Early Childhood Research Quarterly 41 (2017) 37–49

Contents lists available at ScienceDirect

Early Childhood Research Quarterly

journal homepage: www.elsevier.com/locate/ecresq

Preschool expenditures and Chinese children's academic performance: The mediating effect of teacher-child interaction quality

Bi Ying Hu[a], Yisu Zhou[a], Liang Chen[b,*], Xitao Fan[a], Adam Winsler[c]

[a] University of Macau, Avenida da Universidade, Taipa, Macau, China
[b] Shandong Normal University, No.88 East Wenhua Road, Jinan 250014, China
[c] Department of Psychology, 3F5 George Mason University, Fairfax, VA 22030, United States

ARTICLE INFO

Keywords:
Early childhood education (ECE)
Expenditure
Program quality
Child outcomes
Teacher-child interaction

ABSTRACT

This study examined the relationship between investment of financial resources in early childhood education (ECE) and student academic outcomes using survey and observational data from 59 classrooms in Guangdong Province, China (N = 589, 50% girls, and M_{age} = 5.1 ± 0.42 years). We conceptualized the mediating role of teacher-child interaction as an important mechanism that can explain the effects of financial resources. Three types of interactions were considered under the Classroom Assessment Scoring System (CLASS) framework: emotional support, classroom organization, and instructional support. Our multilevel structural equation models indicated that investing in teacher training has a direct positive effect on student vocabulary development, and that neither teacher salary nor school facility has a direct effect on child vocabulary, math, or science outcomes. Giving higher pay to teachers has an indirect effect through increased quality of teacher-child interactions. In particular, the effect of instructional support is most salient for all three outcomes. We discuss our results in light of the recent push by the Chinese government to invest in ECE. We argue for prioritizing support for raising teacher pay to attract more capable talent to the teaching pool, expanding teacher development programs to increase instructional quality, and spending less on equipment.

1. Introduction

When there is a serious shortage of public investment in early childhood education (ECE) or money is spent ineffectively, government initiatives fail to align with educational equity goals (Heckman, 2006). One of the direct consequences of the lack of public funding for ECE is an increase in the number of children—often those who are socio-economically disadvantaged—entering their formal school years without the adequate skills, knowledge, and dispositions necessary for academic and lifelong success. This is a pressing concern in China. Although recent economic boosts have successfully lifted hundreds of millions of families out of poverty, China continues to suffer the consequences of ill-balanced development between urban and rural regions socially, economically, and educationally, and ECE is one of the most adversely affected areas (Hu & Li, 2012; Hu & Roberts, 2013). Having been playing Cinderella to her two stepsisters—primary and secondary education nationwide—ECE received only 1.3% of the total funding for education before 2010, which was gradually increased to 3.24% in 2014 (Ministry of Education, 2014). Most of the limited ECE budget has traditionally been (and continues to be) reserved for urban public programs run by local government agencies (Hu & Roberts, 2013; Zhao & Hu, 2008). As China's central government has set ambitious goals for universalizing and improving the quality of three-year ECE for all children aged three to six by 2020, local governments across the nation are under pressure to reform existing funding and expenditure structures to support the development of high-quality ECE.

ECE quality that nurtures children's development can be defined as structural and process quality. Structural quality—such as teachers' professional qualifications, salary, teacher-child ratio—are the regulable aspect of ECE, and they represent distal quality, setting preconditions of proximal process quality (Cryer, 1999). Proximal process quality consists of children's moment-to-moment experiences in the ECE settings, their academic and social exchanges with peers, adults, and classroom materials which fosters their social, emotional, and academic development (Pianta et al., 2005). So far, research provides abundant evidence that structural and process quality are related to children's social and pre-academic performance (Connor, Morrison, & Slominski, 2006; Howes et al., 2008; Rimm-Kaufman, Curby, Grimm, Nathanson, & Brock, 2009). What is noteworthy is that research has typically found stronger associations between process

* Corresponding author at: School of Psychology, Shandong Normal University, Jinan, China.
E-mail address: chen_liang1010@126.com (L. Chen).

http://dx.doi.org/10.1016/j.ecresq.2017.05.002
Received 12 April 2016; Received in revised form 28 April 2017; Accepted 16 May 2017
Available online 09 June 2017

quality and child outcomes than structural quality and child outcomes (Howes et al., 2008; Mashburn et al., 2008; NICHD Early Child Care Research Network, 2002). However, much less evidence exists regarding the mediational role that process quality may play between structural quality and children's outcomes, especially for structural variables related to school finance, such as school expenditures on teachers' compensation, assets, and professional development. We know that school finance contributes to student achievement (Greenwald, Hedges, & Laine, 1996; Krueger, 2003), but we are less aware of the processes within schools that link expenditures to child outcomes (Rice & Schwartz, 2008). In terms of the correlation between school finance and children's pre-academic skills (i.e., vocabulary/ language, emergent literacy, math, science, fine motor, social and behavioral skills; Winsler et al., 2008), researchers have recently moved away from global research questions about overall levels of spending, and instead are more interested in the specific items purchased and the particular uses made of school funding (Rice & Schwartz, 2008).

In China, ECE has undergone a promising transformation to meet the national goal of improving program quality. Program leaders, researchers, and policy makers are seeking guidance on ECE expenditures — on what specific items should be purchased with preschool funding so that limited financial resources can produce maximized effects on children's pre-academic skills and socio-emotional wellbeing. However, we have little knowledge of how relations between expenditures, ECE quality, and children's academic performance work. Therefore, by examining how ECE process quality functions as part of the process that links kindergarten expenditures to children's academic outcomes during early childhood, the current study advances previous research on ECE quality and children's outcomes. Specifically, this study fills a gap in the literature by investigating the effects of specific ECE expenditures on children's pre-academic performance, and the role that classroom process quality (i.e., teacher-child interactions) plays in potentially mediating between ECE expenditures and children's pre-academic performance.

1.1. ECE process quality: the teacher-child interaction framework

The current frontier of ECE research hinges on one important concept: process quality. Researchers have sought to identify the specific aspects of process quality in ECE classrooms that are most pivotal to children's development and learning across cultures (Hu, Fan, Gu, & Yang, 2016). A widely used framework for measuring ECE quality is the *Teaching Through Interactions* (TTI) framework developed by Pianta, LaParo, and Hamre (2008). This framework is conceptualized around moment-to-moment teacher-child interactions and their relations with children's social and academic growth. Building on previous descriptions of effective teaching (Brophy & Good, 1986; Eccles & Roeser, 2005), Pianta, LaParo et al. (2008) developed the observational tool called the *Classroom Assessment Scoring System* (CLASS) to pinpoint teaching behavior in the classroom through three distinct domains: emotional support, classroom organization, and instructional support. Classrooms with high emotional support are positive and warm learning environments in which children have a secure and close attachment to the teacher who is sensitive to children's learning and emotional needs. A high score in classroom organization indicates that children are constantly engaged in activities and routines and that teachers provide clear, consistent directions and expectations, and utilize a variety of activities and learning modalities to help children learn. A high score in instructional support suggests that teachers use effective strategies that produce opportunities for young children to develop higher-order thinking skills, creativity, and complex language skills.

Empirical evidence robustly supports a positive association between process quality and children's social and academic development, albeit a moderate one (Campbell & Ramey, 1995; Greenberg, Domitrovich, & Bumbarger, 2001; Hamre & Pianta, 2007; Helburn, 1995; Howes & Hamilton, 1993; Kisker, Hofferth, Phillips, & Farguhar, 1991; Kontos & Wilcox-Herzog, 1997; Phillips, Mekos, Scarr, McCartney, & Abbott-Shim, 2000; Yoshikawa et al., 2015). In terms of children's pre-academic skills, studies have typically focused on children's cognitive and language development, often using measures such as the Peabody Picture Vocabulary Test – Revised (PPVT-R; Dunn & Dunn, 1981) and the Test of Early Mathematics Ability (TEMA; Ginsburg & Baroody, 1983, 1990). Recently, however, researchers have started to pay more attention to pre-academic gains in children's science knowledge (Greenfield, 2009, 2015; Kinzie et al., 2014). Children's early science knowledge is predictive of later learning (Duncan et al., 2007; Grissmer, Grimm, Aiyer, Murrah, & Steele, 2010) and science gains are importantly related to children's executive functioning (Nayfeld, Fuccillo, & Greenfield, 2013).

Although originated in the U.S., the CLASS has been applied in numerous studies in multiple countries (Cadima, Leal, & Burchinal, 2010; Leyva et al., 2015; Pakarinen et al., 2010; von Suchodoletz, Fäsche, Gunzenhauser, & Hamre, 2014). Findings from these studies concluded that variation in teacher-child interaction quality as measured by the CLASS is associated with meaningful differences in students' learning across cultures. Recently, Hu, Roberts, Ieong, and Guo (2015) showed that the CLASS exhibits the same (or very similar) factor structures as found in U.S. samples, and provided strong psychometric evidence for its applicability in Chinese preschool ("kindergarten") settings.

1.2. Evidence-based policy supporting ECE: do expenditures matter?

Researchers have reached consensus that only when a government invests in ECE to ensure adequate process quality will investments truly make a difference in children's outcomes (Burchinal et al., 2008; Gilliam & Zigler, 2004; Mashburn et al., 2008; Pianta, 2009; Wong, Luo, Zhang, & Rozelle, 2013). Evidence of the long-term impact of high-quality ECE programs is largely based on randomized trials, such as the Abecedarian Project and the High Scope Perry Preschool projects, that showed benefits exceeding their cost, ranging from 5 to 16 dollars of return on investment for each dollar invested in the program (Arteaga, Humpage, Reynolds, & Temple, 2014; Campbell et al., 2014; Reynolds, Temple, Ou, Arteaga, & White, 2011). Governments worldwide are now increasing their financing commitments to help improve the quality and availability of ECE programs, especially for children in poverty (Gilliam & Zigler, 2004; Kagitcibasi, Sunar, Bekman, Baydar, & Cemalcilar, 2009; Sharma & Nagar, 2009). Most importantly, to maximize the effectiveness of such investments, it is critical to understand how ECE expenditures are associated with different elements of teacher-child interaction quality and, in turn, to children's pre-academic skills.

In the mainstream economics of education literature, the role of financial input has always captured the attention of researchers. Hanushek's (1986) meta-analysis first claimed that school inputs matter little in determining student learning outcomes. This argument has been disputed by others, who have found a positive relationship between financial resources and student achievement (Greenwald et al., 1996; Krueger, 2003). School expenditure is usually used as an indicator of financial resources. In a typical input–output model, however, the process occurring within schools is usually treated as a "black box" (Rice & Schwartz, 2008), where the variation in output (student test scores) is modeled by only variation in inputs (per-child spending, class size, teachers, etc.). However, such studies are inconclusive which has led researchers to shift their focus away from overall levels of spending to more specific purchases and uses made of school financial resources (Rice & Schwartz, 2008).

In China, the most frequently occurring preschool expenditures consist of three elements: school facilities (maintenance, office and classroom equipment, lab consumables, etc.), teacher compensation (salary, subsidy, performance pay, health care, etc.), and services (teacher professional development, utility, transportation, etc.) (Zhou, Li, Hu, & Li, 2017). However, it is unclear which item should receive the highest priority. While a number of studies have examined the association of family resources and children' academic gains (Shanks & Robinson, 2013), none has considered how expenditures on preschool facilities relate to children's learning outcomes. Whether it is better to invest in the preschool facility or to spend money on teachers, including teachers' compensation and in-service training, is an open and important question yet to be addressed, especially across settings and different cultural contexts.

