THE UNIVERSITY OF CHICAGO

Parents' Question Asking Behavior in Low-Socioeconomic Status Families

By

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July 2022

A paper submitted in partial fulfillment of the requirements for the Master of Arts degree in the

Master of Arts Program in the Social Sciences

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Abstract

In this paper, we argued for the significance of research into parent-child interactions and the necessity of observing these dynamics in low-SES families. As an essential aspect of interaction, parental question-asking was categorized into three classifications: pedagogical questions, information-seeking questions, and rhetorical questions, to examine the variances in parental question-asking in a math-related context. The main objective of this study was to probe how parents in low-SES families communicated with their children by using various types of math-related questions in three given tasks simulating daily scenarios. We observed that parents from low-SES backgrounds frequently asked questions in conversation, with the majority of those questions exhibiting a pedagogical focus. The secondary objective was to explore the association between math pedagogical questions and mathematical performance, and children's gender and their math achievement. The W score was utilized to measure the mathematical proficiency of the children. The findings revealed that while there was no correlation between math pedagogical questions and the W score, a marginal effect of gender was found regarding math achievement and a correlation was identified between parental income and children's W score.

Key Words: parent-child interaction, pedagogical question, learning mechanism, low-SES family, math learning

Introduction

Different psychologists have proposed a variety of hypotheses regarding the learning mechanisms of children, and these hypotheses have had a major influence in the field of developmental psychology. The Constructivism theory by Jean Piaget (1969) emphasized the role of children in their learning process, characterizing children as active learners whose learning process did not occur passively. However, learning never took place in isolation from society. The process of children's learning was instead embedded in their immediate sociocultural contexts. According to Bronfenbrenner's (2005) ecological model, the learning process of children was influenced by a complex system of relationships at multiple levels of their environment, ranging from the immediate contexts of home and school to a broad spectrum of contexts that encompassed cultural values and customs. For instance, while children learned addition and subtraction systematically at school, they gained practical experiences with these concepts through interactions with their parents at home.

Similarly, Vygotsky's (1978) sociocultural theory contended that the learning process was influenced by others and mediated by culture and community. Children may develop a greater aptitude in mathematical domains, for instance, when their parents engaged in frequent mathematically relevant discussions with them (Walling, 1976). Walling (1976) conducted a study to determine whether parental involvement in their children's television viewing affected the amount of learning their children (from elementary school) retained from these experiences. The

results indicated that children learned more from television programs if their parents interacted with them while they watched. In addition, Ma et al. (2015) analyzed parental involvement in the early years as one of the many factors that may influence children's learning and development in a meta-analysis comparing 46 studies. This meta-analysis characterized parental involvement as parents' proactive engagement in activities and behaviors that fostered their children's learning and development. Parental involvement was found to have a strong and positive correlation with learning outcomes, as indicated by the findings. The authors concluded that the importance of parental involvement exceeded that of schools and communities. In Sheridan et al.'s (2011) study, the authors further affirmed the relevance of parent-child interaction as these interactions were associated with a number of adaptive traits in preschoolers, including language and literacy development. Accordingly, it could be argued that parental influence is pivotal for the development of children. As evidenced by a number of studies, parents were even more influential than other environmental factors such as school and peers (Sheridan et al., 2011).

Parental interaction, as an important environmental factor, had become an essential focus for psychologists. Kim et al. (2012) emphasized the significance of parental involvement in children's development and learning. The authors described parental involvement as “an essential and fundamental system which serves as a lifelong resource supporting children's learning and development; additionally, healthy parental interaction in a child's daily life lays the foundation for bolstering children's social and academic skills” (Kim et al., 2021). These findings highlighted the significance of parental interaction in the development of children and underscored the need for additional research into this area.

Parent-Child Interaction in Low-SES Families

Few studies have focused on parent-child interaction in low-SES families. The field of psychology is a data-driven science, so if the most prominent journals focus almost exclusively on one cultural context, then their conclusions and data will not be representative. Psychologists could not trust that these models and results could be generalized to a broader population. To be truly representative of human beings, psychological research needs to cover a larger population and increase sample and sample diversity (Thalmayer et al., 2021). Therefore, to better understand parent-child interactions, it is necessary to focus on diverse samples, including low-SES samples. Low-SES families deserve to be studied more closely not only because we lack information about this group compared to higher SES families but also for the purpose of studying education inequality.

Educational equity for underrepresented minority students in the United States has remained elusive (Syed et al., 2011). In a 2013 report by Barnett et al., the authors addressed the issue of education inequality by bringing to light the lack of high-quality early childhood education experiences for African American children. The authors argued that in order to close the achievement gap, the entire educational process, from early childhood to adulthood, needs to be prioritized. In order for educators, researchers, and public policy makers to gain insight into this group and develop culturally sensitive interventions and an education system promoting education equality, it is essential, for example, to examine how low-SES African American parents and children interact during the early stages of childhood. Thus, the primary objective of this paper was to examine parent-child interactions in low-SES households.

Parent-child Interaction and Children's Math Learning

Mathematics had been a crucial element in the growth and education of children (Charlesworth et al., 2003). For instance, mathematical reasoning is cognitively fundamental as early mathematical knowledge predicts later reading and math achievement (Clements &Sarama, 2016). Mathematics may contribute significantly to the cognitive development of children due to the inherent thought process and reasoning involved. Moreover, math exists in all aspects of our lives, both academically and in everyday life, such as the date on the calendar, the time on the clock, the temperature of the day, transportation schedules, the cost of groceries, and other daily events helped children learn mathematics. Hence, the focus of this study is parent-child interactions involving mathematics.

There is evidence that math-related parent-child interactions benefitted children's mathematical development. According to the literature review conducted by Levine and Baillargeon (2016), the existing body of research on parents' number talk indicates that parents' math language usage and the quality of their number talk contribute significantly to children's engagement and later achievement in mathematics.

