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Examining variation in the quality of instructional interaction across teacher-directed activities in head start classrooms

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Abstract

High-quality instructional interaction, in which teachers engage children in conversations that support the development of higher order thinking skills, conceptual understanding, and advanced language skills, is associated with positive outcomes for preschool children. Classrooms serving low-income preschoolers tend to have lower levels of this kind of instruction and yet research suggests that it may be particularly important for these children. The aim of this study was to examine variation in the quality of instructional interactions in Head Start classrooms across different types of teacher-directed activities. Twenty-four Head Start classrooms were observed across four activity types (circle time, math activities, science activities, and storybook reading), and quality of instructional interaction was assessed using the Instructional Support domain of the Classroom Assessment Scoring System. Science activities and storybook reading were associated with higher quality instructional interaction compared with circle time, controlling for teacher characteristics and classroom contextual factors. Math activities were not associated with higher quality instructional interaction compared with circle time. Science and storybook reading may be natural entry points for supporting higher quality instructional interaction in Head Start classrooms.

Keywords

early childhood education, early learning, early years practitioners, science, talk and interaction

Introduction

A key feature that distinguishes high-quality early education from average early education is an emphasis on the quality of *instructional interaction* between teachers and children—interactions

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that support the development of higher order thinking skills, conceptual understanding, and advanced language skills (Pianta et al., 2106). More specifically, high-quality instructional interactions include asking children "why" and "how" questions that encourage analytic thinking, engaging children in back-and-forth exchanges to deepen understanding and metacognition, and maintaining frequent conversation using challenging vocabulary. Research supports this definition of quality, showing that children in preschool classrooms characterized by a greater emphasis on higher order thinking skills show greater gains in achievement (Curby et al., 2009). Although instruction focused on rote skills related to letters and numbers have their place in supporting school readiness, children's higher order thinking skills are a stronger predictor of later academic achievement compared with their mastery of these basic skills (Snow and Oh, 2010).

Several lines of research have provided evidence that high-quality instructional interaction is especially important for low-income children, such as those served by Head Start. This evidence comes from experimental research on classroom-based interventions (e.g. Feagans and Fendt, 1991; Wasik and Hindman, 2011), book-reading interventions (Collins, 2016; Hammer and Sawyer, 2016; Huebner and Meltzoff, 2005; Valdez-Menchaca and Whitehurst, 1992), and also observational research conducted in Head Start as well as public preschool programs and elementary schools, including ethnically and linguistically diverse samples (Anderson and Phillips, 2017; Cash et al., 2019; Dickinson and Smith, 1994; Downer et al., 2012; Hamre and Pianta, 2005; Stipek et al., 1998). These studies examined various cognitive, language, and motivational outcomes, providing robust evidence that an overemphasis on lower level instruction is detrimental for low-income children and an emphasis on higher order thinking skills is especially beneficial. For example, Hamre and Pianta (2005) examined associations between children's socioeconomic status (SES), the quality of instructional interaction they had experienced during the first grade, and their academic achievement at the end of the year. Not surprisingly, lower SES children who had experienced low-quality instructional interaction had significantly lower achievement scores at the end of the year compared with their higher SES peers, after controlling for previous achievement. Lower SES children who had experienced moderate- to high-quality instructional interaction, however, had achievement scores that were commensurate with their higher SES peers. This suggests that improving the quality of instructional interaction in classroom serving low-income children has the potential to close income-related achievement gaps. Given the importance of high-quality instructional interactions for low-income children and the reality that they are less likely to experience them, it is essential for programs like Head Start to find strategic ways to support these interactions.

Importance of considering context

An important step in being able to support high-quality instructional interactions is first understanding when they might be more likely to happen naturally, without intervention. Teacher-directed activities may be a classroom context that provides rich information about the potential for high-quality instructional interaction in preschool classrooms. Research indicates that preschoolers spend about 37 percent of the school day in teacher-directed activities, including activities focused on math, literacy, or science, as well as activities that are not related to any specific content (Early et al., 2010); the remainder of the day may be spent in child-directed play or "free choice," mealtimes, routines, and transitions between activities. These different contexts afford different opportunities for instruction, interaction, and engagement with tasks (Dickinson et al., 2008). Teacher-directed activities are times when teachers may be more intentional about instruction and more likely to use strategies targeted at promoting the development of children's language and cognitive skills. For example, research suggests that preschool teachers are more likely to use rich and challenging language with children during book reading as compared to mealtimes and free play (Gest et al., 2006). Preschool teachers are also more likely to show high-quality instructional interactions during large-group settings compared with free choice, meals, and routine settings (Cabell et al., 2013; Coelho et al., 2019). In these activities of more focused teacher–child interaction, high-quality instructional interaction may be more likely to occur.