Some studies examining the structural predictors of process quality have reported teachers' compensation to be the strongest predictor of program process quality (Howes, Whitebook, & Phillips, 1992; Phillips et al., 2000; Scarr, Eisenberg, & Deater-Deckard, 1994). For instance, Hu et al. (2015) identified teachers' monthly salary as the strongest predictor of ECE process quality in 187 preschools in Zhejiang, China, as measured by the adapted Chinese version of the Early Childhood Environment Rating Scale—Revised. Other studies have considered the direct association between teachers' compensation and children' academic achievement, although most focus on secondary and post-secondary students (Loyalka, Sylvia, Liu, Chu, & Rozelle, 2015). Little research has examined preschool children's pre-academic performance.

Previous studies have, in general, shown a positive association between teachers' formal training in ECE and process quality (Cryer, Tietze, Burchinal, Leal, & Palacios, 1999; Tout, Zazlow, & Berry, 2006). However, results are inconsistent, and in several important studies, researchers have either found mixed results suggesting a nonlinear relationship between the two variables (Early et al., 2006), or reported no effects of teacher education on process quality (De Kruif et al., 2009; Fukkink et al., 2013). Slot, Leseman, Verhagen, and Mulder (2015), in the Netherlands, found that curriculum implementation (children's actual activities and how teachers balanced children's engagement in developmental and pre-academic content) was an important indicator of process quality. They found a strong association between emotional and educational process quality and the center's use of professional development activities.

Additionally, intervention studies have started to demonstrate the benefits of in-service training (Hamre et al., 2012; LoCasale-Crouch et al., 2011) especially when innovative training methodologies are adopted such as consultation, online or face-to-face coaching, and mentoring (Campbell & Milbourne, 2005; Domitrovich et al., 2009; Pianta, Mashburn, Downer, Hamre, & Justice, 2008). In particular, in-service training programs operating under a teacher-child interaction framework—that is, *MyTeachingPartner* (MTP) or *Making the Most of Classroom Interactions* (MMCI)—have reported positive impacts on program process quality (Hamre et al., 2012; Kinzie et al., 2014) and even lead to increased early math skills of preschool children (Kinzie et al., 2014). Overall, previous studies suggest that expenditures on teacher training can improve critical elements of process quality such as teacher-child interactions, which, in turn, might make a positive impact on children's development and learning (Pianta, 2009).

1.3. The current study

According to the Ministry of Education of the People's Republic of China (2014), the gross enrolment rate of children age three to five in preschool (called "kindergarten" in China) has been steadily increasing each year, with the current coverage rate at about 70%. This gross enrolment rate is close to the national goal of universalizing ECE as stated in China's National Plan for Medium and Long-term Education Reform and Development (2010–2020) (State Council, 2006; hereinafter referred to as 'the Plan'). In China, the majority of ECE is funded by the private sector (66.36%), especially ECE programs serving children of low socio-economic status (SES) where programs are of much lower quality than those serving children from affluent families (Hu, Zhou, Li, & Roberts, 2014; Hu & Roberts, 2013). In order to strengthen their capacity to serve families in need, it is the goal of the government to increase public investment in ECE, especially in rural China where poverty is at its worst. The government plans to use a so called "two-legs-walking" approach, meaning on one hand/leg, expanding the number of public preschools that are available, and on the other leg, subsidizing private ECE in order to implement The Plan.

Currently, teacher-child interaction quality in Chinese preschool classrooms presents some unique features. It is important to note that Chinese children have a very structured daily routine in preschools with a significant portion of the school day spent on whole-group teaching. Chinese preschool teachers' prevalent use of whole-group teaching in classrooms is mainly due to large class sizes (averaging 30–35 children), high student-to-teacher ratio (15–20:1), and the traditional cultural influences with a preference for teacher-directed didactic teaching (Hu, Dieker, Yang, & Yang, 2016). In a recent study of the profiles of teacher-child interaction quality, researchers have identified four distinctive profiles: a "High quality" profile (14.1%), a "Medium quality with higher instructional support" profile (14.4%), a "Medium quality with lower instructional support profile" (47.1%), and a "Low quality profile" (24.4%) (Hu, Fan, LoCasale-Crouch, Cheng, & Yang, 2016). Many teacher features (e.g., teaching experience, highest educational level, *bianzhi* or tenure, certification, and ranking) and program features (e.g., economic property/location, funding agency, current government-rated quality levels, and annual government funding) were sensitive in differentiating teachers across the four profiles. In other words, teachers who provide the lowest level of teacher-child interaction quality tended to have less education, teaching experiences, and work in preschools that are located in rural areas without public funding. Also, teachers with no professional title and tenure tended to teach in preschools where children needed the most support (Hu et al., 2015).

It is believed that Chinese preschool teachers' low level of teacher-child interaction quality is strongly associated with their low salary (Hu, Mak, Neitzel, Li, & Fan, 2016; Hu et al., 2015). Preschool teachers' salaries vary significantly across public and private programs, as well as teachers with and without *bianzhi*; therefore, they face tremendous challenges to stay in the profession (Wang, Hong, & Pang, 2015). For instance, a survey showed that 62% of preschool teachers earn monthly between 901(130.41 USD) to 2000 RMB (289.5 USD), and the difference in monthly income between teachers who work for public and private programs can be as high as 4000 RMB (579 USD) (Liu, 2011). Even among public preschools, teachers with tenure make twice as much as teachers without tenure (Wang et al., 2015). A census of public schools in a western province in 2013 showed urban primary teachers earn 40% more annually compared to urban preschool teachers; rural primary teachers earn 58% more annually compared to their rural preschool counterparts (Zhou et al., 2017). Besides the large salary gap, preschool teachers in public preschools typically have abundant opportunities for professional development, and they are adequately resourced for purchasing and upgrading equipment and materials for play and learning (Hu et al., 2014). However, teachers in private programs especially in rural areas struggle the most with the lowest salary, little or no opportunity for professional development, and poor or unacceptable conditions in terms of furnishing and materials for learning (Hu et al., 2015). Professionals have called for an increase of teacher salary in general and public funding to support teachers who work in rural private programs and/or without tenure (Hu Mak et al., 2016; Wang et al., 2015).

So far, few studies have considered relations between ECE quality (both structural and process) and children's learning gains in Chinese preschools (Li et al., 2016), and none has examined the association between ECE expenditure and children's pre-academic skills. Hence, there is a need to understand how ECE process quality might function as a mediator between expenditures and children's pre-academic performance. We seek the answers to two questions in this paper: (1) To what extent are preschool expenditures related to children's pre-academic (vocabulary, mathematics, and science) performance? and (2) Does process quality (teacher-child interactions measured by the CLASS) play a mediating role between preschool expenditures and children's pre-academic skills?

2. Method

2.1. Participants

This study was conducted in southern China's Guangdong province, which is an economically developed province best known for its top-ranking GDP among China's 23 provinces since 1989. With a population exceeding 100 million, Guangdong, like the rest of China, suffers from a widening gap in socioeconomic development between its urban and rural regions. Using a stratified random sampling procedure, we selected three municipalities to reflect Guangdong's diverse socioeconomic development according to GDP per capita as reported by the local government in 2012: one advanced, one average, and one below average. Then, within each municipality, we randomly selected 20 kindergartens (preschools) to reflect programs with different funding sources. However, in the municipality with below-average GDP, only 19 kindergartens were included in the final analysis because one school closed in the middle of the research project. Finally, within each kindergarten, we randomly selected one class of four- and five-year olds. This selection resulted in a total of 59 classrooms for inclusion in this study, out of which 10 classrooms (17%) were from public programs with the others from private ones.

A total of 59 female teachers who were lead teachers of the selected classrooms participated in the study ($M_{age} = 32 \pm 7.4$), having taught an average of 10.89 years ($SD = 8.11$), and their average base salary per month was CNY 3260 ($502); ranging from the highest monthly total of CNY 9400 ($1446) to the lowest of CNY 1200 ($185). Approximately 66% of the teachers majored in ECE. The majority of the teachers (88.1%) received their first degree from teachers' vocational schools, which is equivalent to a high school diploma in the U.S. Less than half (44.1%) obtained a B.S. degree or above.

The children enrolled in these 59 participating classrooms had an average age of 5.07 ($SD = 0.72$). The average class size was 29.85 ($SD = 6.86$), and ranged from 17 to 50. Given limited funding resources, we randomly selected a minority of children in each participating classroom, with equal proportions for both genders. On average, in each classroom we sampled 10 children. The final sample of children included 294 girls and 295 boys. Most of the mothers (63%) and fathers (68%) of the children had educational attainment ranging from vocational school to a university degree. The majority of the parents (mothers, 80%; fathers, 90%) worked outside the home in a variety of occupations ranging from blue collar (e.g., factory or construction workers) to professional (e.g., senior management). Both median and mean annual combined family income was between $7000 and $10,000 (US). Children in the analytical sample had an average age of 5.1 ($SD = 0.42$).

2.2. Measures

2.2.1. Classroom measures

The Classroom Scoring Assessment System (CLASS; Pianta, LaParo et al., 2008) is a reliable and valid measure that defines and assesses the quality of teacher-child interactions in classrooms through three interaction domains: emotional support (including positive climate, negative climate, teacher sensitivity, and regard for student perspectives), classroom organization (including behavior management, productivity, and instructional learning formats), and instructional support (including concept development, quality of feedback, and language modeling). The CLASS utilizes a 7-point rating scale, with a score of 1 or 2 indicating low quality in a classroom, 3, 4, or 5 indicating mid-level quality, and 6 or 7 indicating high quality. One item, negative climate, uses reverse scoring. A recent study in China provided evidence to support the validity of the CLASS and the three-domain construct for measuring quality in the Chinese preschool context (Hu, Fan, Gu et al., 2016). Cronbach αs were 0.83, 0.85, and 0.85 for emotional support, classroom organization, and instructional support, respectively. When scoring, observers gave a score for each dimension using the 7-point range. We then followed CLASS protocol (Pianta, LaParo, et al., 2008, p.15-19) to calculate average scores for each dimension.

2.2.2. Survey of kindergarten-related program features and teacher qualifications

Each director completed a brief questionnaire concerning the basic demographics of the kindergarten, including its geographic location (urban vs. rural), financial sources (public vs. private), overall classroom size, and the amount of funding received annually from the government, if any. The directors were also asked to provide information on kindergarten expenditures on the school facility (per student), teachers' compensation (monthly salary), and training (per teacher). Given that we do not have access to school's administrative spending data so we use a questionnaire to solicit information from the principal. These three items represented the largest expenditures for a typical Chinese kindergarten (Zhou et al., 2017). The lead teacher in each participant classroom was also asked to complete a questionnaire on their teaching qualifications, including their years of ECE experience, major, and educational levels.

2.2.3. Native vocabulary

The Chinese version of the Peabody Picture Vocabulary Test − Revised (C-PPVT-R; Lu & Liu, 2005), which was translated from the original (Dunn & Dunn, 1981), was used to assess Chinese preschoolers' receptive vocabulary. Children were presented with a page of four pictures and were asked to point to the picture that corresponded to the word said by the experimenter. Lu and Liu (2005) further revised the C-PPVT-R based on results for 886 Chinese children (ages 3–12). Strong psychometric evidence, including high reliability, support the use of the C-PPVT-R as a standard measure of Chinese children's receptive vocabulary (Cheng, Chen, Tsai, Chen, & Cherng, 2009). In this study, this scale also showed adequate reliability (Cronbach $\alpha = 0.96$).