Additionally, intervention studies demonstrate that math-related conversations at home could improve children's number skills. Using a randomized field experiment with 587 first-grade students, Berkowitz and colleagues (2015) evaluated an educational math App designed to facilitate math conversations between children and their parents. The App offered number story problems to encourage math-related conversations between children and their parents. In comparison with the control group, which received a reading app, these children's math scores improved significantly. It was determined that brief, high-quality interactions between parents and children facilitated learning of mathematics at home. This was particularly true for the children of math-anxious parents Prior research revealed that math-related conversations between parents and children could

be beneficial to children's overall mathematical performance. Consequently, the focus of observation was on math-related interactions.

Parental Question Asking

Researchers have found that asking questions and providing prompts is crucial to parental engagement. According to findings from earlier research, asking questions and providing prompts during conversations is a crucial factor in relation to children's learning (Zambrana et al., 2020; Levine & Baillargeon, 2016; Walling, 1976). For instance, Zambrana and colleagues (2020) examined the form and function of mothers' questions to their children through longitudinal observations. A set of problem-solving puzzle tasks, a shape-sorting task, and a complex shape-sorting task were administered to the children for 3 minutes during each for observations, on their first, second, and third birthdays, respectively. The mothers were informed of the three tasks and advised they could provide as much assistance as they deemed necessary. Researchers sought to understand the function and impact of mothers' questions on children's development by observing the process of their interaction. The researchers discovered that as the child ages, mothers altered their questions and pedagogical intentions to allow the child to assume greater responsibility for the task. The researchers concluded that pedagogical questions were more effective at encouraging exploration and learning than statements.

Likewise, Eason et al. (2021) also emphasized the importance of prompts in parent-child conversations, which offered children opportunities to improve their capabilities of number language. They observed 50 parents and children between the ages of two and four years old engaging in number talk during pretend play and coded the parents' informative number statements and prompts (questions). The findings suggested that by facilitating children's active participation

and language acquisition, the parents' number statements and prompts could enhance the quality of parent-child math-related conversations. In addition, further analysis revealed that prompts were associated with more extended parent-child number conversations than parental statements. Thus, parents' questions may carry a higher educational value for the child's learning than their statements.

Pedagogical Question and children's learning

With the discovery of the role of questions and prompts (asked by parents) in parental engagement in children's learning, the quality and types of questions has become an additional focus of research. According to Olsen-Fulero and Conforti's (1983) paper, types of questioning could be distinguished based on the responses they elicited from children and how they were presented in terms of function. Different types of questioning did not elicit the same degree of response from children. They featured their own unique dynamics and functions. In other words, the meaning of the questions had varying effects on children. This argument was also supported by the findings of Zambrana et al. (2020), which emphasized that it was not only the questions asked that mattered, but also the intent and manner in which they were asked.

Among all the questions with various functions and intentions, pedagogical questions are the ones with a teaching intention. According to Yu et al. (2018), pedagogical questions could be defined as "questions posed by a knowledgeable individual with the purpose of teaching" or "questions posed by the person who knew the answer (or could reasonably be expected to know the answer) to someone who may not know the answer, in order to elicit learning." This question was an integral component of the instructional interaction that encouraged children to engage in learning

by showcasing their knowledge or advancing their reasoning. Yu et al. (2018) found that parents' everyday pedagogical questions may contribute to children's learning.

Pedagogical questions that were embedded in interactional sequences were referred to as having an IRE structure (initiation-response-evaluation). This structure was established when parents asked a pedagogical question and provided an evaluation of the child's response as feedback to (Mehan, 1979). According to Mehan (1979), pedagogical questions and the IRE structure were essential for formal instructional contexts such as the classroom. Thus, pedagogical questions may serve a didactic function in both formal and informal teaching and learning contexts.

Additionally, Yu et al. (2018) conducted a more specific study on pedagogical issues. The CHILDES database was mined for conversations between parents and children in order to examine the frequency and distribution of pedagogical questions that arose at home. They analyzed 2,166 questions from 166 mother-child dyads and 64 father-child dyads (with children ages 2 to 6) into three categories: pedagogical, information-seeking, and rhetorical. According to the results of the study, even before children were able to comprehend or respond to pedagogical questions, these questions would benefit them by captivating their attention and serving as language input without expecting a verbal response. It was discovered that parents frequently utilized pedagogical questions in their daily conversations, and that the frequency of these questions varies according to the child's age, home environment, and historical context. They served as a road map for the next stage of research, which would evaluate children's inferences based on pedagogical questions and learning outcomes.

Asking pedagogical questions is an essential aspect of parental engagement in instructional contexts. However, prior studies on pedagogical questions failed to reach a conclusion about their

impact on children's academic performance. In addition to observing the frequency of math-related question-asking behavior in parent-child interaction in low-SES families, we also examined the relationship of these questions to children's math achievement.

Gender and Children's Achievement

While parental involvement is essential in children's development, there are wide variations in the amount and nature of this involvement. One factor that may be associated with this variation is child gender. Researchers have found that math gender-stereotypes arise early, and can influence the child's math self-concept (Cvenvek et al., 2011). This prejudice stems from the stereotypical perception parents and teachers held concerning gender. It is common for girls to be encouraged to pursue language learning over math, whereas boys are more likely to be pushed to excel in math-related subjects (Cvenvek et al., 2011). Yee and Eccles (1988) found that after middle school, girls estimated their mathematical abilities to be lower and expressed more negative attitudes toward mathematics than boys, and that parents displayed the same gender bias. The perceptions and attributes of mathematics held by parents varied according to their child's mathematical aptitude and gender (Yee &Eccles, 1988). Misconceptions about boys' and girls' mathematics abilities among parents may have an impact on their children's self-evaluation and motivation to learn mathematics, which subsequently may have an impact on their overall performance. Therefore, we also analyzed whether gender influenced parent-child interaction and mathematical achievement.