Potential variation in quality of instructional interaction based on content

The context of teacher-directed activities may be further subdivided into "subcontexts" based on the content of instruction; these subcontexts may be an important source of variation in quality of instructional interaction. Storybook reading is a teacher-directed activity that has been well-studied for its potential in providing language-based cognitive stimulation in early childhood (Gest et al., 2006). Children may be more likely to experience higher quality instructional interaction during storybook reading because of the common practice of *interactive shared book reading*. This describes a varied set of pedagogical strategies that have been widely recognized for engaging young children in a text (Lonigan and Shanahan, 2009; What Works Clearinghouse (WWC), 2015). Interactive shared book reading includes strategies such as asking children to make predictions about a book before reading it, discussing the story to support comprehension and make connections to children's lives, and explaining the meaning of vocabulary words; these and other techniques can engage children in higher order thinking in the context of a story. In a study of preschool classrooms serving low-income children, researchers examined the types of questions teachers asked across different activities; teachers asked a greater proportion of cognitively challenging, open-ended questions during storybook reading compared with other observed teacher-directed activities (considered in aggregate; Massey et al., 2008). This suggests that storybook reading may tend to have higher quality instructional interaction relative to other learning activities.

Science learning is another subcontext that may facilitate higher quality instructional interaction (Baldwin et al., 2009; French, 2004; Gelman and Brenneman, 2004). Scientific inquiry has been defined as the pursuit of understanding of the natural world based on evidence (National Science Teaching Association (NSTA), 2004). To guide children effectively in this pursuit, it is necessary to ask questions that engage children's higher order thinking skills (Harlen, 1999; Monk and Osborne, 2000). Early education is no exception. According to a position statement from the NSTA (2014), young children, with the support of adults, are capable of engaging in science practices and developing conceptual understanding as they explore the world around them. With this growing understanding of children's early capacity to engage in science, current preschool curricula, state standards for preschool and kindergarten science, and the national preschool science standard reflect an emphasis not only on specific science content, such as facts about plants and weather, but also on the practices of science inquiry (Amsel, 2010; Greenfield et al., 2009). These practices include observing objects and phenomena, making comparisons, formulating predictions, carrying out simple experiments, and drawing conclusions based on results. Focusing on these practices, preschool teachers can engage children in exercising higher order thinking skills through collaborative discussions with open-ended questions (Peterson and French, 2008). One exploratory study suggests that science activities are likely to have higher quality instructional interaction compared with other activities. Cabell et al. (2013) observed preschool classrooms serving low-income children during one morning, for a minimum of three cycles of 15 minutes each, coding both the quality of instructional interaction and the primary content of instruction during each cycle. In this purely observational design, teachers rarely led science activities; they accounted for only 6 percent of observed cycles. Cycles characterized by science activities, however, had significantly higher quality instructional interaction compared with those focused on shared reading, literacy, math, social studies, and music or art activities. Because teachers were free to conduct any activities during these observations and many did not conduct science activities, it is possible that the teachers who were observed doing science were not representative, and were perhaps more confident or skilled in teaching science. To investigate further how science might afford opportunities for higher quality instructional interaction, it is necessary to systematically observe the same teachers leading science as well as other activities.

Some research suggests that high-quality instructional interactions in the context of math instruction may be relatively infrequent. Teachers can guide conversations with young children, both in formal and informal instruction, to further their skills and understanding of concepts relevant to mathematics achievement (Whitin and Whitin, 2003). These interactions may be related to a range of lower or higher mental processes (Rudd et al., 2008). For example, interactions related to lower level skills may include prompting children to count objects, label numbers, or use spatial words to describe object locations. Interactions related to higher level skills, on the other hand, may include demonstrations of counting-based strategies for addition, asking children to recognize and repeat simple patterns, or providing opportunities to sort objects into groups and represent the different quantities using graphs. Research on math instruction in preschool classrooms, however, indicates that teachers regularly engage children in interactions related to lower level mathematical skills, but they rarely use conversation related to higher level mathematical skills (Rudd et al., 2008).