2.2.4. Mathematics achievement

The Test of Children Mathematics Achievement (TCMA; Xie, 2014) was used to assess Chinese preschoolers' mathematics skill. Xie (2014) adapted the TCMA based on the Test of Early Mathematics Ability (TEMA; Ginsburg & Baroody, 1983, 1990), a standardized measure, with the addition of 10 items to address children's mathematics performance in Chinese preschools. As with the original version, the adapted measure included 120 items and covers children's formal and informal mathematics achievement. The informal mathematics section focuses on mathematical knowledge that is implicitly acquired rather than formally taught. It is acquired outside the context of formal schooling, such as verbally counting the number of objects on a page, and determining which of two spoken number words is larger. The formal mathematics part focuses on mathematical knowledge that is explicitly taught, usually in school, such as reading and writing Arabic numerals and addition. Cronbach α of this measure was high ($\alpha = 0.95$).

2.2.5. Science knowledge

The Life Science Assessment (LiS) and Earth and Physical Science Assessment (EPS) developed by the University of Virginia's MTP—Math/Science research team (Kinzie et al., 2014) were used to assess Chinese preschoolers' science knowledge. The LiS evaluates children's understanding of living versus non-living things, characteristics of plants and animals, human and animal bodies, use of the senses, and plant and animal life cycles. The EPS evaluates children's understanding of scientific tools, weather, temperature, material composition, motion, and buoyancy. Both LiS and EPS employed forced-choice and card-sort items with each worth 1 point. For example, a child was shown a picture of a tree and was asked, “What is this?” then asked the forced-choice question, “Are trees plants or animals?” For some questions, children were asked to sort photographs according to a specific (forced-choice) dimension (e.g., plants versus animals). The two measures were highly correlated ($r = 0.70$, $p < 0.01$). Therefore, all the items of the two measures were summed to produce one science knowledge score as was done in previous studies (Kinzie et al., 2014). The Cronbach α of the whole scale was 0.86 for the current study.

2.2.6. Child and school socioeconomic status (SES)

Child/family SES was measured by five indices reported by the parents, including mothers’ and fathers’ educational levels, occupations, and annual income. These variables have been frequently used in previous studies to construct a composite SES variable (Bradley & Corwyn, 2002). The education levels include seven categories ranging from “primary school education” to “doctoral degree.” Parental occupation was coded into five categories from “unemployment, job-seeking, part-time job, or farmer” to “senior management, professional, public servant, or manager.” Home total income per year was divided into nine grades ranging from “less than RMB 2,000.00 ($ 308)” to “RMB 100,000 ($ 15,385) or more.” Cronbach α of the five items was 0.87. Overall family SES was formulated by averaging all variables after transforming these variables into *z*-scores, with higher scores indicating higher levels of SES (Cohen, Doyle, & Baum, 2006). In addition, we made a school-level SES variable by calculating the school means from all sampled children’s family SES.

2.3. Procedure

2.3.1. CLASS reliability training

Informed consent was obtained from teachers before data collection. From May to June of 2015, two graduate assistants majoring in ECE who are certified CLASS coders conducted observations of teacher-child interactions in the 59 participating classrooms on a typical day, with one of them coding 30 classrooms and the other one coding 29 classrooms. Prior to the field observation, they received four days of CLASS reliability training from Teachstone®, the company that provides CLASS training, certification, and professional development. They then passed Teachstone’s online reliability test. Observations started at the beginning of the day and ended around lunchtime, lasting for approximately three hours. The data collectors attempted to conduct at least four, 20-min CLASS cycles during a single observation visit. Cycles covered daily activities such as whole-group teaching, meals/snacks, center play activities, and routine/care activities. They took detailed notes about teacher-child interaction patterns and specific behavior while watching and coding. For each cycle, the coder provided a rating for each of the dimensions based on the scoring criteria in the CLASS manual. Since the observation of one classroom took about 3 h, a total of 177 h was needed for 59 classrooms.

For scoring, the two observers strictly followed the observation and coding protocols specified in the CLASS manual (Pianta, LaParo et al., 2008). In the previous year’s validation study of the CLASS in this project, the inter-rater reliability estimates (intraclass correlation, ICC) were 0.87, 0.91 and 0.89 for the dimensions of emotional support, classroom organization, and instructional support, respectively, suggesting a high degree of inter-rater consistency in the CLASS ratings (Hu, Fan, Gu et al., 2016).

2.3.2. Child assessment

Child assessment was conducted concurrent to classroom observations. Parental consent was obtained prior to the children’s participation in the one-on-one assessments on the following measures: Vocabulary, Mathematics, Science. All the assessments were done in Mandarin Chinese, which was the first language of all the children in the study. Twenty graduate assistants majoring in either psychology or ECE conducted the assessments after receiving reliability training from the researchers. To guarantee a high reliability in test administration, all assistants went through an intensive training of the measures and they were given continuous feedback from the researchers during practice sessions. The assessment took place in a quiet room at each participating preschool. The graduate assistants tried to build a rapport with the children prior to the assessment. Each test administration took 5–20 min depending on the child’s performance, and there were three tests in total. Once each test administration was completed, the child took a break for several minutes before starting the next assessment. Each child received a picture book as a token of appreciation.

2.4. Analytic strategy

Analyses took place in two stages. First, a multilevel linear modeling technique (MLM) was used to examine the effects of school expenditures on children’s academic outcomes, including vocabulary, math, and science knowledge. Before testing these effects, an unconditional MLM model was analyzed for each independent variable to estimate the proportion of variance in outcomes that can be explained by the children-nested-in-school data structure. If the data clustering was substantial (ICC larger than 0.1; Field, 2005), we built a full model that included both child-level covariates and school-level predictors. Based on previous studies (Loyalka et al., 2015), we included three types of control variables: child-level demographic variables (gender, age, and family SES), school demographic variables (school location and classroom size), and teacher qualifications (years of ECE experience, major, and educational attainment). When estimating models, child-level continuous variables were centered using grand means.

Thus, the full model can be represented by the following equations:

Child-level model

$$Y_{ij} = \beta_0 + \beta_1(\text{gender}) + \beta_2(\text{age}) + \beta_3(\text{SES}) + r_{ij}$$

School-level model

$$\beta_0 = \gamma_{00} + \gamma_{01}(\text{teacher monthly salary}) + \gamma_{02}(\text{expenditures for professional training per teacher}) + \gamma_{03}(\text{expenditures for school facility per child}) + \gamma_{04}(\text{school location}) + \gamma_{05}(\text{classroom size}) + \gamma_{06}(\text{teacher's ECE experience}) + \gamma_{07}(\text{teacher's major}) + \gamma_{08}(\text{teacher's educational attainment}) + u_0$$

Once the significant effects of school expenditures on children’s pre-academic performance were identified, we further used the multilevel structural equation modeling (MSEM) framework to test multilevel indirect effects (Preacher, Zyphur, & Zhang, 2010), in which we assumed teacher-child interaction quality (measured by CLASS) as a mediator between school expenditures and pre-academic performance. The MSEM is a novel statistical approach that allows investigators to disentangle within- and between-group effects and test the significance of indirect effects occurring at the group level. The assumed model is shown in Fig. 1. As depicted in Fig. 1, this study employed a 2-2-1 multilevel mediation model, in which child academic performance was predicted by school expenditures directly and indirectly via CLASS (both are school-level variables). Once again, both child-level and school-level control variables were considered in MSEM. The multilevel mediation models were conducted separately for PPVT, math, and science knowledge. All analyses were estimated using maximum likelihood estimation with robust standard errors in Mplus 7.0 (Muthén & Muthén, 1998–2012). Both child-level and school-level continuous variables were centered using grand means for meaningful interpretation of the intercepts in the models. Few missing data existed in this study (less than 0.5%). Little's MCAR test indicated that these missing data were completely at random ($\chi^2 = 119.05$, $df = 96$, $p > 0.05$), thus not biasing the model estimates.

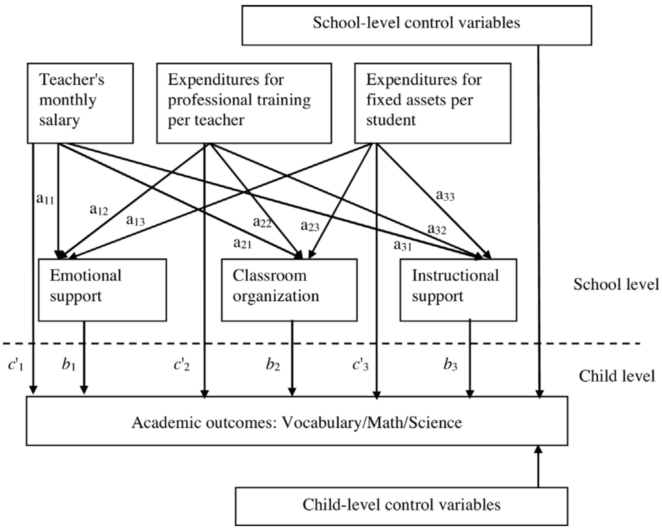

Fig. 1. Hypothesized multilevel mediation model on the relations between kindergarten expenditures, CLASS, and child academic outcomes.

3. Results

3.1. Descriptive statistics

We first conducted a set of analyses to describe the sample. Table 1 provides the descriptive statistics of the main variables for the total sample. The correlations among study variables are presented in Table 2. The correlations were in expected directions. Correlations among predictor variables were in the low to moderate range, thus not likely to bias estimates.

Table 1
Descriptive Statistics of Variables.

Variables	*N*	%	*Min*	*Max*	*M*	*SD*
School-level variables						
School locations	59					
Urban schools	35	59.3				
Rural schools	24	40.7				
School program type	59					
Public schools	10	16.9				
Private schools	49	83.1				
School-level SES	59		−1.12	1.08	−0.02	0.61
Classroom size	59		17.00	50.00	29.86	6.71
Years of teaching experiences	59		1.00	30.00	10.91	8.05
Teacher's Major	59					
ECE major	39	66.1				
Other major	20	33.9				
Teacher's educational level	59					
Some college or higher	38	64.4				
Lower than college	21	35.6				
Teacher's monthly salary	59		1.20	9.40[a]	3.26	1.87
Expenditures for professional training per teacher	59		0.00	9.52	1.28	1.71
Expenditures for school facility per student	59		0.17	8.22	1.58	1.79
Emotional Support	59		3.75	6.13	5.08	0.60
Classroom Organization	59		2.92	5.92	4.82	0.70
Instructional Support	59		1.33	3.83	2.37	0.51
Child-level variables						
Gender	589					
Girls	294	49.9				
Boys	295	50.1				
Age	588		3.50	6.50	5.07	0.42
Family SES[b]	549		−1.53	1.85	−0.01	0.80
Vocabulary	587		3.00	106.00	37.27	19.64
Math	586		2.00	78.00	27.17	12.97
Science	584		13.00	100.00	72.61	14.33

Note: School expenditures were in the unit of 1000 Chinese *yuan* (about 150 US dollars). a) 9.4 equals to 9400 *yuan* (about 1300 US dollars) for average income for an urban kindergarten in Guangzhou. The salary does not include the salary for principals or management staff. b) SES = socioeconomic status.

3.2. Effects of school expenditures on children's pre-academic performance

The unconditional multilevel models accounted for the nesting in each outcome variable. Thus, the amount of child-level and school-level variance could be calculated for each outcome. By dividing the amount of school-level variance by the total variance, we computed the ICC for each dependent variable. The results revealed that the school-level variance was 188.57, 32.83, and 124.47 for vocabulary, math and science, respectively, while the child-level variance was 195.97, 135.52, and 79.60 for vocabulary, math and science, respectively. The ICCs indicated that 49% of the variance in vocabulary, 19% of the variance in math, and 61% of the variance in science could be explained by school-level differences, indicating that large variations exist among preschools in terms of children' pre-academic performance. These ICCs justified the use of a multilevel approach. Then we conducted MLM models with child-level and school-level covariates. Note that, given that preschool program type (public vs. private) and school-level SES showed relatively high correlations with teacher's salary (see Table 2), which resulted in multicollinearity, these two variables were excluded from the subsequent analyses in order not to bias the model estimates.