Present Study

Parental involvement in children's math development and learning is the focus of this study. This involvement was measured through conversations of parents and children from low-SES households. We identified that parent-child interaction is an important factor influencing children's

development and learning and focused on low-SES families because of the relevance of these interactions for education equality. As previous literature pointed out that questions varied in terms of types and functions, we determined to look at pedagogical question because it has been frequently used by parents in daily conversations and has a teaching function. In addition, we chose to focus specifically on parents' question-asking behavior based on prior research findings showing that questions are an effective means of engaging children in conversations, including math conversations (Eason et al., 2021).

Combining these findings, the purpose of this study was twofold. Characterizing math-related parent-child interactions in low-SES families in three tasks simulating daily scenarios was the primary objective. Specifically, this objective aimed to examine whether the gender of the child played a role in how parents of children from low-SES families guided their children through three math-related tasks. The secondary objective was to explore whether various math-related questions, particularly pedagogical questions related to children's mathematical achievement, as well as to determine whether children's gender influenced these outcomes.

Methods

Participants

The participants were recruited from a larger project that examined the efficacy of a math App in enhancing low-SES children's mathematical development and learning attitudes. All children were elementary school student at a Chicago elementary school. Participants consisted of 33 dyads of caregivers and children. There were 15 boys and 18 girls among these 33 children, and their average age was 6.33 years (*SD*=0.47). A parental survey was used to evaluate the family's demographic information; of the thirty-three parents, four (12%) were fathers, twenty-eight (85%)

were mothers, and one (3%) was the child's aunt. Over 91% of the participants were African Americans.

Procedure

The researchers described themselves as a bedtime learning study group, and the participants were invited to participate in a study on Zoom with their children and were promised a $50 Amazon gift card. The researchers recorded the parent-child interaction on Zoom. The process took 15 to 20 minutes, with one-time observations of the three tasks. The experimenter timed each task to last five minutes. Parents were told that the experimenter would return when they moved on to the next task, and they could also end the task early if they wished.

The three tasks were given in a fixed order: a weather report, a train scene, and a produce stand. Parents were required to interact with their children as they usually would without other specific instructions.

Three Tasks

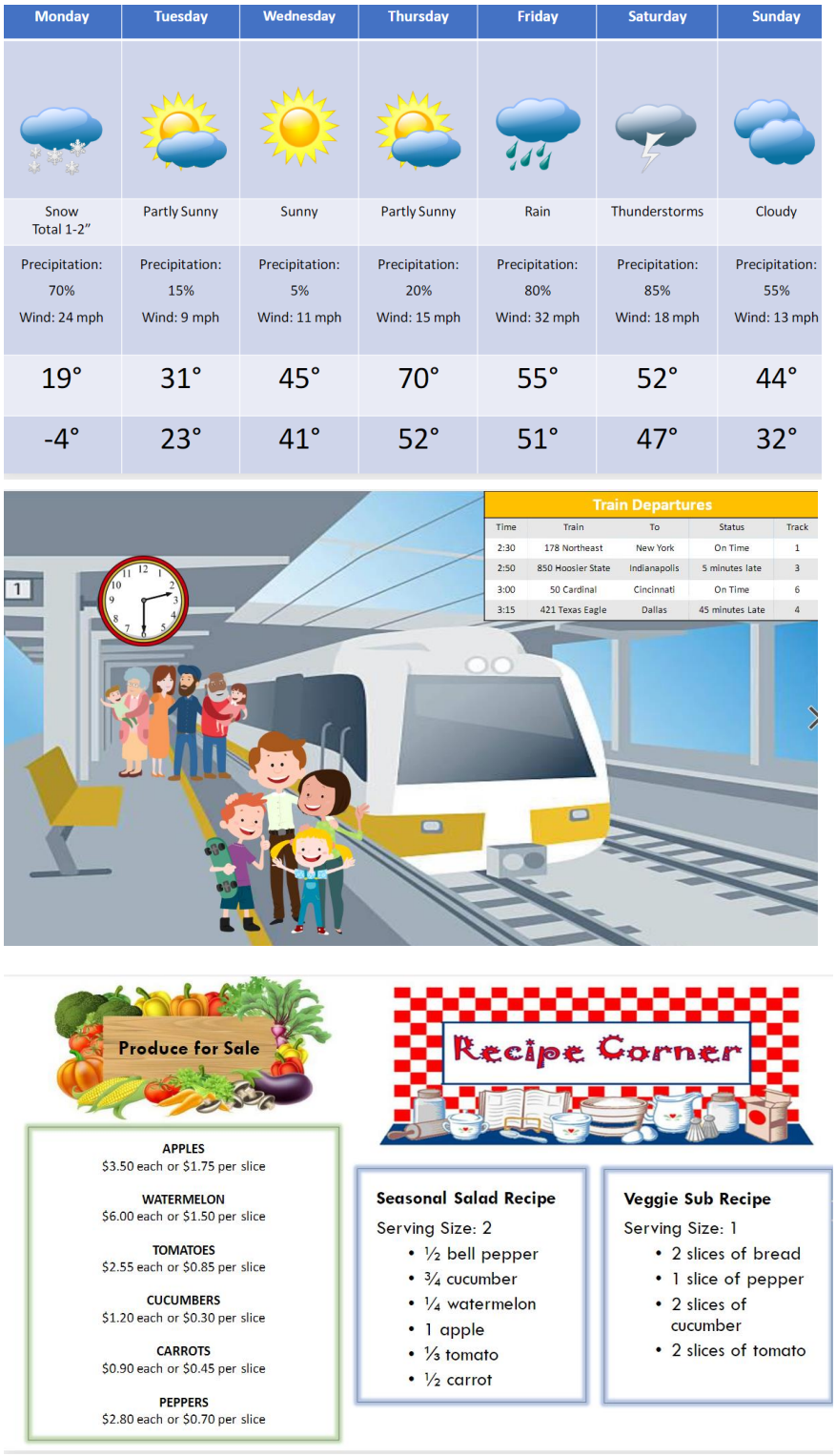
Materials for the three tasks were provided via a PowerPoint shared in zoom (figure 1.).