Finally, circle time, or "morning meeting," is a whole-group activity that often begins the preschool day. Although this subcontext does not represent one specific content area of instruction, it is a teacher-directed activity that is a staple of early childhood curricula (Bustamante et al., 2018); most preschool classrooms across the nation include some kind of circle time in their daily schedule (Zaghlawan and Ostrosky, 2011). During circle time, teachers may orient children to upcoming activities, and lead children in routines such as singing, greeting each other, taking attendance, talking about the calendar or weather, and rehearsing academic skills (Vargo et al., 2014). A recent study focused on circle time indicated that teacher talk predominates during this time of day, with few open-ended questions or back-and-forth exchanges, and overall low-quality instructional interaction; this may be because many typical circle time activities involve rote memorization and recitation (Bustamante et al., 2018). Despite the ubiquitousness of this subcontext in preschool classrooms, we know very little about instructional interaction during this time relative to other times of day (Bustamante et al., 2018).

Current study

To foster conditions that support high-quality instructional interactions in classrooms serving low-income children, systematic research is needed on the contexts in which these interactions naturally occur. By understanding when teachers tend to show higher quality instructional interactions, intervention efforts can be targeted to build on areas of strength. Specifically, this study focuses on teacher-directed activities that typically occur in Head Start classrooms, when teachers are likely to be intentional about stimulating children's language and cognitive development: circle time, math activities, science activities, and storybook reading. This study seeks to address the research question: *Does the quality of instructional interaction in Head Start classrooms vary based on the type of teacher-directed activity?* Specifically, we hypothesized that science and storybook reading activities would have higher quality instructional interaction compared with math and circle time activities. To examine differences across activity types, quality of instructional interaction was observed during these four types of teacher-directed activities. Because teacher characteristics and classroom contextual factors are also likely to influence the quality of instructional interactions, we also sought to statistically control for these other influences.

Materials and methods

Participants

Twenty-four preschool teachers from Head Start classrooms were asked to participate in this research study and all consented. Classrooms were distributed across five Head Start Centers within one urban area in the southeastern United States, with 2–10 classrooms per center (mean of 4.8 classrooms per center). These centers were convenience sampled; all were participating in a larger study aimed at developing a preschool science curriculum called Early Childhood Hands-On Science (Brown and Greenfield, 2006). Seventeen of the teachers participating in the current study were also receiving training in the newly developed curriculum. All classrooms were full-day programs. Among the 24 classrooms, 23 lead teachers and 19 teacher assistants participated in video observations. Teachers responded to a brief survey about their demographics, teaching experience, education, and teaching practices. All participating lead teachers were female, 18 were Hispanic or Latino, 4 were African American, and 1 was Asian. They had an average of 12.6 years of teaching experience ($SD=9.17$). Four had master's degrees, 12 had bachelor's degrees, and 7 had associate degrees. Among participating teacher assistants, 18 of the 19 were female, 10 were African American, and 9 were Hispanic or Latino. They had an average of 10.8 years of teaching experience ($SD=9.08$). Two had bachelor's degrees, 14 had associate degrees, 2 had a high school degree as the highest level of education, and 1 did not report education information. All teachers reported that they regularly conducted circle time, math activities, science activities, and storybook reading in their classrooms.

Although child demographic data were not collected from all children in participating classrooms, data were collected from a total of 214 children (mean of 8.9 children per classroom) who were randomly sampled as part of the larger study. All classrooms were mixed-age classrooms, meaning they included both 3- and 4-year-olds. Based on data from sampled children, ages ranged across classrooms from 36 to 59 months at the start of the school year ($M=47.9$, $SD=6.3$); individual classrooms included children with average ages ranging from 42.0 to 52.4 months. Across classrooms, 50.5 percent of children were female, 59.2 percent were African American, 34.0 percent were Hispanic or Latino, and 6.8 percent were Asian, White, or Other.

Procedures

Classrooms were videotaped in the spring during four teacher-directed activities: circle time, a math activity, a science activity, and a storybook reading. Teachers in each classroom were asked to schedule two mornings between March and April for observations: one day when circle time and a science activity would be videotaped and another day when a math activity and a storybook reading would be videotaped. The order of these observation days was counter-balanced so that half of the classrooms were observed first in circle time and a science activity and second in a math activity and a storybook reading, and half were observed first in a math activity and a storybook reading and second in circle time and a science activity. No effort was made to counter-balance the order of activities within the morning, to allow teachers to implement activities as naturalistically as possible, at a time in the morning when they would normally implement each type of activity. All observations began before noon. Teachers were also free to include as few or as many children in each activity as they normally would; the number participating in each activity was recorded although individual children were not identified.

Teachers were asked to conduct circle time, any science activity, and any math activity as they normally would. For the storybook reading, all teachers were given a book (*Edward the Emu;*

Knowles, 1998) and asked to read it as they would normally read a story; this was constrained because of a separate research question being addressed as part of the larger study. Teachers were given the book in advance to allow time for preparation, but were asked not to read it to the class until the scheduled observation. Videotaping included as much of the group as possible in order to document exchanges between the teacher and children, but focused primarily on the teacher. At the end of the school year, each teacher was provided with a DVD of observations in her classroom for personal review. Classroom videos were edited so that observations began when the teacher indicated that the activity had begun and ended when the teacher indicated that the activity had ended.