The results of the full models are presented in Table 3. For the child-level predictors, we found that scores on vocabulary, math, and science were associated with age and family SES. Girls scored lower than boys on science and math, but the effect size was trivial (i.e., explaining less than 1% of the total variance), especially on math. The child-level covariates accounted for a small part of the variance in vocabulary (3.7%), math (4.4%), and science (4.7%). With regard to school demographic variables and teacher qualifications, we found that scores on vocabulary and science were higher for those children who were from urban schools (uniquely explaining 3% and 5% of the variance of vocabulary and science, respectively) and with teachers having higher level of education (uniquely explaining 2% and 5% of the variance of vocabulary and science, respectively). Children also had higher vocabulary scores with smaller classroom sizes (explaining 1% of variance in test scores). The school-level covariates accounted for 39%, 16%, and 36% of variance in vocabulary, math, and science, respectively, which are relatively large effect sizes in educational research (Fan, 2001).

Beyond these control variables, we found that school expenditures contributed to the variance in pre-academic performance − the focus of this study. Overall, school expenditures accounted for 2.7% and 4.7% of variance in vocabulary and science, respectively, representing acceptable and meaningful effect sizes (Fan, 2001). Specifically, teacher's monthly salary predicted children's science scores positively (*estimates* = 2.07, $p < 0.01$, 95% CI [0.62, 3.53]). In addition, children's vocabulary scores were positively associated with school expenditures on teachers' professional training (*estimates* = 0.98, $p < 0.05$, 95% CI [0.17, 1.78]). Contrary to our expectations, school expenditures did not account for variance in children's math performance. School expenditures on school facilities were unrelated to children's pre-academic performance.

3.3. The mediation roles of CLASS

We used the MSEM model according to the assumed model (see Fig. 1) for each dependent variable (i.e., vocabulary, math, and science) separately. Although no significant effects of school expenditures on math were found, we still include these variables in our model to examine whether any indirect effect via CLASS domain scores could be identified. All three models fit the data extremely well (for all models, χ^2 (3) ≤ 3.59, $p > 0.05$, RMSEA ≤ 0.019, both CFI and TLI = 1.00).

Across all three models (vocabulary, math, and science), the associations between school expenditure and CLASS scores did not vary.

Table 2
Correlation among variables.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
School-level																		
1 Urban	–																	
2 Public	0.29***	–																
3 School-level SES	0.57***	0.50***	–															
4 Class size	0.04	0.17***	−0.03	–														
5 Yrs teach experience	0.42***	0.55***	0.43***	0.29***	–													
6 Teacher ECE major	.28***	0.14**	0.37***	−0.11**	0.20***	–												
7 Teach Educ level	0.27***	0.24***	0.32***	0.06	0.28***	0.15***	–											
8 Teach month salary	0.43***	0.77***	0.78***	0.06	0.51***	0.30***	0.36***	–										
9 Expend − training	.15***	0.00	0.27***	−0.13**	0.00	0.13**	−0.06	0.13**	–									
10 Expend − facilities	0.25***	0.50***	0.41***	0.09*	0.41***	0.26***	0.21***	0.52***	0.34***	–								
11 Emotional Support	0.27***	0.40***	0.56***	−0.18**	0.32***	0.41***	0.37***	0.56***	0.08*	0.29***	–							
12 Classroom Organization	0.22***	0.27***	0.37***	−0.16***	0.23***	0.23***	0.24***	0.39***	0.18***	0.25***	0.75***	–						
13 Instructional Support	0.43***	0.41***	0.68***	0.06	0.48***	0.32***	0.42***	0.68***	0.07	0.27***	0.71***	0.53***	–					
Child-level																		
14 Gender	−0.03	0.02	−0.02	0.05	−0.01	−0.02	0.06	−0.01	−0.01	0.03	0.05	0.04	0.03	–				
15 Age	−0.18***	0.03	−0.09*	−0.03	−0.13**	0.03	0.03	−0.02	−0.09*	0.01	0.02	−0.01	0.03	−0.09*	–			
16 Fam SES	0.44***	0.38***	0.75***	−0.01	0.32***	0.28***	0.25***	0.58***	0.20***	0.32***	0.43***	0.29***	0.51***	−0.06	−0.11**	–		
17 Vocabulary	0.41***	0.31***	0.64***	−0.09*	0.29***	0.26***	0.31***	0.52***	0.18***	0.32***	0.44***	0.27***	0.55***	−0.05	0.15***	0.57***	–	
18 Math	0.14***	0.11**	0.29***	−0.05	0.11**	0.19***	0.18***	0.25***	0.06	0.15***	0.24***	0.15***	0.32***	−0.10*	0.29***	0.29***	0.44***	–
19 Science	0.43***	0.34***	0.60***	0.04	0.31***	0.26***	0.38***	0.52***	0.14**	0.31***	0.41***	0.21***	0.57***	−0.08	0.18***	0.50***	0.47***	0.70***

Note: Categorical variables was coded as: Urban school = 1, Rural school = 0; Public school = 1, Private school = 0; ECE major = 1, Other major = 0; Educational level of college or higher = 1, Lower levels of education = 0; and Girls = 1, Boys = 0.

*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Teach month salary = Teacher's monthly salary; Expend − training = Expenditures for professional training per teacher; Expend − facilities = Expenditures for school facility per student.

Table 3
Unstandardized Estimates of Effects of Child-level and School-level Demographic Variables, Teacher Qualifications and School Expenditures on Child Academic Outcomes.

	Vocabulary			Math			Science		
	Estimate	*SE*	*p*	*Estimate*	*SE*	*p*	*Estimate*	*SE*	*p*
Fixed effect									
Intercept	30.15	1.78	0.000	25.44	1.81	0.000	66.08	3.59	0.000
Child-level									
Girl	0.00	1.11	0.997	−1.81	0.91	0.047	−1.86	0.70	0.008
Age	9.60	1.60	0.000	9.10	1.49	0.000	6.80	1.23	0.000
SES	7.24	1.11	0.000	3.65	0.81	0.000	2.37	0.57	0.000
School-level									
Urban	7.03	2.00	0.000	0.62	1.34	0.645	6.09	2.24	0.007
Classroom size	−0.32	0.13	0.012	−0.06	0.08	0.479	0.03	0.11	0.751
Years of teaching	0.06	0.16	0.719	0.01	0.08	0.941	−0.04	0.13	0.790
Teacher's major	0.80	1.75	0.648	1.73	1.42	0.222	0.71	1.99	0.722
Educational level	4.22	1.99	0.034	2.12	1.22	0.083	5.52	2.37	0.020
Teach month salary	2.08	1.22	0.087	0.37	0.35	0.286	2.07	0.74	0.005
Expend − training	0.98	0.41	0.017	0.01	0.36	0.981	0.46	0.46	0.320
Expend − facilities	0.22	0.81	0.787	0.16	0.38	0.685	0.06	0.43	0.886
Random effect									
Child-level Residual	180.58	16.85	0.000	127.90	10.14	0.000	69.85	5.50	0.000
School-level Residual	28.09	8.45	0.001	6.37	3.71	0.086	40.71	9.06	0.000

Note: SES = socioeconomic status. Categorical variables was coded as: Urban School = 1, Rural School = 0; ECE Major = 1, Other Major = 0; Educational level of college or higher = 1, Lower levels of education = 0; and Girls = 1, Boys = 0. Teach month salary = Teacher's monthly salary; Expend − training = Expenditures for professional training per teacher; Expend − facilities = Expenditures for school facility per student.

Specifically, the three dimensions of CLASS showed significant links only with teacher's salary, but not expenditures for training and school facilities ($ps > 0.05$). The model estimates revealed that teacher’s emotional support (*estimates* = 0.18, *SE* = 0.04, $p < 0.001$, 95% CI [0.11, 0.26]), classroom organization (*estimates* = 0.14, *SE* = 0.04, $p < 0.001$, 95% CI [0.07, 0.23]), and instructional support (*estimates* = 0.20, *SE* = 0.04, $p < 0.001$, 95% CI [0.13, 0.28]) were positively predicted by teacher's monthly salary.

Table 4 summarizes the direct and indirect effects of school expenditures and CLASS on child academic outcomes. After taking into consideration the mediating roles of CLASS, school expenditures showed no significant direct effects on pre-academic performance except that per-teacher expenditure on professional training predicted children’s vocabulary (*estimates* = 0.94, $p < 0.01$, 95% CI [0.26, 1.63]). Teacher’s salary showed significant indirect effects via instructional support on children’s vocabulary (*estimates* = 1.97, $p < 0.0001$, 95% CI [1.01, 2.93]), math (*estimates* = 1.29, $p < 0.01$, 95% CI [0.45, 2.13]), and science scores (*estimates* = 1.98, $p < 0.01$, 95% CI [0.81, 3.14]). In addition, teacher's salary linked to child vocabulary (*estimates* = −0.57, $p < 0.01$, 95% CI [−0.99, −0.16]) and science (*estimates* = −0.58, $p < 0.05$, 95% CI [−1.14, −0.02]) indirectly via classroom organization in a negative direction − teacher classroom organization negatively predicted child pre-academic performance.

As Wen and Fan (2015) recently discussed, for mediation effects, “… no single index appears to be a viable mediation effect size measure” (p. 199), because all measures currently available have their own issues. Given this situation, we used the R_m statistic as proposed by Sobel (1982) as our mediation effect size measure. R_m is the ratio of the indirect effect to the direct effects (i.e., R_m = a*b/c'), and it reflects the contribution of the indirect effect relative to the direct effect. More specifically, $R_m < 1$, $R_m = 1$, or $R_m > 1$ indicates that the indirect effect is smaller than, equal to, or larger than the direct effect, respectively. Following Sobel’s procedures, the R_m statistics for the statistically significant indirect effects in the current study ranged from

Table 4
Unstandardized Estimates of Direct and Indirect Effects of School Expenditures and CLASS on Child Academic Outcomes.

Effects	Vocabulary			Math			Science		
	Estimate	*SE*	*p*	*Estimate*	*SE*	*p*	*Estimate*	*SE*	*p*
Direct effects on academic outcomes									
ES (b_1)	4.14	2.41	0.086	−0.35	1.70	0.836	2.29	2.85	0.421
CO (b_2)	−3.84	1.34	0.004	−0.52	1.06	0.622	−3.91	1.89	0.039
IS (b_3)	9.85	2.11	0.000	6.45	1.81	0.000	9.88	2.65	0.000
Teach month salary (c'_1)	0.48	1.06	0.648	−0.41	0.34	0.237	0.72	0.58	0.212
Expend − training (c'_2)	0.94	0.35	0.007	−0.07	0.30	0.817	0.49	0.39	0.214
Expend − facilities (c'_3)	0.87	0.66	0.188	0.51	0.34	0.131	0.64	0.43	0.136
Indirect effects									
Teach month salary → ES → Outcome ($a_{11}b_1$)	0.77	0.48	0.111	−0.07	0.32	0.836	0.43	0.55	0.437
Teach month salary → CO → Outcome ($a_{21}b_2$)	−0.57	0.21	0.007	−0.08	0.16	0.622	−0.58	0.29	0.043
Teach month salary → IS → Outcome ($a_{31}b_3$)	1.97	0.49	0.000	1.29	0.43	0.003	1.98	0.59	0.001
Expend − training → ES → Outcome ($a_{12}b_1$)	0.06	0.15	0.720	−0.01	0.03	0.865	0.03	0.09	0.745
Expend − training → CO → Outcome ($a_{22}b_2$)	−0.23	0.15	0.113	−0.03	0.06	0.605	−0.23	0.17	0.165
Expend − training → IS → Outcome ($a_{32}b_3$)	0.04	0.17	0.796	0.03	0.11	0.794	0.04	0.17	0.796
Expend − facilities → ES → Outcome ($a_{13}b_1$)	−0.07	0.14	0.634	0.01	0.03	0.851	−0.04	0.09	0.670
Expend − facilities → CO → Outcome ($a_{23}b_2$)	0.04	0.15	0.793	0.01	0.02	0.808	0.04	0.15	0.796
Expend − facilities → IS → Outcome ($a_{33}b_3$)	−0.36	0.29	0.213	−0.23	0.19	0.225	−0.36	0.30	0.230

Note: Teach month salary = Teacher's monthly salary; Expend − training = Expenditures for professional training per teacher; Expend − facilities = Expenditures for school facility per student.