The material for the weather report task was a picture recording the weather conditions, temperature changes (maximum and minimum temperatures), precipitation rates, and wind speeds for each day from Monday to Sunday.

The train scene task showed a cartoon character at a train station, and there is a clock and a table showing departure time, train name, target location, status, and serial number.

The produce stand task provided a picture of a produce stand table and a recipe table. The table shows the goods for sale and prices (different portions correspond to different prices). The recipe page showed the ingredients needed for different dishes.

Figure 1. The Three Pictures Provided in the Three Tasks



Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Snow Total 1-2"	Partly Sunny	Sunny	Partly Sunny	Rain	Thunderstorms	Cloudy
Precipitation: 70% Wind: 24 mph	Precipitation: 15% Wind: 9 mph	Precipitation: 5% Wind: 11 mph	Precipitation: 20% Wind: 15 mph	Precipitation: 80% Wind: 32 mph	Precipitation: 85% Wind: 18 mph	Precipitation: 55% Wind: 13 mph
19°	31°	45°	70°	55°	52°	44°
-4°	23°	41°	52°	51°	47°	32°

Coding

Every video was transcribed and parsed into individual utterance. According to the content of the conversation, researchers first determined whether the utterance involved mathematics. We defined math-related utterances as follows “An utterance should be categorized as a math code when it involved mathematical concepts. Mathematical concepts included stating numbers, as well as explaining symbols, values, or the meaning of math concepts. If the utterance identified something as ‘first, second, third, etc.,’ it was considered math-related. If an utterance contained both mathematical and non-mathematical concepts, it was still considered a mathematical utterance.”

The researchers then ascertained whether the utterance was a statement or a question. A statement was a definite or clear expression, typically delivered in a neutral tone, that expressed a fact or the speaker's opinion. The emotional expression in a statement was relatively more subdued than in a question. A question was an interrogative expression frequently employed to assess knowledge or elicit information that required resolution or discussion. It was differentiated from a statement by the expression, the intonation, and the speaker's essential intent. In lieu of applying the question mark as a criterion for determining whether an utterance was a question, researchers used the question's wording, interrogative structure, and a discernible ascending tone or intonation change as criteria as a benchmark for judgment. In this paper, prompts were also considered to be questions as they sometimes served the same purpose as questions, namely eliciting responses. The purpose of prompting was to encourage or assist a person in providing the desired response by offering hints or clues (*e.g., parent: "75?"*, with a rising tone and in response to the prompt, the *child responded "degree"*). The distinctive change in intonation allowed us to distinguish prompts.

The next step was to classify questions into different categories. The coding scheme in our

study for categorizing different types of questions was derived from Yu et al. (2018). (See Table 1.). The questions were categorized as *pedagogical*, *information-seeking*, and *rhetorical*. A pedagogical question was a question with a known answer and an IRE structure that was intended for teaching. The first step of determining a pedagogical question required determining whether the questioner knows the answer to the question or whether we can reasonably expect that the questioner knows the answer. When we had a hard time determining whether the parent knew the answer or not, the second step was to observe whether the question followed the basic three-part sequential structure: IRE structure (initiation-reply-evaluation). This structure was initiated by parents using a pedagogical question to initiate a topic and providing evaluations as feedback after the child's reply. The third step was to see whether the question contained a teaching intention that can be interpreted as an endeavor to help children learn. Teaching intention cannot be directly measured so that it is defined in a specific way: "if the questions can be interpreted as intended to teach, where teaching is broadly defined as any endeavor to help children learn" (Yu et al., 2018). In cases when the parent's knowledge state and intention were difficult to judge the question itself, coders would then refer to (a) contexts before and after the question (~ 5 lines before or after), (b) the linked video clips. Those questions that have an explicit pedagogical intent include teaching general concepts, labels, object properties, conventions (*e.g., "What is the meaning of precipitation?"*), teaching about (or helping a child recall) a specific event, object, or person (*e.g., "Can you tell me which day is the hottest day?"*), and interpreting or correcting child's use of language (*e.g., Parent: "What does that say?" Parent: "Pretty cl-pretty sunny" Parent: "No, not pretty sunny. Partly sunny."*).

Information-seeking questions were ones that the questioner did not know the answer to and had no teaching intentions. The function of these questions was to seek unknown information from

the person being asked. Sometimes the way of asking a question may indicate that the question is seeking information, e.g., "do you remember…" for these questions, we need to see whether the parent made connections with the instructional material we provided in the immediate context (five utterances before and after). If parents related back to the material, it is a pedagogical question (*e.g., Parent: "And what type of train does it look like? Does it look like a local train? Like a Chicago L subway type train? Or does it look like it's going out of state or something?" Child: "It looks like a subway train." Parent: "Like a subway train. It does look kind of like like…"*); if parents did not relate, it is an information-seeking question (*e.g., Parent: You think that'll be super winter? Child: Yeah (laughs)Parent: What is super winter? Child: (laughs)Parent: Is that different than regular winter? Child: Um yeah Parent: Oh, tell me how Child: So it comes with rain, storm, I'm pretty sure, I think it's sun too Parent: That what super winter is? Child: Yes Parent: That doesn't sound right Child: And it turns and then um there's storm. And it turns all around (laughs)Parent: A tornado? Child: Yeah. So it turns into a tornado*).