Measures

Quality of instructional interaction. This construct was measured using the *instructional support* domain of the Classroom Assessment Scoring System (CLASS; Pianta et al., 2008). The CLASS is an observational measure of classroom process quality validated for use in preschool settings. This measure was designed to capture the quality of teacher–child interactions associated with positive child outcomes. The CLASS includes 10 dimensions that are scored on a scale of 1 (low quality) to 7 (high quality), including three dimensions representing Instructional Support. An instructional support composite score is calculated by averaging the following dimensions: *concept development*, the extent to which teachers promote higher order thinking skills through discussion and activities; *quality of feedback*, the extent to which teachers extend students' learning by responding to what children say and do; and *language modeling*, the extent to which teachers facilitate students' development of more complex language abilities. Following the CLASS protocol, classrooms are to be observed for cycles of 20 minutes, with each cycle potentially including multiple activities and content areas (Pianta et al., 2008). For the purposes of the current study, however, observations included only the specified teacher-directed activity.

Two research assistants participated in a CLASS Pre-K Observation training and became certified CLASS coders by successfully completing the CLASS Reliability Test (independently coded five classroom videos with 80% of codes within one point of the master codes, and at least two of five codes within one point of the master codes for each dimension; Teachstone Inc., 2010). Coders then watched and coded video observations from the current study, blind to the study hypotheses. The order of activity types was counter-balanced. Twenty observations (21% of all observations), including equal numbers of each activity type, were double-coded to evaluate inter-rater reliability. Using CLASS criteria for reliability (80% of codes within one point; Pianta et al., 2008), inter-rater reliability was good at 87 percent across all observations, 90 percent for circle time observations, 94 percent for math observations, 82 percent for science observations, and 82 percent for storybook observations. Coders then met to review any discrepant codes and reach consensus on a final code for each dimension. Instructional support scores were calculated by averaging scores of concept development, quality of feedback, and language modeling. This yielded four scores of instructional support for each classroom, one for each activity type observed.

Data analytic plan

In order to compare the quality of instructional interaction across the four activity types, associations between activity type and quality were tested using hierarchical linear modeling (HLM), with observations (level 1) nested in teachers (level 2). This approach was employed to account for the shared variance in observations within teachers while also controlling for observation-specific variables at level 1, teacher variables at level 2, and cross-level interactions. Observation-level covariates included the length of activities (in minutes), number of children participating, and time of day varied (in minutes after the time of the earliest observation). To test the hypotheses, activity type was modeled at level 1 using three dummy variables, representing math, science, and storybook reading, with circle time as the reference group. Teacher-level covariates included participation in the science curriculum, years of teaching experience, and level of education. Participation in the science curriculum was represented by a dichotomous variable (*participant*=1, *non-participant*=0). Years of teaching experience was represented by the number of years reported by the primary teacher in observations, or the teacher who did the majority of the instruction. Teacher education level was modeled using one dummy code to represent lower education level (associate), and one dummy code to represent higher education level (master's), with mid education level (bachelor's) as the reference group. Finally, because participation in the science curriculum may have affected the quality of science instruction, cross-level interaction terms were also included, between the math, science, and storybook reading variables (level 1) and curriculum condition (level 2). Length of activities and time of day (both in minutes) were grand-centered for ease of interpretation, as well as teacher years of experience; all other variables were uncentered.

Results

Descriptive analyses

Each activity type was conducted in various ways across observations. Math observations included activities such as counting (e.g. blocks in a tower, unit cubes, objects needed to make a cup overflow), playing "number bingo," and sorting objects by color. (See Table 1 for a complete list of all the ways each activity type was conducted.) Science observations included activities such as estimating the number of cups of water it would take to fill a bottle, testing which objects would sink and float in water, and racing toy cars down different heights of ramps. For storybook observations, many began by reviewing print concepts (e.g. author, illustrator, cover, title). All but one included some kind of discussion around the book; discussion occurred before reading the book (e.g. looking at pictures and predicting what it would be about), during the reading (e.g. defining words, asking comprehension questions), and/or after the reading (e.g. reviewing what had happened, asking what children liked). One observation was conducted as a "picture walk" in which the teacher elicited the students' ideas about what the book might be about without actually reading it, and two included a follow-up activity related to the story (acting out the story, and drawing pictures of the characters). Finally, circle time observations included various types of content and activities. All circle time observations included some kind of music and movement activity such as singing songs with or without a recording, acting out specific movements or making sounds as prescribed by a song, using sticks to beat in rhythm, and general dancing; these activities occupied the majority of the time for 80 percent of observations. Circle time observations also included activities such as using a calendar or talking about the day and month, greetings and social conversations (e.g. asking how children were feeling that day, sharing about what they did over the weekend), and taking attendance.