0.81 to 4.10, indicating that the contribution of the indirect effects is either close to or outweighs the direct effects.

4. Discussion

This study represents an effort to understand the effects that preschool expenditures may have on children's pre-academic performance during early childhood. We advance past research that typically treats process quality as a "black box" by examining both different type of expenditures and different quality indicators as potential mediators. Our analysis suggests that per-teacher expenditure on training predicted children's vocabulary, while teacher's salary was linked to child science knowledge with robust effect sizes. Significant indirect effects of teacher's salary on children's outcomes were also found. Specifically, instructional support mediates the relationship between teacher's salary and children's vocabulary, mathematics, and science knowledge performance, whereas classroom organization mediates the relationship between teacher's salary and children's vocabulary development and science knowledge (in a negative direction). These findings suggest that ECE quality is part of the mechanism through which school expenditures on teacher's salary affects children's academic performance. In addition, we found that about 49% of the variance in vocabulary, 19% of the variance in math, and 61% of the variance in science could be explained by school-level differences, suggesting that children's pre-academic performance varies considerably across these preschools. These ICC values are bigger when compared with previous studies (Schulting, Malone, & Dodge, 2005), which is not hard to understand considering the large urban-rural disparity that exists in terms of the financial wellbeing and overall program quality of preschools in China–a developing country (Hu & Roberts, 2013; Hu et al., 2014; Zhao & Hu, 2008). It is also notable that family-level factors such as SES in the current study explained only a very small amount of variance in children's outcomes, also unlike what is typically found in studies in the United States (Burchinal. Peisner-Feinberg, Pianta, & Howes, 2002; Curby et al., 2009). Our findings suggest that, at least for our sample and context, the experiences that children have with teachers in preschools are more important for children's pre-academic school readiness skills than economic and educational influence in the home.

4.1. Direct effect of school expenditures on children's academic outcomes

Of the direct effect of school-level variables, expenditures on teacher salary contributed only to variance in child science knowledge, but not their vocabulary and mathematics scores. In other words, children taught by teachers with varying pay schedules scored similarly in their vocabulary and mathematics performance. This is in contrast to the previous literature, in which some researchers reported that children score better on math when taught by teachers with better pay, although these studies were done in elementary and secondary school settings instead of preschool, and in other countries (Loyalka et al., 2015).

Expenditures on training also directly related to variation in Chinese preschool children's pre-academic outcomes. Expenditures on training significantly predicted children's vocabulary scores but not math or science. This indicates that preschools' training efforts may have made a difference in children's Chinese receptive vocabulary skills. However, money preschools spent on training was not related to children's mathematics and science learning. It is possible that the majority of training offered at the preschool level is geared toward teaching curricula and methodology more closely associated with children's vocabulary skills. Teaching math and science at the pre-K level is new in the Chinese setting, and has not been considered as important by practitioners (Hu, Fuentes, Wang, & Ye, 2014). In the future, researchers could consider examining different types of teacher training in math and science and their associations with children's outcomes.

We found that expenditures on the school facility did not directly relate to children's academic learning. Such findings are supported by the previous literature that found that investments in the structural quality of ECE (such as provisions for learning) do not lead automatically to children's increased academic performance (Yoshikawa et al., 2013). School facility typically refers to large equipment such as outdoor stationary and portable large-motor equipment and indoor furnishings for play and learning (e.g., a piano, a dramatic play furniture set). There are several possibilities for the lack of a school facility effect. First, there might be a threshold effect for adding new equipment, whereby at some point after a minimum standard of equipment is available, any additional effect on student learning outcomes drops to zero. Such an effect is more likely to be present after several years of implementation of the nation's initiative to add more ECE programs. Another explanation is that the school facility might be more closely associated with other areas of children's development besides academics, such as physical, socio-emotional, and creativity development. For example, the provision of both quality stationary and portable equipment affords children many opportunities to exercise a range of large motor skills (e.g., pulling, climbing, throwing, catching, and sliding). Past studies have found an association between the provision of outdoor equipment and children's large motor development and their social and self-regulatory skills, outcomes not explored in the present study (Wells & Evans, 2003).

4.2. Mediation between school expenditures and children's pre-academic performance

This study extends previous theory and findings by evaluating the relationship between school expenditures and children's pre-academic performance in a mediation framework. The results indicate that such a relationship is partially accounted for by ECE quality—specifically, by teacher-child interaction quality, as a mechanism through which expenditures on teacher salary is positively linked to children's vocabulary, math, and science performance. In other words, unlike teacher training, salary itself does not necessarily translate into better child outcomes directly; instead, it is anticipated that it is through the quality of teaching that salary can make an impact on children's pre-academic learning.

Particularly, the higher the salary was that schools paid to teachers, the better instructional quality children received in the classrooms, and the better performance the children achieved in vocabulary, mathematics, and science. This finding is consistent with the previous literature highlighting the important predictive role of teacher salary in relation to ECE quality (Howes et al., 1992; Mak et al., 2016; Phillips et al., 2000). Moreover, our finding on the mediating role of instructional support quality is consistent with the growing body of international literature on the importance of quality instructional support for children's academic achievement (Araujo, Carneiro, Cruz-Aguayo, & Schady, 2014; Burchinal et al., 2000, 2008; Hamre et al., 2013; Mashburn et al., 2008; Penno, Wilkinson, & Moore, 2002).

The negative associations we found in the mediation analysis between teacher's salary and children's vocabulary and science outcomes via classroom organization at first glance might seem non-intuitive. A closer look at the Chinese classroom provides some explanations. Once we unfold the patterns of teacher-child interactions in the Chinese classrooms in light of classroom organization, two different patterns of classrooms both with high scores in classroom organization emerged. The first group of teachers (most likely urban public preschool teachers) tend to score high on classroom organization because of effective use of proactive strategies and rich instructional formats and they provide overall higher teacher-child interaction quality (Hu, Fan, LoCasale-Crouch et al., 2016). Working in better-resourced preschools, these teachers adopt a more developmentally appropriate way to stimulate children's vocabulary and science learning. Children in these classrooms tend to be more active learners who likely initiate ideas and take a lead in activities.

However, in another group of Chinese teachers (more likely rural teachers), they score high on classroom organization not because they were good at applying proactive strategies and redirections and rich instructional formats. It is important to clarify that, according to the scoring criteria for behavior management, when proactive strategies and effective redirection were absent in the classroom, but no student misbehavior is evident, the raters can assume that "effective behavioral strategies are in place and a classroom may score in the high range" (Paro et al., 2008, p. 44). The second group of Chinese teachers, owing to traditional teacher-centered practice and the collectivist mainstream social culture, typically are good at disciplining children. It is believed that in classrooms where discipline is viewed as essential, students tend to be dependent and obedient individuals who try to comply with demands (Biggs, 1996; Chan & Rao, 2010). Thus, given the tendency to focus on rules and disciplines in classrooms, these Chinese teachers (more likely rural teachers) score high on classroom organization because their children were trained to be obedient and follow the teachers' lead in learning. In a separate study, we found that in such classrooms of high teacher control, students tend to show decreased motivation for learning, are rather dependent, and rarely make initiations in learning or acknowledged for making such initiations (Hu, Teo, Nie, & Wu, 2017). Overall teacher-child interaction quality in this second group of teachers tends to be low especially in showing awareness of, and responding to, children's academic and social needs and promoting their creative thinking. In conclusion, the way many Chinese teachers approach classroom organization might be unfavorable for preschoolers' academic performance but they nonetheless score high on classroom organization given the current CLASS rubrics, which might explain the negative direction observed in some of the mediation analyses.

Moreover, this finding also raises concerns about the cultural appropriateness of the behavior management dimension of the teacher-child interaction framework. It might be necessary to revise the specific scoring criterion so that is more culturally sensitive for assessing process quality in Chinese preschools. Given the scope of the current study, we did not collect any data on teacher or school administrator's beliefs on the teacher-child interaction framework and associated CLASS assessment tool. We leave this topic for future research. In terms of the relationship between teacher salary, classroom organization, and academic outcome, we hypothesize that teachers who subscribed to the rules- and discipline-focused teaching style actually are more likely to be retained in their job over the years. Because teacher salary is largely determined by seniority, the more compliant the teacher, the more likely that they will remain in their job longer, thus with higher salary. In this sense, teacher quality could be negatively related with teacher salary. To understand such issues better, researchers will need to look into Chinese kindergarten's organizational culture of how teachers are evaluated and compensated inside various kindergarten settings.

The mediation analysis also revealed that teacher-child interaction quality is not the mechanism through which school expenditure on training affects children's pre-academic learning, at least within the Chinese context. This suggests that school expenditure on training may not affect the quality of classroom learning experiences. Such findings support the view that professional development requires a more specialized focus on the most critical aspect of the classroom experience that has the largest effects on children's learning (Fukkink & Lont, 2007; Pianta, 2009). Our findings also highlight the need to develop professional development programs with empirical evidence given the association between program quality and children's pre-academic achievement (Hamre et al., 2010; Kinzie et al., 2014; Mashburn et al., 2008).

The direct effect of training expenditures on children's vocabulary performance suggests that training may have made a difference in children's vocabulary learning. However, no indirect effect was found when examining the role of teacher-child interaction quality in mediating the relationship between expenditure on training and children's vocabulary learning. This implies that other mediators not examined in the current study might be responsible for the relationship between training and vocabulary learning. For instance, training expenditure might have helped teachers improve their abilities in creating a developmentally appropriate, literacy-rich environment, which studies suggest can also be helpful in improving children's early language and literacy skills (Neuman & Carta, 2011; Reutzel & Morrow, 2007).

In this study, neither direct nor indirect effects were found between school asset expenditures and children's pre-academic learning. Further, we found that asset expenditure did not make a difference in teachers' use of emotional, behavioral, or instructional support in the classroom. This finding suggests that the government would do well to invest in things that increase process quality and the quality of teacher-child interactions (rather than equipment) if the goal is to make a difference in children's outcomes (Burchinal et al., 2008; Gilliam & Zigler, 2004; Mashburn et al., 2008; Pianta, 2009; Wong et al., 2013). In contrast, it is possible that asset expenditure has helped teachers to improve other aspects of program quality, such as the learning environment. For example, as mentioned earlier, the purchase of large outdoor equipment could help increase the quality of outdoor play, which might in turn enhance the development of children's physical and social skills.