Rhetorical questions do not intend to elicit new information or test knowledge; they are devices used not for teaching the child but to make some rhetorical effect on the hearer thus they are used for many purposes like chide, command, and stirring emotions. The question itself is not intended to be answered verbally, however, sometimes it can elicit verbal answer, this happens for report rhetorical question where rather than eliciting information these question function to express (like a comment) and elicit response (*e.g., Parent: "You know a train station, right? You've been to a train station before yeah? The first time you went on a train you really loved it, right?"*). See Table 1.

In addition to the aforementioned question, two additional categories of questions were "other" and "incomplete," respectively. The "Other" category represented questions without a clear subject

and were vague, such as questions that were unrelated to the task, typically consisted of sounds (e.g., "mm"), and other questions that did not convey a clear meaning (e.g., "okay?") or parents talking about themselves. However, it was important to note that if "okay" appeared as a single utterance on its own without a prior sentence or after sentences attached to it, then we counted it in the "other" category, but if the "okay" was at the end of a sentence (e.g., xxx, okay?), then it counted as a rhetorical question. The "incomplete" category consisted of utterances that began in the form of a question but were not completed (e.g., What is-).

Table 1. Question Type Coding and Examples

Category	description	Example
Pedagogical question	The questioner already knew the correct response in order to help the children learn (Including teaching about kinds of objects or people, general concepts, rules, or scripts, and teaching about specific objects, events, or people))	Which day is the coldest? What is the temperature on Monday?
Information-seeking question	the questioner sought responses from the questioned (including asking about specific objects, events, or people, and checking status by inquiring about the child's needs, opinions, or physical/emotional/cognitive state, and asking the child to repeat what he/she just said)	Did you learn that at school? Did you say 2:15?
Rhetorical question	Rhetoric refers to questions that were not intended to be answered verbally (including giving commands in the form of questions, obtaining the child's attention in the form of	Can you sit straight? You just say 85 cents per slice, okay?

	questions, and report rhetorical questions)

Measures

Children's mathematics achievement was measured using the Applied Problems subtest from the Woodcock-Johnson IV (Schrank, F.A. & Wendling, B.J., 2018). This test measures children's ability to apply their mathematical skills to real-world situations. In developmental psychology research, the W score is commonly used to measure growth of children's mathematical achievement (Levine & Baillargeon, 2016). The Applied Problems test was administered at the beginning of their school year and before the current study was conducted. The SES was indicated by two scores: income and highest education (see table 2 below). In the pretest survey, we asked the parent to provide information about their income (scales ranging from less than $15,000 to more than $100,000), as well as the highest level of education they attained (from scale one indicating no high school diploma to scale seven indicating doctoral degree).

Table 2. Descriptive Data for SES Scores

SES Score	***n***	***%***
income		
Less than $15,000	7	21
$15,000 to $34,999	7	21
$35,000 to $49,999	7	21
$50,000 to $74,999	4	12
$75,000 to $99,999	2	6
$100,000 or more	4	12
Education		
Did not complete high school	1	3
Completed high school or GED	4	12
At least 1 year of college	10	30
Associate's degree or equivalent 2-year undergraduate degree	4	12
Bachelor's degree or equivalent 4-year undergraduate degree	6	18
Some graduate training (not 5completed)	1	6

Graduate degree	7	21

Results

Gender Effect

All data were entered and analyzed in IBM SPSS, and the effect of gender was examined using one-way ANOVAs. We only found a significant gender effect in parents' use of statement (F (1,31) =4.41, p=.04). Specifically, parents made more statements to girls (M=122, SD=33.03) than boys (M=96, SD=38.47). Other than that, child gender was not significantly linked to parents' use of total questions (F (1,31) =.04, p =.95) and utterances (F (1,31) =1.42, p =.24), math and non-math questions (F (1,31) =.48, p =.50), and types of questions (ps > .27) across three tasks (ps > .38). See table 3 for descriptive data. Thus, gender is excluded from the subsequent analyses on parent question use.

Table 3. Descriptive Statistics of gender

	Male			**Female**		
	Sum	**Mean**	**SD**	**Sum**	**Mean**	**SD**
Utterance	2376	158.40	56.67	3416	189.78	52.15
Question	932	62.13	30.90	1213	67.39	30.91
Statement	1444	96.27	36.72	2203	122.39	32.50
Math Question	405	27	16.61	484	26.89	16.41
Non-Math Question	512	34.13	20.26	700	38.89	18.11
Math Pedagogical Question	329	21.93	15.67	389	21.61	14.01
Math Information-seeking Question	43	2.87	3.07	30	1.67	2.54
Math Rhetorical Question	33	2.20	3.21	65	3.61	5.11
Non-Math Pedagogical Question	295	19.67	12.48	396	22	13.66
Non-Math Information-seeking Question	150	10	8.32	227	12.61	7.33
Non-Math Rhetorical Question	25	1.67	1.96	53	2.94	3.81

Overall Question

Parents (*n*=33) produced an accumulated 5792 utterances, 2145 questions, and 3647 statements (see table 4.). Generally, parents used more statements (*M*=111, *SD*=36.93) than questions (*M*=65, *SD*=31.54), *t* (32) =6.82, *p* < .05.