For each of the observations, teachers were asked to conduct activities that lasted approximately 15–20 minutes. To collect observations that were as naturalistic as possible, however, the actual length of observations was determined based on teachers' indications that activities had begun and ended. The average length across all observations was within the requested range (M=15.4 minutes, SD=6.05). Length of activities varied significantly across activity types, $F(3, 69)=2.86$, $p=.043$, $\eta_p^2=.110$, with science activities lasting longer, on average, than storybook reading (See Table 2). Teachers were free to include as few or as many children in each activity as they desired and to conduct activities at the time of their choosing. The number of children who

Table 1. Specific ways each activity type was conducted, with counts.

Activity type	Specific enactment (number of observations)
Circle time	Music and movement (24) Calendaring (9) Social conversation (7) Taking attendance (6) Literacy activity (5) Book reading (4) Talking about weather (4) Reviewing previous lessons (2) Introducing a new theme (2) Assigning classroom jobs (1)
Math	Counting objects (5) Counting backwards using objects (3) Matching numerals to quantities (3) Measuring objects with blocks (3) Sorting objects by color and counting (3) Number bingo (2) Patterning (2) Cutting circles into halves and quarters (1) Making a bar graph (1) Sequencing numerals (1)
Science	Testing how much water will fill a container (6) Drawing clouds (2) Changing color of water/eggs with food coloring (2) Measuring towers or plants (2) Racing cars down ramps (2) Testing how different materials absorb water (2) Testing which objects sink or float (2) Baking soda and vinegar volcano (1) Charting weather preferences (1) Discussing the five senses (1) Making a model of an ocean in a bottle (1) Making and drawing shadows (1) Testing strength of different magnets (1)
Storybook	Reviewing print concepts (17) Discussion before reading (12) Discussion during reading (20) Discussion after reading (22) Picture walk (1) Follow-up activity (2)

participated in each activity varied significantly across activity types, Greenhouse-Geisser-adjusted $F(2.02, 46.4)=41.3$, $p<.001$, $\eta_p^2=.642$; circle time including more children, on average, than all other activities, and storybook reading including more children than math and science activities (See Table 2). Activity start times ranged from 8:50 to 11:40 a.m. For analysis, start time was transformed to the number of minutes after 8:50 a.m. (the time of the earliest observation). The exact start time was missing for one circle time observation; to avoid list-wise deletion of this observation, the mean start time for circle time was imputed (19.0 minutes). Start time showed

Table 2. Descriptive statistics for all observations and for individual activity types.

	All observations	Circle	Math	Science	Storybook
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
Activity length (minutes)	15.4 (6.05)	15.6 (5.79)	13.8 (6.66)	17.9 (5.52)	14.2 (5.65)
Number of participating children	9.99 (4.27)	15.3 (3.25)	7.71 (1.97)	7.04 (2.07)	9.96 (3.62)
Start time of activity (min. after 8:50 a.m.)	33.8 (29.8)	19.0 (32.7)	39.8 (21.9)	38.6 (26.8)	35.8 (34.6)
Instructional support	1.90 (0.88)	1.42 (0.58)	1.64 (0.70)	2.56 (0.89)	2.00 (0.88)
Concept development	1.64 (0.77)	1.13 (0.34)	1.42 (0.58)	2.29 (0.86)	1.71 (0.69)
Quality of feedback	1.91 (1.00)	1.38 (0.71)	1.88 (0.95)	2.58 (1.06)	1.79 (0.88)
Language modeling	2.17 (1.20)	1.75 (0.90)	1.63 (0.92)	2.79 (1.25)	2.50 (1.32)

SD: standard deviation.

Table 3. Instructional support in classrooms with and without a science curriculum.

	Overall classroom average		Science	
	M	(*SD*)	*M*	(*SD*)
Science curriculum (n = 17)	1.92	(0.51)	2.59	(0.95)
No science curriculum (n = 7)	1.86	(0.40)	2.50	(0.79)

SD: standard deviation.

marginal differences across activity types, Greenhouse-Geisser-adjusted $F(1.79, 39.4) = 2.95$, $p = .069$, $\eta_p^2 = .118$. Pairwise comparisons, using the Bonferroni adjustment for multiple comparisons, indicated that circle time occurred significantly earlier in the morning than science activities (see Table 2), with an average difference of 19.6 minutes.