4.3. Limitations and directions for future research

This study is among the few to clarify the potential effect of school expenditure on preschooler's pre-academic performance and the potential indirect effect of teacher-child interactions. To ensure the robustness of the findings, multiple child-level and school-level variables were included in the analyses. Effect sizes in this study were acceptable and meaningful. However, we acknowledge that several limitations exist within this study. First, only some aspects of children's pre-academic performance (vocabulary, math, and science) were examined. Thus, we do not know about how expenditures and quality might relate to other domains of child development, such as physical, social, and emotional development. Second, in the current study, we examined a specific type of process quality: teacher-child interaction measured by the CLASS in terms of emotional support, class organization, and instructional support. In future studies, researchers should consider other aspects of program quality which might be associated with expenditures on training, salaries, and assets.

Third, although we used a representative sample of preschools in Guangdong Province, caution must be taken when generalizing the findings to other parts of China, especially West and Central China. Fourth and most importantly, as a cross sectional, correlational study, we cannot conclude anything about causal relations between school expenditure, classroom quality, and children's outcomes. Nor were we able to compare fully how these processes may play out differently in various combinations of public/private and urban/rural kindergartens. In general, public and urban kindergartens have more financial resources, thus they may be able to offer teachers a higher salary. It is possible that other elements related to school types also contribute to the varying instructional capacity of teachers. But our data do not allow examining these areas of omitted variable bias. It is important that this study be replicated with other samples, longitudinally, and using other experimental and quasi-experimental designs to examine further causal links between expenditures, classroom quality, and children's academic growth over time. Finally, the non-intuitive negative relations found in the mediation analysis between teachers' salary and children's vocabulary and science outcomes via classroom organization warrant attention in future research. Specifically, researchers should consider longitudinal approaches to understand dynamic relationships between classroom organization and children's development.

4.4. Implications for early childhood policies

In the field of early childhood education, policy makers and professionals are called on to improve teacher-child interaction quality and children's development and learning through evidence-based policy reform (Arteaga et al., 2014). This study advanced this field by examining how teacher-child interaction quality may serve as part of the mechanism through which school expenditures are linked to children's pre-academic performance, thus offering important implications for policy reform concerning preschool expenditures in the Chinese sociocultural and policy context. Our findings indicate the need to prioritize expenditures to maximize the benefits of limited financial resources for ECE. First, a more effective way for schools to improve children's outcomes, according to our findings, is by increasing teacher pay. Higher teacher pay can lure high-quality candidates that will improve teacher-child interaction quality into the teacher pool and stay long-term in the profession (Early et al., 2006). Despite the large variation among preschools (ranging from $184 to $1446), especially between urban and rural teachers, the average monthly salary of Chinese ECE teachers is relatively low in Guangdong compared to those of elementary and secondary school teachers. We thus join other professionals in advocating for pay increases for ECE teachers, especially teachers serving the most disadvantaged rural children. Teacher compensation right now only constitutes a small proportion of ECE expenditure in China (Zhou et al., 2017). While arguing for overall improvements in teacher compensation, further studies should look into whether there is a baseline threshold for teachers' salary in relation to teacher-child interaction quality in preschool classrooms across China. Such evidence could provide specific guidelines for setting salary levels in each province's ECE quality evaluation system.

Second, the lack of a mediation effect of teacher-child interaction quality on the association between training expenditure and children's academic outcomes suggests that future professional development may need to be reorganized and perhaps target teacher-child interaction quality. However, if teacher-training shifts to better align with the CLASS, it will be important to be sure that other types of training shown to be effective in the past are kept. Recognizing the lack of effectiveness of several types of professional development, many professionals recommend improving teacher-child interaction quality (Pianta, 2009). For instance, observational studies in both developed countries like Finland (Pakarinen et al., 2010) and the U.S. (Hamre et al., 2013) and developing countries like Chile (Leyva et al., 2015) and China (Hu, Fan, Gu et al., 2016) suggest that teachers rate rather poorly on instructional support quality and have a great deal of room for improvement. Furthermore, many researchers worldwide have called on the professional community to increase efforts to help teachers improve instructional support quality through innovative and effective professional development (Pianta, Mashburn et al., 2008). Additionally, studies have repeatedly shown that the most effective way to improve teaching quality is through observation-based, specific, ongoing feedback given by expert teachers (Goe, Biggers, & Croft, 2012; Landry, Swank, Smith, Assel, & Gunnewig, 2006; Mashburn et al., 2008). Some recent empirically validated professional development programs (e.g., MTP and Making the Most of Classroom Interactions) have shown effectiveness in improving teachers' practices and children's outcomes (Hamre et al., 2010; Kinzie et al., 2014; Mashburn et al., 2008).

Finally, in addition to prioritizing expenditures to ensure levels of teacher pay and training that can help improve classroom quality, schools need to be cautious about expenditures on school facilities. The lack of direct and indirect effects of asset expenditure on children's academic outcomes does not necessarily suggest that fixed assets are unimportant. Expenditures on some assets are necessary to ensure safety and the daily operation of schools, and the enrichment of the learning environment could help improve ECE quality. However, asset expenditure should not be considered a priority. Currently, stakeholders are working toward the national goal of providing all Chinese children with three-year ECE. As a result, many new programs, public and private, have been implemented to serve the growing number of Chinese children. The number of children in need of ECE services will increase in the next decade, as China has recently loosened its one-child-per-family policy, allowing families to have two children. According to past experience, local governments, especially those in rural areas, tend to spend a substantial portion of funding on assets at the expense of funding teacher salaries and effective professional development (Hu et al., 2015). While it is necessary to invest some in minimal to adequate structural provisions for learning, policy makers need to be strategic about expenditures that maximize benefits for children's development and learning.

Acknowledgements

The study and the preparation of the manuscript were supported by the project "A Longitudinal Study on the Effects of Preschool Program Quality on Children's Learning and Development Outcomes." (University of Macau Multi-Year Research Grant; MYRG20l5-00156-FED). The authors of this paper deeply appreciate the support.

References

Araujo, M. C., Carneiro, P., Cruz-Aguayo, Y., & Schady, N. (2014). *A helping hand? Teacher quality and learning outcomes in kindergarten*. Washington, DC: Inter-American Development Bank.

Arteaga, I., Humpage, S., Reynolds, A. J., & Temple, J. A. (2014). One year of preschool or two: is it important for adult outcomes? *Economics of Education Review*, *40*, 221–237. http://dx.doi.org/10.1016/j.econedurev.2013.07.009.

Biggs, J. (1996). Western misperceptions of the Confucian-heritage learning culture. In D. Watkins, & J. Biggs (Eds.), *The Chinese learners: cultural, psychological, and contextual influences* (pp. 45–68). Hong Kong: The University of Hong Kong.

Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology*, *53*(1), 371–399. http://dx.doi.org/10.1146/annurev.psych.53.100901.135233.

Brophy, J., & Good, T. (1986). Teacher behavior and student achievement. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (pp. 328–375). (3rd ed.). New York, NY: Macmillan.

Burchinal, M. R., Roberts, J. E., Riggins, R., Jr., Zeisel, S. A., Neebe, E., & Bryant, D. (2000). Relating quality of center-based child care to early cognitive and language development longitudinally. *Child Development*, *71*(2), 339–357. http://dx.doi.org/10.1111/1467-8624.00149.

Burchinal, M. R., Peisner-Feinberg, E., Pianta, R., & Howes, C. (2002). Development of academic skills from preschool through second grade: family and classroom predictors of developmental trajectories. *Journal of School Psychology*, *40*(5), 415–436. http://dx.doi.org/10.1016/S0022-4405(02)00107-3.

Burchinal, M. R., Howes, C., Pianta, R. C., Bryant, D., Early, D., Clifford, R., & Barbarin, O. (2008). Predicting child outcomes at the end of kindergarten from the quality of pre-kindergarten teacher-child interactions and instruction. *Applied Developmental Science*, *12*(3), 140–153. http://dx.doi.org/10.1080/10888690802199418.

Cadima, J., Leal, T., & Burchinal, M. (2010). The quality of teacher-student interactions: associations with first graders' academic and behavioral outcomes. *Journal of School Psychology*, *48*(6), 457–482. http://dx.doi.org/10.1016/j.jsp.2010.09.001.

Campbell, P. H., & Milbourne, S. A. (2005). Improving the quality of infant—toddler care through professional development. *Topics in Early Childhood Special Education*, *25*(1), 3–14. http://dx.doi.org/10.1177/02711214050250010101.

Campbell, F. A., & Ramey, C. T. (1995). Cognitive and school outcomes for high-risk African-American students at middle adolescence: positive effects of early intervention. *American Educational Research Journal*, *32*(4), 743–772. http://dx.doi.org/10.3102/00028312032004743.

Campbell, F., Conti, G., Heckman, J. J., Moon, S. H., Pinto, R., Pungello, E., & Pan, Y. (2014). Early childhood investments substantially boost adult health. *Science*, *343*(6178), 1478–1485. http://dx.doi.org/10.1126/science.1248429.

Chan, C. K. K., & Rao, N. (2010). *Revisiting the Chinese learner: Changing contexts, changing education (CERC Studies in comparative education)*. New York, NY: Springer.

Cheng, H. C., Chen, H. Y., Tsai, C. L., Chen, Y. J., & Cherng, R. J. (2009). Comorbidity of motor and language impairments in preschool children of Taiwan. *Research in Developmental Disabilities*, *30*(5), 1054–1061. http://dx.doi.org/10.1016/j.ridd.2009.02.008.

Cohen, S., Doyle, W. J., & Baum, A. (2006). Socioeconomic status is associated with stress hormones. *Psychosomatic Medicine*, *68*(3), 414–420. http://dx.doi.org/10.1097/01.psy.0000221236.37158.b9.

Connor, C. M., Morrison, F. J., & Slominski, L. (2006). Preschool instruction and children's emergent literacy growth. *Journal of Educational Psychology*, *98*(4), 665–689. http://dx.doi.org/10.1037/0022-0663.98.4.665.

Cryer, D., Tietze, W., Burchinal, M., Leal, T., & Palacios, J. (1999). Predicting process quality from structural quality in preschool programs: A cross-country comparison. *Early Childhood Research Quarterly*, *14*, 339–361. http://dx.doi.org/10.1016/S0885-2006(99)00017-4.

Cryer, D. (1999). Defining and assessing quality. *Annals of the American Academy of Political and Social Sciences*, *563*, 39–55. http://dx.doi.org/10.1177/000271629956300103.

