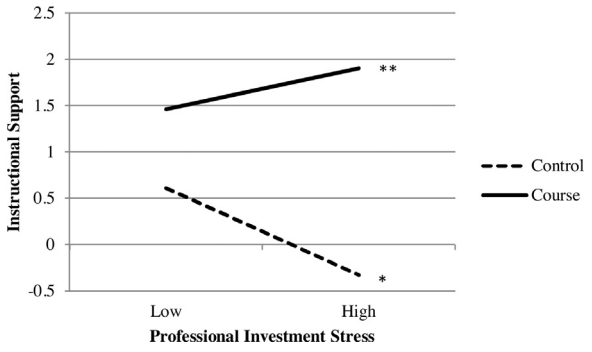

Fig. 2. Interaction between Professional Investment Stress and Treatment Condition to Predict Change in Instructional Support.
*p < 0.05. **p < 0.01. *p < 0.001.

Simple slopes were then examined to determine the nature of the interactions. Results revealed a negative relation between reports of professional investment stress and observed emotional support for teachers in the control condition ($\beta = -0.30$, $p < 0.01$), but not for teachers in the course condition ($\beta = 0.07$, $p > 0.05$; Fig. 1). This finding confirms a moderating effect of the treatment condition (course vs. control) on the relation between professional investment and change in teachers' emotional support across the year. That is, teachers in the control condition who reported higher professional investment stress made fewer gains in emotional support relative to control teachers experiencing less professional investment stress. This association was not present for teachers in the course condition.

Similar to the findings for emotional support, teachers' reports of stress in professional investment related negatively to change in their observed instructional support for the control condition ($\beta = -0.24$, $p < 0.05$). In contrast, for the teachers in the course condition, the relation between stress and change in instructional support was positive ($\beta = 0.11$, $p < 0.01$; Fig. 2). In other words, teachers with higher professional investment stress showed fewer gains in instructional support in the control condition and greater gains in the course condition, relative to teachers in their respective treatment groups who reported lower levels of professional investment stress.

Additionally, simple slopes were not significant for either group (course or control condition) for two of the other significant two-way interactions: a) the interaction between treatment condition and teacher-reported stress in professional investment on change in classroom organization and b) the interaction between treatment condition and teacher-reported stress in discipline and motivation on change in instructional support. Although the trends were similar, non-significant simple slopes suggest that while the relation between teacher-reported stress and change in teacher-child interaction quality significantly differed across the course and control conditions, the main effect of stress did not reach statistical significance in either group.

3.1. Robustness check

Given the high inter-correlations among the three sources of stress (i.e., 0.56–.67), moderation analyses were also run using

structural equation modeling (SEM) in order to verify the robustness of the regression findings. Specifically, observed stress items were used to create the three latent stress factors, which were then used to predict the latent CLASS outcomes with treatment condition as the moderator. The SEM results were consistent with the regression analyses, with significant moderation occurring between professional investment stress and treatment condition for emotional support ($b = 0.94$, $p < 0.05$) and instructional support ($b = 1.04$, $p < 0.05$).[3] However, because interactions using latent predictors in M*plus* must be run with the 'type = random' function, the SEM models were unable to account for clustering by site. Thus, the regression results were selected as the main findings given that those analyses were consistent with SEM and also robust to the effects of clustering.

4. Discussion

The present study explored the moderating effect of participation in PD on the relation between job stress and change in teacher–child interactions. Prior research indicated that teachers who participated in the course (intervention) condition exhibited improvements in emotional support, classroom organization, and instructional support (Hamre et al., 2012). Extending those findings, the current results demonstrated that participation in the PD course significantly moderated the relation between one specific source of job stress and change in two domains of observed teacher–child interaction quality.

An examination of interactions and simple slopes between stress and treatment condition revealed that professional investment was the only source of stress significantly associated with teacher–child interaction quality. Professional investment stress refers to teachers' general displeasure with their career, such as not feeling emotionally or intellectually stimulated by their job, lacking sufficient opportunities for professional development, and perceiving low levels of control over job-related decisions. For the teachers in the control condition, high professional investment stress at the start of the school year related negatively to growth in emotional and instructional support over the course of the year. The mechanisms behind this finding align with the burnout literature. Perceptions of limited job growth and lack of supports for career development can lead to a reduced sense of personal accomplishment, which has long been considered an important aspect of career burnout (Maslach & Jackson, 1981). As teachers' sense of accomplishment or growth in their career diminishes, they may also experience waning enthusiasm for their job and feelings of emotional burnout. This experience of stress and emotional burnout will not only influence teachers' ability to support others emotionally, but could impair their own motivation and cognition, consequently weakening their ability to provide high quality instructional supports to students over the course of a school year (Jennings & Greenberg, 2009).