Comparison of instructional interactions across activity types

Descriptive statistics of instructional interaction variables, averaged within classrooms across all activity types and for each individual activity type, are reported in Table 2. Descriptive statistics of instructional support scores for classrooms in each curriculum condition, averaged within classrooms across all activity types and for science activities specifically, are presented in Table 3. According to the CLASS manual, a score of 1 or 2 represents the low range of quality, a score of 3, 4, or 5 represents the middle range, and a score of 6 or 7 represents the high range. Across classrooms and activity types, all instructional support dimension scores varied from the low to mid range, with the exception of concept development during circle time observations which only received low-range scores. (For descriptions of low vs mid-level quality in each of the instructional support dimensions, see Supplemental Appendix A.)

First, the full model was tested, including observation-level covariates (level 1), teacher-level covariates (level 2), and cross-level interactions (curriculum condition × activity type). Among observation-level covariates, activity length was significantly associated with quality of instructional interaction, $B(SE) = 0.04(0.10)$, $t(63) = 2.70$, $p = .009$, but number of children and time of day were not. With the interaction terms included between curriculum condition and activity type, the main effects for activity types represented the effects of those activities only for teachers who were not participating in the science curriculum. For these teachers, science was

Table 4. HLM models testing associations between quality of instructional interaction and activity setting, controlling for teacher and classroom contextual factors.

Fixed effects	Full model		Final model	
	B (*SE*)	*p*	*B* (*SE*)	*p*
Intercept	1.78 (0.53)	.003	1.86 (0.47)	<.001
Observation-level covariates				
Activity length	0.04 (0.01)	.009	0.04 (0.01)	.006
Number of children	−0.04 (0.03)	.170	−0.03 (0.03)	.217
Time of day	−0.00 (0.00)	.135	−0.00 (0.00)	.068
Activity types				
Math	0.55 (0.42)	.194	0.14 (0.28)	.614
Science	1.05 (0.42)	.015	0.88 (0.30)	.005
Story	0.55 (0.42)	.196	0.54 (0.24)	.029
Teacher level				
Curriculum	0.09 (0.32)	.782	−0.17 (0.18)	.361
Years teaching	−0.02 (0.01)	.029	−0.02 (0.01)	.026
Lower education	0.10 (0.17)	.550	0.10 (0.17)	.549
Higher education	0.71 (0.31)	.032	0.69 (0.31)	.039
Cross-level interactions				
Curriculum × Math	−0.66 (0.44)	.135		
Curriculum × Science	−0.33 (0.43)	.450		
Curriculum × Story	−0.08 (0.44)	.859		

HLM: hierarchical linear modeling; *SE*: standard error.

significantly associated with quality of instructional interaction relative to circle time, controlling for other factors, $B(SE) = 1.05(0.42)$, $t(63) = 2.49$, $p = .015$, but math and story were not. Among teacher-level covariates, years of teaching experience had a significant negative association with quality of instructional interaction, $B(SE) = -0.02(0.01)$, $t(19) = -2.36$, $p = .029$. Higher level of education was associated with significantly higher quality of instructional interaction relative to mid-level education, $B(SE) = 0.71(0.31)$, $t(19) = 2.31$, $p = .032$, but lower level of education did not have an association relative to mid-level. Participation in the science curriculum was not associated with quality of instructional interaction, $B(SE) = 0.09(0.32)$, $t(19) = 0.28$, $p = .782$; the cross-level interaction effects between curriculum condition and activity types were also not associated and so were removed from the final model. By removing these terms, the effects of activity types then represented the effects for the full sample of teachers. The pattern of results remained the same except that the association between story activities and quality of instructional interaction relative to circle time reached significance, $B(SE) = 0.54(0.24)$, $t(66) = 2.24$, $p = .029$. Complete results of the full and final models are presented in Table 4.

Discussion

The aim of this study was to examine differences in the quality of instructional interaction across teacher-directed activity types within Head Start classrooms. Using the CLASS, we showed significant differences across four activities that typically occur in preschool classrooms. As hypothesized, both science activities and storybook reading were associated with higher quality instructional interaction compared with circle time activities, while math was not. Several features of our study design support our ability to draw conclusions about how activity type relates to instructional quality. First, we controlled for key teacher characteristics and classroom contextual factors. We also observed each activity type within each classroom, ensuring that teachers could not self-select activity types that may have been more comfortable for them (Cabell et al., 2013). Finally, instead of conducting continual, timed observation cycles that might include multiple activities or settings, we limited each observation to one discrete activity in order to capture important differences across activity types that might otherwise be obscured (Pianta and Hamre, 2009).