Curby, T. W., LoCasale-Crouch, J., Konold, T. R., Pianta, R. C., Howes, C., Burchinal, M., & Barbarin, O. (2009). The relations of observed pre-K classroom quality profiles to

children's achievement and social competence. *Early Education and Development*, *20*(2), 346–372. http://dx.doi.org/10.1080/10409280802581284.
De Kruif, R. E. L., Riksen-Walraven, J. M., Gevers Deynoot-Schaub, M. J. J. M., Helmerhorst, K. O. W., Tavecchio, L. W. C., & Fukkink, R. G. (2009). *Pedagogogische kwaliteit van de opvang voor 0- tot 4-jarigen in Nederlandse kinderdagverblijven in 2008 [Pedagogical quality of Dutch child care for 0-to4- years-olds in 2008]*. Amsterdam/Nijmegen: NCKO.
Domitrovich, C. E., Gest, S. D., Gill, S., Bierman, K. L., Welsh, J. A., & Jones, D. (2009). Fostering high-quality teaching with an enriched curriculum and professional development support: The head start REDI program. *American Educational Research Journal*, *46*(2), 567–597. http://dx.doi.org/10.3102/0002831208328089.
Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., & Sexton, H. (2007). School readiness and later achievement. *Developmental Psychology*, *43*(6), 1428–1446. http://dx.doi.org/10.1037/0012-1649.43.6.1428.
Dunn, L., & Dunn, L. (1981). *Peabody picture vocabulary test revised*. Circle Pines, MN: American Guidance Service.
Early, D. M., Bryant, D. M., Pianta, R. C., Clifford, R. M., Burchinal, M. R., ... Ritchie, S., Barbarin, O. (2006). Are teachers' education, major, and credentials related to classroom quality and children's academic gains in pre-kindergarten? *Early Childhood Research Quarterly*, *21*(2), 174–196. http://dx.doi.org/10.1016/j.ecresq.2006.04.004.
Eccles, J. S., & Roeser, R. W. (2005). School and community influences on human development. In M. H. Boorstein, & M. E. Lamb (Eds.), *Developmental science: An advanced textbook* (pp. 513–556). (5th ed.). Mahwah, NJ: Erlbaum.
Fan, X. (2001). Statistical significance and effect size in education research: Two sides of a coin. *The Journal of Educational Research*, *94*(5), 275–282.
Field, A. P. (2005). Intraclass correlation. In B. S. Everitt, & D. C. Howell (Eds.), *Encyclopedia of statistics in the behavioral sciences* (pp. 1296–1305). Chichester, England: Wiley.
Fukkink, R. G., & Lont, A. (2007). Does training matter? A meta-analysis and review of caregiver training studies. *Early Childhood Research Quarterly*, *22*(3), 294–311. http://dx.doi.org/10.1016/j.ecresq.2007.04.005.
Fukkink, R. G., Gever Deynoot-Schaub, M. J. J. M., Helmerhorst, K. O. W., Bollen, I., & Riksen-Walraven, J. M. A. (2013). *Pedagogische kwaliteit van de kinderopvang voor 0–4 jarigen in Nederlandse kinderdagverblijven in 2012 [Pedagogical quality of Dutch child care for 0- to 4- years-olds in Dutch day care centers in 2012]*. Amsterdam/Nijmegen: NCKO.
Gilliam, W. S., & Zigler, E. F. (2004). *State efforts to evaluate the effects of prekindergarten: 1977–2003*. Retrieved from: https://www.researchgate.net/profile/Walter_Gilliam/publication/253316034_State_Efforts_to_Evaluate_the_Effects_of_Prekindergarten/links/0046353bc838cd3e75000000/State-Efforts-to-Evaluate-the-Effects-of-Prekindergarten.pdf.
Ginsburg, H. P., & Baroody, A. J. (1983). *The test of early mathematics ability*. Austin, TX: Pro-Ed.
Ginsburg, H. P., & Baroody, A. J. (1990). *The test of early mathematics ability* (2nd ed.). Austin, TX: Pro-Ed.
Goe, L., Biggers, K., & Croft, A. (2012). *Linking teacher evaluation to professional development: Focusing on improving teaching and learning (Research & Policy Brief)*. Washington, DC: National Comprehensive Center for Teacher Quality. Retrieved from: www.tqsource.org/publications/LinkingTeacherEval.pdf.
Greenberg, M. T., Domitrovich, C., & Bumbarger, B. (2001). The prevention of mental disorders in school-aged children: Current state of the field. *Prevention & Treatment*, *4*(1), 1–62. http://dx.doi.org/10.1037/1522-3736.4.1.41a.
Greenfield, D. B. (2009). *Lens on science: Development and validation of a computer- administered, adaptive, IRT-based science assessment for preschool children*. R305A090502: Institute of Education Sciences Goal 5 Measurement Grant.
Greenfield, D. B. (2015). Assessment in early childhood science education. *Research in Early Childhood Science Education*, 353–380. http://dx.doi.org/10.1007/978-94-017-9505-0_16.
Greenwald, R., Hedges, L. V., & Laine, R. D. (1996). The effect of school resources on student achievement. *Review of Educational Research*, *66*(3), 361–396. Retrieved from: http://www.jstor.org/stable/1170528.
Grissmer, D., Grimm, K. J., Aiyer, S. M., Murrah, W. M., & Steele, J. S. (2010). Fine motor skills and early comprehension of the world: Two new school readiness indicators. *Developmental Psychology*, *46*(5), 1008–1017. http://dx.doi.org/10.1037/a0020104.
Hamre, B. K., & Pianta, R. C. (2007). Learning opportunities in preschool and early elementary classrooms. In R. Pianta, M. Cox, & K. Snow (Eds.), *School readiness and the transition to kindergarten in the era of accountability* (pp. 49–84). Baltimore, MD: Brookes.
Hamre, B. K., Justice, L. M., Pianta, R. C., Kilday, C., Sweeney, B., Downer, J. T., & Leach, A. (2010). Implementation fidelity of MyTeachingPartner literacy and language activities: Association with preschoolers' language and literacy growth. *Early Childhood Research Quarterly*, *25*(3), 329–347. http://dx.doi.org/10.1016/j.ecresq.2009.07.002.
Hamre, B. K., Pianta, R. C., Burchinal, M., Field, S., LoCasale-Crouch, J., Downer, J. T., & Scott-Little, C. (2012). A course on effective teacher-child interactions effects on teacher beliefs, knowledge, and observed practice. *American Educational Research Journal*, *49*(1), 88–123. http://dx.doi.org/10.3102/0002831211434596.
Hamre, B. K., Pianta, R. C., Downer, J. T., DeCoster, J., Mashburn, J., Jones, S., & Hamagami, A. (2013). Teaching through interactions: Testing a developmental framework of teacher effectiveness in over 4, 000 classrooms. *The Elementary School Journal*, *113*(4), 461–487. http://dx.doi.org/10.1086/669616.
Hanushek, E. A. (1986). The economics of schooling: Production and efficiency in public schools. *Journal of Economic Literature*, *24*(3), 1141–1177. Retrieved from: http://www.jstor.org/stable/2725865.
Heckman, J. J. (2006). Skill formation and the economics of investing in disadvantaged children. *Science*, *312*(5782), 1900–1902. http://dx.doi.org/10.1126/science.1128898.
Helburn, S. W. (Ed.), (1995). *Cost, quality, and child outcomes in child care centers: Technical report, public report, and executive report*. Denver, CO: Economics Department, University of Colorado.
Howes, C., & Hamilton, C. E. (1993). The changing experience of child care: Changes in teachers and in teacher-child relationships and children's social competence with peers. *Early Childhood Research Quarterly*, *8*(1), 15–32. http://dx.doi.org/10.1016/S0885-2006(05)80096-1.
Howes, C., Whitebook, M., & Phillips, D. (1992). Teacher characteristics and effective teaching in child care: Findings from the national child care staffing study. *Child Care Forum*, *21*(6), 399–414. http://dx.doi.org/10.1007/BF00757371.
Howes, C., Burchinal, M., Pianta, R., Bryant, D., Early, D., Clifford, R., & Barbarin, O. (2008). Ready to learn? Children's pre-academic achievement in pre-kindergarten programs. *Early Childhood Research Quarterly*, *23*(1), 27–50. http://dx.doi.org/10.1016/j.ecresq.2007.05.002.
Hu, B., & Li, K. (2012). The quality rating system of Chinese preschool education: Prospects and challenges. *Childhood Education*, *88*(1), 14–22. http://dx.doi.org/10.1080/00094056.2012.643711.
Hu, B., & Roberts, S. K. (2013). A qualitative study of the current transformation to rural village early childhood in China: Retrospect and prospect. *International Journal of Educational Development*, *33*(4), 316–324. http://dx.doi.org/10.1016/j.ijedudev.2012.04.006.
Hu, B., Zhou, Y., Li, K., & Roberts, S. K. (2014). Examining program quality disparities between urban and rural kindergartens in China: Evidence from Zhejiang. *Journal of Research in Childhood Education*, *28*, 461–483. http://dx.doi.org/10.1080/02568543.2014.944720.
Hu, B., Roberts, S. K., Ieong, S. S. L., & Guo, H. (2015). Challenges to early childhood education in rural China: Lessons from the Hebei province. *Early Child Development and Care. Advanced Online Publication.*. http://dx.doi.org/10.1080/03004430.2015.1062984.
Hu, B., Teo, T., Nie, Y., & Wu, Z. (2017). Classroom quality and Chinese preschool children's approaches to learning. *Learning and Individual Differences*, *54*, 51–59. http://dx.doi.org/10.1016/j.lindif.2017.01.007.
Hu, B., Dieker, L., Yang, Y., & Yang, N. (2016). The quality of classroom experiences in Chinese kindergarten classrooms across settings and learning activities: Implications for teacher preparation. *Teaching and Teacher Education*, *57*, 39–50. http://dx.doi.org/10.1016/j.tate.2016.03.001.
Hu, B., Fan, X., Gu, C., & Yang, N. (2016). Applicability of the classroom assessment scoring system in Chinese preschools based on psychometric evidence. *Early Education and Development*, *27*(5), 714–734. http://dx.doi.org/10.1080/10409289.2016.1113069.
Hu, B., Fan, X., LoCasale-Crouch, J., Chen, L., & Yang, N. (2016). Profiles of teacher-child interactions in Chinese kindergarten classrooms and the associated teacher and program features. *Early Childhood Research Quarterly*, *37*, 58–68. http://dx.doi.org/10.1016/j.ecresq.2016.04.002.
Hu, B., Fuentes, S. Q., Wang, C., & Ye, F. (2014). A case study of the implementation of Chinese kindergarten mathematics curriculum. *International Journal of Science and Mathematics Education*, *12*(1), 193–217. http://dx.doi.org/10.1007/s10763-013-9429-5.
Hu, B., Mak, M. C. K., Neitzel, J., Li, K., & Fan, X. (2016). Predictors of Chinese early childhood program quality: Implications for policies. *Children and Youth Services Review*, *70*, 152–162. http://dx.doi.org/10.1016/j.childyouth.2016.09.013.
Kagitcibasi, C., Sunar, D., Bekman, S., Baydar, N., & Cemalcilar, Z. (2009). Continuing effects of early enrichment in adult life: The Turkish early enrichment project 22 years later. *Journal of Applied Developmental Psychology*, *30*(6), 764–779. http://dx.doi.org/10.1016/j.appdev.2009.05.003.
Kinzie, M. B., Whittaker, J. V., Williford, A. P., DeCoster, J., McGuire, P., Lee, Y., & Kilday, C. R. (2014). MyTeachingPartner − math/science pre-kindergarten curricula and teacher supports: Associations with children's mathematics and science learning. *Early Childhood Research Quarterly*, *29*(4), 586–599. http://dx.doi.org/10.1016/j.ecresq.2014.06.007.
Kisker, E. E., Hofferth, S. L., Phillips, D. A., & Farquhar, E. (1991). *A profile of child care settings: Early education and care in 1990*. Princeton, NJ: Mathematica Policy Research.
Kontos, S., & Wilcox-Herzog, A. (1997). Influences on children's competence in early childhood classrooms. *Early Childhood Research Quarterly*, *12*(3), 247–262. http://dx.doi.org/10.1016/S0885-2006(97)90002-8.
Krueger, A. B. (2003). Economic considerations and class size. *The Economic Journal*, *113*(485), F34–F63. http://dx.doi.org/10.1111/1468-0297.00098.
Landry, S. H., Swank, P. R., Smith, K. E., Assel, M. A., & Gunnewig, S. B. (2006). Enhancing early literacy skills for preschool children: Bringing a professional development model to scale. *Journal of Learning Disabilities*, *39*(4), 306–324. http://dx.doi.org/10.1177/00222194060390040501.
Leyva, D., Weiland, C., Barata, M. C., Yoshikawa, H., Snow, C., Treviño, E., & Rolla, A. (2015). Teacher-child interactions in Chile and their associations with pre-kindergarten outcomes. *Child Development*, *86*(3), 781–799. http://dx.doi.org/10.1111/cdev.12342.
Li, K., Pan, Y., Hu, B., Burchinal, M., De Marco, A., Fan, X., & Qin, J. (2016). Early childhood education quality and child outcomes in China: Evidence from Zhejiang province. *Early Childhood Research Quarterly*, *36*, 427–438. http://dx.doi.org/10.1016/j.ecresq.2016.01.009.
Liu, X., (2011).《教育规划纲要》与幼儿园教师队伍发展——基于广州市的现状分析 [The Educational Planning Program and Development of Kindergarten Teachers： Based on the Present Situation of Guangzhou], *Early Childhood Education*, 501/502 (1/2), 16–22. 10.3969/j.issn.1004-4604-B. 2011.01.004.