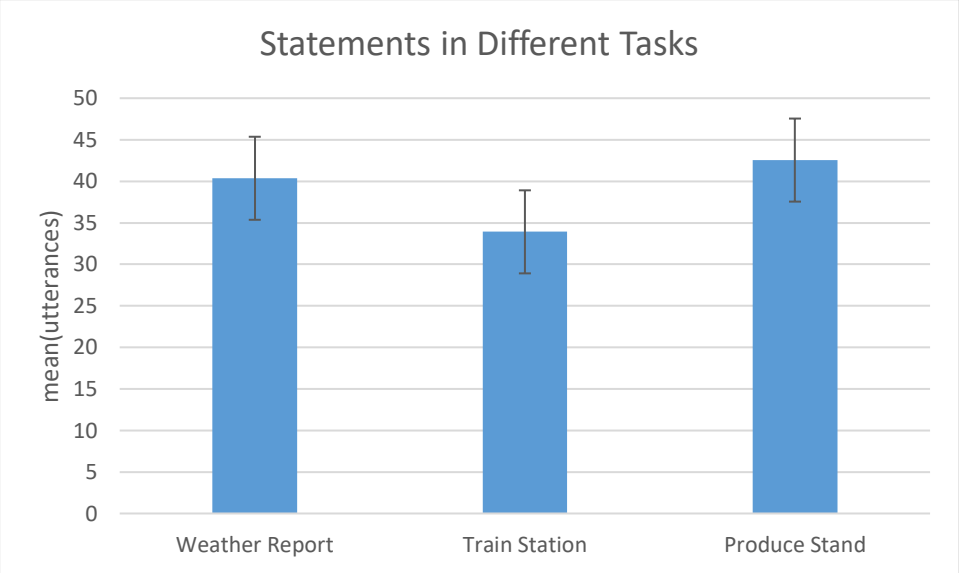
Table 4. Descriptive Statistics of Utterances, Statement, and Question

	Min	Max	Sum	Mean	SD
Utterance	50	284	5792	175.52	57.37
Question	4	134	2145	65.01	31.54
Statement	46	181	3647	110.53	36.93

A 3 (Tasks) x 2 (Statement & Question Use) repeated measures ANOVA was performed to compare the effect of different tasks (weather report task, train station task, and produce stand task) on parents' use of statement and question. The results exhibited a significant main effect of the use of questions and statements (*F* (1, 32) =56.34, *p*<.001). such that parents used a significantly more statements (*M* =38.94, *SD* =2.15) than questions (*M* = 22.98, *SD* = 1.78; *M difference* = 15.96, *SE*= 2.13; *p* <.001, 95% CI of the differences [11.63, 20.29]) across three tasks. There was no main effect of task (*F* (1, 32) =3.24, *p*=.17).

In addition, the results revealed a significant interaction between tasks and parents' statement use (*F* (2,31) = 4.50, *p* =.013). Post hoc tests using the Bonferroni correction revealed that parents used fewer statements in the train station task (*M* = 33.91, *SD* = 2.33) compared to the weather report task (*M* =40.36, *SD* =2.66; *M difference* = 6.46, *SE*= 2.57; *p* =.05, 95% CI of the differences [.04, 12.95]) or produce stand task (*M* =42.54, *SD* =3.35; *M difference* = 8.64, *SE*= 3.21; *p* =.034, 95% CI of the differences [.53, 16.74]). There were no statistically significant differences in parental use of questions across the three tasks (*ps* > .22). See Figure 2.

Figure 2. Statement Use in Different Tasks



Math and Non-Math Questions

Of the total of 2145 questions, 41% were mathematical in nature while 57% were not (see Table 5.). During the conversation, parents asked significantly more non-math questions (M=36.74, SD=19.62) than math questions (M=26.91, SD=16.87), t (32) =3.00, $p < .05$.

Table 5. Descriptive Statistics for Math and Non-math Questions

	Min	Max	Sum	Mean	SD
Math Question	2	60	889	26.91	16.87
Non-Math Question	2	86	1212	36.74	19.62

To compare the effect of different tasks on parents' use of math and non-math questions during the interactions, we conducted a 3 (Tasks) x 2 (Math & Non-Math Question Use) repeated measure ANOVA. The result revealed a significant main effect of the use of math and non-math questions (F (1, 32) =13.53, p<.001) by parents. Parents asked more non-math questions (M =13.05, SD =1.04)

than math questions (*M* = 9.47, *SD* = .99; *M difference* = 3.59, *SE*= .98; *p* <.001, 95% CI of the differences [1.60, 5.57]). There was no main effect of task (*F* (1, 32) =1.88, *p*=.20).

There was an interaction between math question use and different tasks (*F* (2, 31) = 3.05, *p* =.05). Post hoc tests using the Bonferroni correction revealed that parents used significantly more math question in the produce stand task (*M* = 10.61, *SD* = 1.31) than the weather report task (*M* =7.73, *SD* =.98; *M difference* = 2.88, *SE*= 1.15; *p* =.053, 95% CI of the differences [.03, 5.78]). There was no significant difference in parents' use of math questions in the train station task comparing to the produce stand task (*p* = .21) and the weather report task (*p* = .42). There was no interaction found in non-math question use and different tasks.

Within each task we found that, in the weather report task, parents used significantly more non-math questions (*M* = 14.61*, SD* = 1.37) than math questions (*M* =7.73, *SD* =.98; *M difference* = 6.88, *SE*= 1.33; *p*< .001, 95% CI of the differences [4.18, 9.58]). Nevertheless, in other two tasks, there was no significant difference between math and non-math questions use (*ps* >.28). See Figure 3. and Figure 4.

Figure 3. Math Questions in Different Tasks.