It should be noted that, although there was significant variation in instructional support across activity types, all average scores, including those for science and storybook reading, were in the low range (<3, according to the CLASS manual, Pianta et al., 2008). As a reference, the Head Start Family and Child Experiences Survey (FACES; Moiduddin et al., 2012), using a large nationally representative sample of Head Start classrooms reported an average instructional support score of 2.3 (SD = 0.1), with 87 percent of classrooms scoring below 3, and a total range of 1.0–4.6. Average scores reported in the current study for science and storybook reading were similar to the FACES average; average scores for math and circle time were in the low end of the FACES range, but still well within the bounds of typical for Head Start. When interpreting these results, it is important to bear in mind that science and storybook reading did not have *high* or even *moderate* levels of instructional quality, but instead had *relatively higher* quality compared with other activities.

In addition to activity type, some other associations with instructional quality are worth noting. First, activity length was positively related to quality of instructional interaction, indicating that longer activities had higher quality. This makes sense given that higher quality instructional interactions often involve lengthy back-and-forth exchanges, potentially with multiple children. Early educators have the difficult task of structuring the day so that activities are long enough to meet instructional goals, but short enough to avoid overtaxing young children's attention spans. One implication of this finding is that instructional quality may be supported by allotting more time for an activity, and specifically allowing more time for discussion and extended conversations.

Some teacher characteristics were also associated with instruction. First, greater number of years of experience was associated with lower quality. Second, higher teacher education (i.e. a master's degree) was associated with higher quality of instructional interaction relative to mid-level teacher education (i.e. a bachelor's degree), but mid-level teacher education did not show any advantage over lower teacher education (i.e. associate degree). In light of past research, this inconsistent pattern is not surprising. Evidence for the link between teacher credentials and classroom quality has been quite mixed (Early et al., 2007), potentially because the quality and content of teacher preparation programs and experiences vary so greatly (Bogard et al., 2008).

Interestingly, although some teachers in the sample were receiving training in a science curriculum and some were not, these two groups of teachers did not vary in quality of instructional interaction across any of the activity types. There are several reasons that teachers receiving training in the science curriculum may not have had higher quality instructional interactions. First, it should be noted that this study was not designed to test effects of the curriculum training, nor was it designed to evaluate differences in the quality of science teaching. The study was not adequately powered to detect even a small intervention effect. Second, this particular curriculum was not explicitly aimed at increasing the quality of instructional interaction, but instead focused on introducing basic science content to preschoolers through guided inquiry. Finally, at the time of the videotaped observations, teachers had only partially completed their curriculum training; any potential effects of the curriculum training on instruction would not have been fully realized at the time of this study.

Our findings suggest that science activities and storybook reading are contexts that afford greater opportunities for higher quality instructional interaction. This may be because, for many teachers, these two areas of learning more strongly evoke a "culture of inquiry"—a culture in which finding the answers to compelling questions is the driving force of learning (Center for Secondary School Redesign (CSSR), 2015). This culture is reflected clearly in the principles of inquiry-based science teaching, an approach that is becoming more widely valued in early education. While preschool teachers are unlikely to have received professional development in inquiry-based science (Brenneman et al., 2009), they may readily associate science with "doing experiments." As teachers conduct an experiment with children, even if it does not adhere to best-practices in early science, they may still support a culture of inquiry, for example, by encouraging children to make predictions about what will happen, to test their hypotheses, and to discuss the results. A culture of inquiry is also reflected in the practices of interactive shared book reading, for example, when teachers encourage children to predict what will happen in a story, or to reflect on how a character might feel. Whether investigating a natural phenomenon or the plot of a story, teachers may be more likely in these contexts to prioritize the meaningful questioning and conversations that are associated with higher quality instructional interaction.

While a culture of inquiry might be more naturally fostered in science and storybook reading, it is by no means exclusive to these contexts; this culture can permeate all areas of learning. For example, Goos (2004) explored how teachers supported a culture of inquiry in the context of math learning, by emphasizing mathematical sense-making and discussion of thought processes. Particularly in early childhood, teachers may be more focused on rote practice of basic math skills so that children can provide correct answers, as opposed to supporting children in thinking about *how* they arrive at those answers (Rudd et al., 2008). But research suggests that children who experience higher quality instructional interaction during early math learning, including discussion about cognitive processes and metacognition, make greater gains in math fluency and calculation compared with children who simply practice these skills (Grammer et al., 2016). It may require a greater paradigm shift, but the same kinds of rich conversations that can happen in a science investigation can happen in math and other content areas, deepening children's learning across domains.