In contrast, for the teachers receiving PD, professional investment stress did not relate to change in the quality of emotional support. These findings suggest that PD participation buffered the relation between professional investment stress and the teachers' ability to foster an emotionally supportive classroom. Given that the course focused directly on improving interactions and provided outlets for discussing classroom concerns, it is possible that teachers strengthened their skills in emotional support to such an extent that their interactions were less vulnerable to personal factors such as emotional state. Since teacher stress was measured only prior to the start of the intervention, it was not possible to directly test whether or not the course actually reduced professional investment stress for teachers in the course condition. Therefore, an important next step in examining professional development interventions, such as the model used in this study, is to explore the intervention's direct impact on sources of stress at post-test.

Professional investment stress at the start of the school year was associated with growth in instructional support in the course group. One aspect of professional investment stress reflected teachers' concerns about their own professional growth; it is possible that teachers who were high in professional investment stress prior to the start of the intervention had greater uptake of the intervention. This finding was not anticipated. However, it is plausible that teachers' heightened awareness and anxiety over their need to develop professionally may have made them more responsive to an intervention designed to improve practice. Still, it is not clear why teachers in the course condition showed a significant positive association between professional investment stress and instructional support, but not for emotional support. One potential explanation relates to the intervention's focus on improving interactions that contribute to language and literacy skills. It is possible that teachers elected to participate in the larger study if they needed more assistance with content-specific instructional supports, which may help to explain why there was a significant positive association between professional investment stress and instructional support in the course condition. To unpack this further, more information is needed regarding teachers' motivations for participating in the larger study.

Although trends suggested that discipline and motivation stress had a more deleterious influence on teacher–child interactions in the control group than in the course group, the main effect did not yield statistical significance. Existing literature reveals that student behavioral issues (e.g., behavioral problems, attentional issues, low motivation) can degrade teacher-student relationships due to ongoing conflict in the classroom (Friedman-Krauss et al., 2014; Grayson & Alvarez, 2008; Kyriacou, 2001). However, in this sample, we see no statistically detectable relation between teachers' frustration with discipline issues and declines in the quality of teacher–child interactions.

Work-related stress, such as reporting that there is too much work to complete or that the pace of the school day is too fast, did not relate to change in teacher–child interactions in either the course or control condition. Although factors such as work-overload and time pressures have been linked to job stress and eventual burnout (Lambert et al., 2006; Maslach et al., 2001), it may be that these job characteristics are more closely tied to general career attitudes rather than day-to-day interactions with students. These findings suggest that teachers in this sample who experienced high work-related stress did not interact differently with students when compared to teachers reporting lower levels of work-related stress.

Yet another surprising finding was that none of the sources of stress were significantly associated with changes in levels of classroom organization, which assesses teachers' ability to manage behavior, facilitate a productive classroom that maximizes learning time, and provide varied materials for learning. This finding is unexpected given that existing literature has identified links between teacher stress and classroom management (Friedman-Krauss et al., 2014; Klassen & Chiu 2010) and has described this relation in the context of a "burnout cascade" (e.g., Jennings & Greenberg, 2009). It is possible that the lack of association stems from key differences in the domains being assessed. The dimensions of classroom organization tap into aspects of teaching and instruction that may already be established as classroom routines (e.g., behavioral expectations, rapid transitions, classroom materials; Pianta, La Paro et al., 2008). In contrast, emotional support

[3] SEM output using the 'type = random' function in M*plus* does not provide standardized beta weights. Therefore, only unstandardized betas are reported in the robustness check section.

involves warmth and sensitivity in interpersonal interactions and instructional support requires cognitive energy (e.g., concentration, memory) to cultivate higher-order thinking, all of which tend to be affected by stress (American Psychiatric Association, 2013; Sapolsky, 1996). Consequently, it may be that some of the more routinized aspects of teaching measured in classroom organization are less sensitive to an individual's day-to-day emotional functioning than the emotionally- or cognitively-demanding aspects of teaching. Moreover, the duration and latency of the measurement of CLASS scores may not have been sufficiently long enough to detect changes or a "cascading effect" in these more routinized aspects of teaching. Continued work exploring the association between stress and instructional effectiveness is needed to further understand these relationships (or lack thereof).