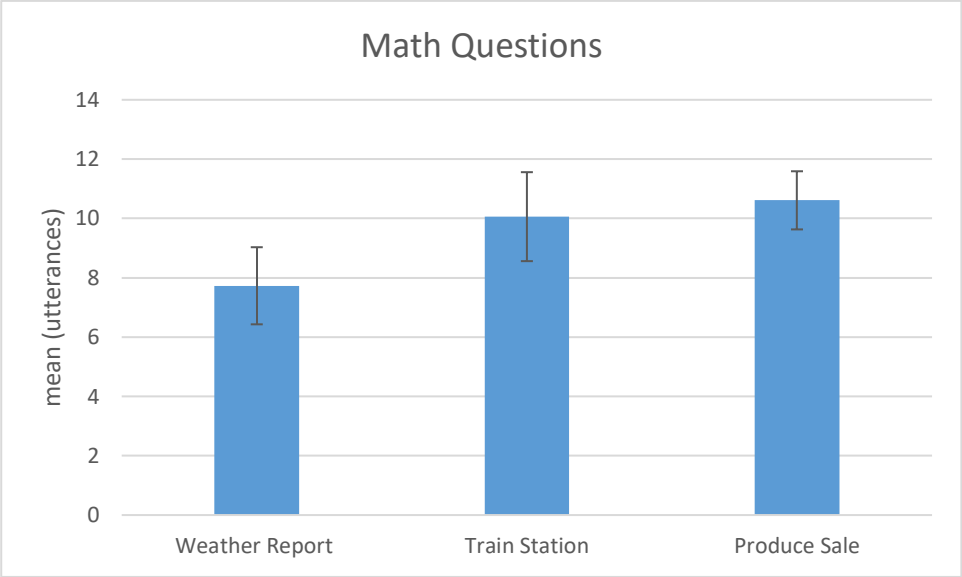
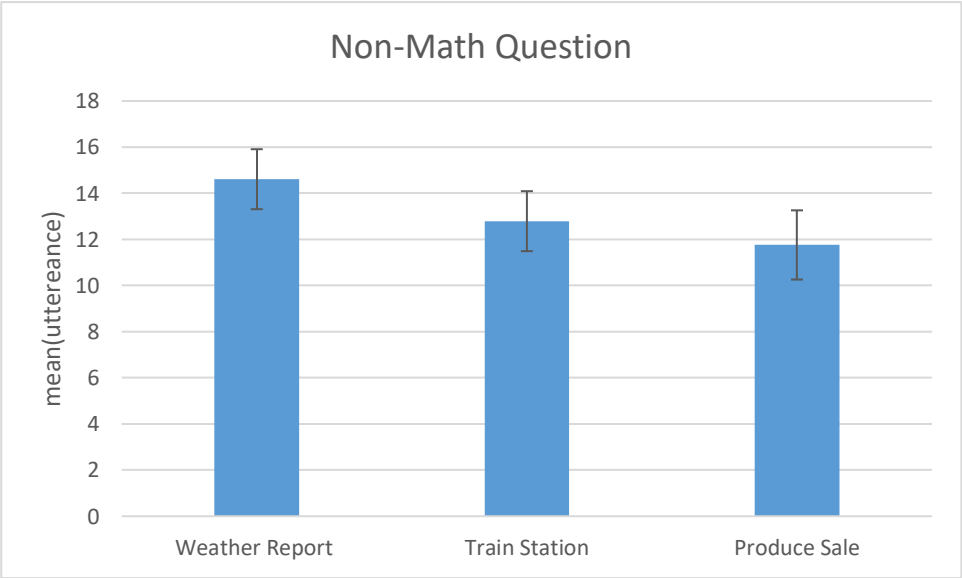


Figure 4. Non-math Questions in Different Tasks



Question Type

We coded the questions into three categories: pedagogical questions, information-seeking questions, and rhetorical questions. Across both math and non-math talks, parents used a total of 1409 pedagogical questions, which was 66% of total questions; 450 information-seeking questions, which was 21% of total questions; and 176 rhetorical questions, which was 8% of total questions.

Regarding different types of question, parents used more non-math than math information-seeking questions (non-math: M=11.43, SD=8.00; math: M=2.27, SD=2.96; t (32) = 7.13, $p < .05$, while there was no difference in the use of other types of math and non-math questions (ps>.14). In the subsequent analyses, we separated math and non-math talks regarding questions types. The rest 5% were in the other two question categories.

Math Related Questions. In the math questions, there were a total of 718 pedagogical questions, accounting for 81% of the total math related question; 73 information-seeking questions, accounting for 8% of the total math questions; and 98 rhetorical questions, accounting for 11% of total math questions (see table 6.). A paired sample two-tailed t-test was performed to compare the variation between three types of questions, the result showed that parents use more pedagogical question (M=21.83, SD=15.03) than information-seeking questions (M=2.27, SD=2.96), t (32) =7.20, $p < .05$) and rhetorical questions (M=3.01, SD=4.59), t (32) =7.50, $p < .05$) in math talks. There was no significant difference between parents' use of information seeking and rhetorical question (t (32) = .79, p =.65) in math talks.

Table 6. Descriptive Statistics for Math Question Types

	Min	Max	Sum	Mean	SD
Math Pedagogical Question	0	60	718	21.83	15.03
Math Information-seeking Question	0	9	73	2.27	2.96
Math Rhetorical Question	0	18	98	3.01	4.59

A 3 (Tasks) x 3 (Math Question Types) repeated measures ANOVA was performed to compare the effect of different tasks on parents' use of three types of math related questions during the interactions. The result revealed a significant main effect of math question types (F (1, 32) =53.77,

p<.001). Specifically, parents used more pedagogical questions (M =7.64, SD =.90) than information-seeking questions (M =.88, SD =.18; *M difference* = 6.76, SE= .95; p <.001, 95% CI of the differences [4.36, 9.16]) and rhetorical questions (M = .90, SD = .23; *M difference* = 6.74, SE= .84; p <.001, 95% CI of the differences [4.62, 8.85]) in math talks. There was no main effect of task (F (1,32) = 7.77, p =.39) and there was no significant interaction (F (2, 32) =1.24, p=.36) between tasks and math question types.