These results have important implications for intervention efforts in early childhood, particularly for classrooms serving low-income children. Given the tremendous potential of high-quality instructional interaction to improve the academic trajectories of low-income children, the preschool classroom represents a crucial context for providing this kind of stimulation. Unfortunately, classrooms serving low-income children tend to have lower instructional quality compared with classrooms serving higher income children (Hamre and Pianta, 2007; Hindman and Wasik, 2013; LoCasale-Crouch et al., 2007), likely because teachers in these classrooms are often the least prepared and least supported (Peske and Haycock, 2006). Science activities and storybook reading may be natural entry points for encouraging higher quality instructional interaction in preschool classrooms. Low-income preschoolers, however, tend to spend less time in both science and language and literacy activities compared with their higher income peers (Early et al., 2010). Spending more time in these activities may be one strategy among many that could contribute to improved child outcomes.

To increase the quality and quantity of science and storybook reading in preschool classrooms, high-quality and targeted professional development is necessary. Professional development in early science has the potential to increase the quality of instructional interaction during science, particularly when it emphasizes an inquiry-based approach using developmentally appropriate content (Gropen et al., 2017; Lee et al., 2012). With additional training, teachers are also more likely to have greater self-efficacy in science, and so teach it more frequently (Gerde et al., 2017; Saçkes, 2014). Likewise, professional development in shared book reading can increase the quality of preschool teachers' conversations with children, including their inferential questions (Rezzonico et al., 2015). In general, evidence-based approaches for improving the quality of instructional interaction often include both training and classroom-based coaching that supports teachers in reflecting on their practice and applying their learning directly to their work with children (Domitrovich et al., 2009; Pianta et al., 2008 Raver et al., 2008).

Limitations and future directions

Several limitations of the current study are worth noting. First, it is not known how representative these observations were of a typical school day in these classrooms. Although all teachers reported conducting the observed activity types regularly, it is not possible to say definitively that these activities occurred consistently in the observed formats within these classrooms. For example, teachers were asked to conduct a "math activity" but some preschool teachers have reported that they tend to do math throughout the day, embedding skills such as counting within other activities (Lee and Ginsburg, 2007). Teachers in the current study were asked to conduct a math activity for 15 to 20 minutes, but they may or may not have regularly conducted these kinds of discrete math activities throughout the year. Furthermore, teachers were asked to read a specific book for the storybook reading; this particular book may have influenced the types of questions teachers asked or the quality of instructional interaction. This book may or may not be representative of the books that the teachers typically read in their classrooms. Depending on how often these activities were conducted and how typical these examples were, observed quality of instructional interaction may or may not accurately represent children's experiences across the school year.

Next, although we statistically controlled for several uncontrolled factors, activity types differed in important ways and we cannot completely disentangle how these factors may have impacted the quality of instructional interaction that occurred during observations. Circle time activities occurred somewhat earlier in the morning, and larger groups of children were included in circle time and storybook reading compared with math and science. It is interesting to note that the two activities with higher quality instructional interaction had both a smaller average group size (science) and a larger average group size (storybook reading). Still, these factors may have either inflated or deflated observed differences across activity types.

Although it was outside of the scope of the current study, it may be fruitful in future studies to examine the specific formats and content of these teacher-directed activities. As described above, the teachers in the current study varied especially in the ways they conducted math, science and circle time activities. These differences may help to explain variation in the quality of instructional interaction. For example, one study examining different formats of preschool science activities found that teachers asked twice as many open-ended questions during experiments as they did while reading science books, or using science practices in non-experimental contexts (i.e. in the absence of an inquiry question; Lee and Kinzie, 2012). A study focused on circle time revealed that "sharing time," when children shared about what they did over the weekend or something about their lives, included more open-ended questions and extended back-and-forth exchanges compared with other components of circle time (Bustamante et al., 2018). More detailed examination of these activity types may shed light on particular approaches that afford more or less opportunity for high-quality instructional interaction.

Conclusion

This study contributes to knowledge of how quality of instructional interaction between teachers and children varies across activities in Head Start classrooms. We observed low levels of quality in instructional interaction overall, but relatively higher quality during the contexts of science and storybook reading. These findings have important implications both for continued research related to quality of instructional interaction and for potential strategies that might improve these interactions. Preschool programs may be able to increase the quality of instructional interactions that children experience by increasing time spent engaging in science and storybook reading, and by applying pedagogical techniques related to inquiry-based science and interactive shared reading to other parts of the school day.

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Supplemental material

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