These results are important for administrators and policymakers who face challenging decisions on whether or not to adopt professional development for teachers. Decision-makers should weigh the advantage of professional development against the disadvantage of adding a time-consuming activity to the lives of already burdened and busy teachers. Though specific to the NCRECE professional development, these findings can inform decision-making. Engagement in this professional development appears to mitigate the effect of stress related to professional investment on teachers' emotionally supportive interactions. The presence of professional investment stress also may be a proxy of teachers' readiness to engage in PD aimed at improving instructional practice.

4.1. Limitations and future directions

There are several limitations that warrant mention. The first two limitations relate to teacher selection and the nature of the intervention (Hamre et al., 2012). First, the teachers at each site volunteered to participate in this study. Given the voluntary nature of participation, we cannot determine the extent to which these volunteer teachers differed from non-participating teachers at the different sites or from the larger population of pre-kindergarten teachers in the United States. Additionally, the fact that teachers in the course condition were voluntarily taking the course may have resulted in improved uptake of course material. Consequently, the findings have limited generalizability beyond the current sample. Second, the control teachers were placed in a business-as-usual condition and did not receive any alternative coursework as part of the study. Future work is needed to examine whether or not coursework in a different area, such as programming focused on stress-reduction (e.g., mindfulness, wellness, social-emotional learning; Greenberg et al., 2016; Roeser, Skinner, Beers, & Jennings, 2012), still moderates the influence of stress on teachers' interactions with students or if the coursework needs to be targeted to the outcome of interest (i.e., teacher–child interactions). Third, the CLASS data collection timeline was such that there was variation in teachers' exposure to the course when they submitted CLASS videos (e.g., teachers may have submitted their first of four post-test videos as early as the mid-point of the course). To ensure that all teachers have roughly equivalent exposure to a PD intervention when examining outcomes of interest, future studies on this topic should strive to collect all pre- and post-data exclusively before and after the PD has taken place. Lastly, the final limitations relate to the measurement of stress. Teachers reported on stress through a rating scale rather than a diagnostic instrument. Thus, we do not know whether this sample of preschool teachers was more or less stressed than the general population of preschool teachers or other working adults. In addition, stress was only measured at one time point (pre-test) during this study. As a result, the main effect of the intervention on stress reduction could not be examined and potential meditational processes could not be tested. Future studies can extend existing work by including normative measures of emotional health in an effort to generate comparisons with the general population and by administering stress measures at pre and post intervention.

4.2. Implications for research and practice

The findings from this study have both empirical and practical implications. Research has indicated that teacher–child interactions are beneficial to students' academic and emotional development and that high levels of teacher stress may be detrimental to classroom quality (e.g., Li-Grining et al., 2010). The present findings reveal that professional investment stress may be particularly salient to teacher–child interaction quality. Continued research exploring the differential influence of sources of stress on teacher functioning is needed to better understand the ways in which teachers can be more effectively supported in their profession. Future studies of various early childhood PD models should also consider teachers' emotional well-being as an outcome of interest in addition to changes in teachers' instructional practice.

In a practical context, this study has implications for training within the early childhood education workforce. For example, rather than simply utilizing a quality rating system to evaluate preschools, the rating tools could be used diagnostically to target professional development efforts. In light of the findings related to professional investment stress, early childhood centers would be well-served to provide more training and continuing education opportunities to preschool teachers, particularly in areas of instruction that are causing them concern or stress. In particular, preschools should consider PD and other experiences that allow for conversations and feedback regarding classroom interactions (Garet et al., 2001) given that the opportunity to develop in this area appeared to positively affect teachers' classroom practices and emotional functioning. In addition, preschool centers could benefit from surveying teachers at regular intervals to gauge aspects of the work environment that may be causing stress. This type of school-based data collection would enable administrators to be more responsive to instructional and contextual issues that arise in their centers, and it would also convey a message to teachers that their emotional well-being is valued.

In conclusion, teachers' emotional well-being demands attention as we explore ways to improve early childhood educational experiences. Continued consideration and exploration of the pivotal role that various sources of stress can play in teacher behavior is an important issue as we identify ways to improve developmental outcomes for young children. Further, the potential buffering effect that high quality PD can have on the relation between stress and teacher–child relationships may have great benefit for preschool education.

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