LoCasale-Crouch, J., Kraft-Sayre, M., Pianta, R. C., Hamre, B. K., Downer, J. T., Leach, A., & Scott-Little, C. (2011). Implementing an early childhood professional development course across 10 sites and 15 sections: Lessons learned. *NHSA Dialog*, *14*(4), 275–292. http://dx.doi.org/10.1080/15240754.2011.617527.

Loyalka, P., Sylvia, S., Liu, C., Chu, J., & Rozelle, S. (2015). Teaching to the tails: teacher performance pay and the distribution of student achievement. *Paper presented at the society for research on educational effectiveness spring 2015 conference*. Abstract retrieved from: https://www.sree.org/conferences/2015s/program/downloads/abstracts/1566.pdf.

Lu, L., & Liu, H.H. (2005). 修订毕保德图画词汇测验 [Peabody Picture Vocabulary Test-revised]. Taipei, Taiwan : Psychological Publishing.

Mashburn, A. J., Pianta, R. C., Hamre, B. K., Downer, J. T., Barbarin, O., Bryant, D., & Howes, C. (2008). Measures of classroom quality in prekindergarten and children's development of academic, language, and social skills. *Child Development*, *79*(3), 732–749. http://dx.doi.org/10.1111/j.1467-8624.2008.01154.x.

Ministry of Education (MOE) of People's Republic of China. (2014, June 4). *学前教育财政 投入五年间曾 5 倍——教育部有关负责人就学前教育财政投入答记者问* [Governmental financial investment in early childhood education has increased fivefold in five years: Education department official's answers to reporters' questions]. Retrieved from: http://www.moe.edu.cn/publicfiles/business/htmlfiles/moe/s271/201406/169763.html.

Muthén, L. K., & Muthén, B. O. (1998-2012). *Mplus user's guide* (7th ed.). Los Angeles, CA: Muthén & Muthén.

NICHD Early Child Care Research Network (2002). Early child care and children's development prior to school entry: Results from the NICHD study of early child care. *American Educational Research Journal*, *39*(1), 133–164.

Nayfeld, I., Fuccillo, J., & Greenfield, D. B. (2013). Executive functions in early learning: Extending the relationship between executive functions and school readiness to science. *Learning and Individual Differences*, *26*, 81–88. http://dx.doi.org/10.1016/j.lindif.2013.04.011.

Neuman, S. B., & Carta, J. J. (2011). Advancing the measurement of quality for early childhood programs that support early language and literacy development. In M. Zaslow, L. Martinez-Beck, K. Tout, & T. Halle (Eds.), *Quality measurement in early childhood settings* (pp. 51–76). Baltimore, MD: Brookes.

Pakarinen, E., Lerkkanen, M. K., Poikkeus, A. M., Kiuru, N., Siekkinen, M., Rasku-Puttonen, H., & Nurmi, J. E. (2010). A validation of the classroom assessment scoring system in Finnish kindergartens. *Early Education and Development*, *21*(1), 95–124. http://dx.doi.org/10.1080/10409280902858764.

Penno, J. F., Wilkinson, I. A. G., & Moore, D. W. (2002). Vocabulary acquisition from teacher explanation and repeated listening to stories: Do they overcome the Matthew effect? *Journal of Educational Psychology*, *94*(1), 23–33. http://dx.doi.org/10.1037/0022-0663.94.1.23.

Phillips, D., Mekos, D., Scarr, S., McCartney, K., & Abbott-Shim, M. (2000). Within and beyond the classroom door: Assessing quality in child care centers. *Early Childhood Research Quarterly*, *15*(4), 475–496. http://dx.doi.org/10.1016/S0885-2006(01)00077-1.

Pianta, R., Howes, C., Burchinal, M., Bryant, D., Clifford, R., Early, D., & Barbarin, O. (2005). Features of Pre-kindergarten programs, classrooms, and teachers: do they predict observed classroom quality and child-teacher interactions? *Applied Developmental Science*, *9*(3), 144–159. http://dx.doi.org/10.1207/s1532480xads0903_2.

Pianta, R. C. (2009). School psychology and developmental psychology: Moving from programs to processes. In T. B. Gutkin, & C. R. Reynolds (Eds.), *The handbook of school psychology* (pp. 107–123). (4th ed.). New York, NY: Wiley.

Pianta, R. C., LaParo, K. M., & Hamre, B. K. (2008). *Classroom assessment scoring system*. Baltimore, MD: Paul H. Brookes.

Pianta, R. C., Mashburn, A. J., Downer, J. T., Hamre, B. K., & Justice, L. (2008). Effects of web-mediated professional development resources on teacher-child interactions in pre-kindergarten classrooms. *Early Childhood Research Quarterly*, *23*(4), 431–451. http://dx.doi.org/10.1016/j.ecresq.2008.02.001.

Preacher, K. J., Zyphur, M. J., & Zhang, Z. (2010). A general multilevel SEM framework for assessing multilevel mediation. *Psychological Methods*, *15*(3), 209–233. http://dx.doi.org/10.1037/a0020141.

Reutzel, D. R., & Morrow, L. M. (2007). Promoting and assessing effective literacy learning classroom environments. In R. McCormick, & J. Paratore (Eds.), *Classroom literacy assessment: Making sense of what students know and do* (pp. 33–49). New York, NY: Guilford.

Reynolds, A. J., Temple, J. A., Ou, S. R., Arteaga, I. A., & White, B. A. (2011). School-based early childhood education and age-28 well-being: Effects by timing, dosage, and subgroups. *Science*, *333*(6040), 360–364. http://dx.doi.org/10.1126/science.1203618.

Rice, J. K., & Schwartz, A. E. (2008). Toward an understanding of productivity in education. In H. F. Ladd, & E. B. Fiske (Eds.), *Handbook of research in education finance and policy* (pp. 131–145). New York, NY: Routledge.

Rimm-Kaufman, S. E., Curby, T. W., Grimm, K. J., Nathanson, L., & Brock, L. L. (2009). The contribution of children's self-regulation and classroom quality to children's adaptive behaviors in the kindergarten classroom. *Developmental Psychology*, *45*(4), 958–972. http://dx.doi.org/10.1037/a0015861.

Scarr, S., Eisenberg, M., & Deater-Deckard, K. (1994). Measurement of quality in child care centers. *Early Childhood Research Quarterly*, *9*(2), 131–151. http://dx.doi.org/10.1016/0885-2006(94)90002-7.

Schulting, A. B., Malone, P. S., & Dodge, K. A. (2005). The effect of school-based kindergarten transition policies and practices on child academic outcomes. *Developmental Psychology*, *41*(6), 860–871. http://dx.doi.org/10.1037/0012-1649.41.6.860.

Shanks, T. R. W., & Robinson, C. (2013). Assets, economic opportunity and toxic stress: A framework for understanding child and educational outcomes. *Economics of Education Review*, *33*, 154–170. http://dx.doi.org/10.1016/j.econedurev.2012.11.002.

Sharma, S., & Nagar, S. (2009). Influence of home environment on psychomotor development of infants in Kangra district of Himachal Pradesh. *Journal of Social Sciences*, *21*(3), 225–229.

Slot, P. L., Leseman, P. P., Verhagen, J., & Mulder, H. (2015). Associations between structural quality aspects and process quality in Dutch early childhood education and care settings. *Early Childhood Research Quarterly*, *33*, 64–76. http://dx.doi.org/10.1016/j.ecresq.2015.06.001.

Sobel, M. E. (1982). Asymptotic confidence intervals for indirect effects in structural equation models. In S. Leinhart (Ed.), *Sociological methodology* (pp. 290–312). San Francisco, CA: Jossey-Bass.

State Council, (2006). 国家中长期科学和技术发展规划纲要 [National plan for medium and long-term scientific and technological development (2006–2020)]. Beijing : China Legal Publishing House.

Tout, K., Zaslow, M., & Berry, D. (2006). Quality and qualifications: Links between professional development and quality in early care and education settings. In M. Zaslow, & I. Martinez-Beck (Eds.), *Critical issues in early childhood professional development* (pp. 77–110). Baltimore, MD: Brookes.

von Suchodoletz, A., Fäsche, A., Gunzenhauser, C., & Hamre, B. K. (2014). A typical morning in preschool: Observations of teacher-child interactions in German preschools. *Early Childhood Research Quarterly*, *29*(4), 509–519. http://dx.doi.org/10.1016/j.ecresq.2014.05.010.

Wang, M., Hong, X., & Pang, L. (2015). 聚焦我国民办幼儿园教师队伍的发展:问题、影 响因素及政策建议 [Focus on the Development of Non-government Kindergarten Teachers in China: Issues, Influence Factors and Policy Suggestions]. *Teacher Education Research*, 27 (3), 36–42.

Wells, N. M., & Evans, G. W. (2003). Nearby nature: A better life stress among rural children. *Environment and Behavior*, *35*(3), 311–330. http://dx.doi.org/10.1177/0013916503035003001.

Wen, Z., & Fan, X. (2015). Monotonicity of effect sizes: Questioning kappa-squared as mediation effect size measure. *Psychological Methods*, *20*(2), 193–203.

Winsler, A., Tran, H., Hartman, S., Madigan, A. L., Manfra, L., & Bleiker, C. (2008). School readiness gains made by ethnically-diverse children in poverty attending center-based childcare and public school pre-kindergarten programs. *Early Childhood Research Quarterly*, *23*, 314–329. http://dx.doi.org/10.1016/j.ecresq.2008.02.003.

Wong, H. L., Luo, R., Zhang, L., & Rozelle, S. (2013). The impact of vouchers on preschool attendance and elementary school readiness: A randomized controlled trial in rural China. *Economics of Education Review*, *35*, 53–65. http://dx.doi.org/10.1016/j.econedurev.2013.03.004.

Xie, R. (2014). 学童数学成就测验 [Test of Children Mathematics Achievement, 3–9 years]. Taipei, Taiwan : Psychological Publishing.

Yoshikawa, H., Weiland, C., Brooks-Gunn, J., Burchinal, M., Espinosa, L., Gormley, W., ... Zaslow, M. J. (2013). *Investing in our future: the evidence base for preschool education*. Society for Research in Child Development and the Foundation for Child Development.

Yoshikawa, H., Leyva, D., Snow, C. E., Treviño, E., Barata, M. C., Weiland, C., ... Arbour, M. C. (2015). Experimental impacts of a teacher professional development program in Chile on preschool classroom quality and child outcomes. *Developmental Psychology*, *51*(3), 309–322. http://dx.doi.org/10.1037/a0038785.

Zhao, L., & Hu, X. (2008). The development of early childhood education in rural areas in China. *Early Years: An International Research Journal*, *28*(2), 197–209. http://dx.doi.org/10.1080/09575140802079756.

Zhou, Y., Li, H., Hu, B. Y., & Li, L. (2017). On the road to universal early childhood education: A financial perspective of the post-2010 developments in a western province of China. *International Journal of Educational Development*, *53*, 137–144. http://dx.doi.org/10.1016/j.ijedudev.2017.01.004.