Non-Math Related Questions. In non-math questions, there were 691 pedagogical questions, 377 information-seeking questions, and 78 rhetorical questions (see table 7.). A paired sample two-tailed t-test was performed to compare the variation between three question types, similar to the findings in math talks, the result revealed that parents used more pedagogical questions (M=20.90, SD=13.47) than information-seeking questions (M=11.43, SD=8.00), t (32) =3.71, p < .05 and rhetorical questions (M=2.45, SD=3.24), t (32) =8.67, p < .05.) Further, parents use more information-seeking question (M=11.43, SD=8.00) than rhetorical questions (M=2.45, SD=3.24), t (32) = 5.648, p < .05.

The 3 (Tasks) x 3 (Non-Math Question Types) repeated measure ANOVA showed no significant main effects of Tasks (F (1, 32) =2.23, p=.19) and non-math question types (F (1, 32) =9.85, p=.44) or interactions between tasks and parents' use of non-math question types (F (2, 32) =1.79, p=.15).

Table 7. Descriptive Statistics for Non-Math Question Types

	Min	Max	Sum	Mean	SD
Non-Math Pedagogical Question	2	62	691	20.90	13.47
Non-Math Information-seeking Question	0	32	377	11.43	8.00
Non-Math Rhetorical Question	0	15	78	2.45	3.24

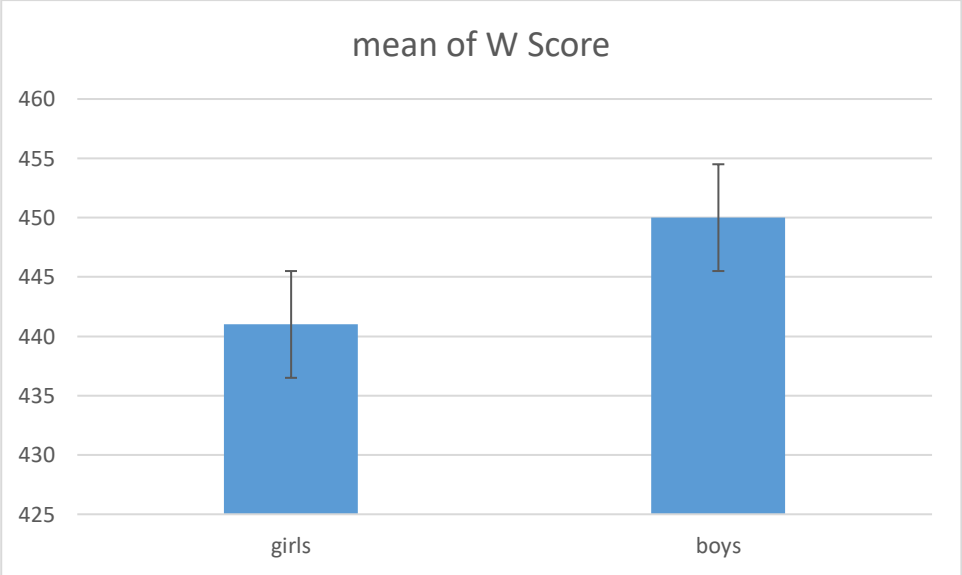
Applied Problems Scores

The average W score was 445, the mean value for girls was 441, while the mean value for boys was 449 (see Table 8 and Figure 5). To compare the relation of gender to W scores, a one-way ANOVA was conducted. The result indicated that there was no statistically significant difference between boys and girls W scores, F (1,31) =2.39, p =.13.

Table 8. W Applied Math Score.

	Min	**Max**	**Mean**	**SD**
W Score	415	485	445	15.92

Figure 5. Means of W Score



Adopting a correlation model, we found that parental income (but not highest level of education) was strongly and positively correlated with children's W scores, r (32) =. 45, p < .01. This finding is consistent with prior research by Starkey et al., 2004. Parental income and the highest level of education were also found to be strongly correlated, r (32) =. 51, p < .01. The

highest level of parental education was found to be strongly correlated with the total number of questions asked (r (32) =. 35, $p < .01$) as well as the number of math information-seeking questions asked by parents (r (32) =.49, $p < .01$). See table 9.

Table 9. Correlations for Math W Score

Variable	M	SD	1	2	3	4	5	6	7	8
1. W Score	445	15.94								
2. Gender	.45	.51	.27							
3. Income	2.79	1.76	**.45****	-.10						
4. Education	4.24	1.82	.17	.01	**.51****					
5. Q	65.00	31.49	-.05	-.08	-.08	**.35***				
6. MQ	26.94	16.76	-.16	.00	-.05	.31	.84**			
7. MPQ	21.76	15.02	-.21	.01	-.16	.17	.82**	.95**		
8. MIQ	2.21	2.90	.17	.21	.22	**.49****	.17	.05	-.11	
9. MRQ	2.97	4.48	.00	-.16	.21	.27	.30	.51**	.29	-.08

** p < 0.01 (2-tailed) * p < 0.05; N=33; Q=total question use; MQ=total math question use; MPQ=math pedagogical question use; MIQ=math information-seeking question use; MRQ=math rhetorical question use

To answer the second research question, we conducted a multiple regression analysis to examine what factors predicted children's math performance (W score of Woodcock Johnson IV Applied Problem). The results showed that family SES (income) significantly predicted children's math performance (R^2 =.19, F (1, 31) = 7.63, p <.01), and child gender marginally predicted children's math performance (R^2 =.45, F (1, 31) = 3.33, p =.06). Contrary to our prediction, parent pedagogical question did not predict children's math performance (see Table 10).

Table 10. Predicting W Score

	B	SE B	Beta	t	Sig.
SES (income)	5.86	1.72	.65	3.40	**.00**
SES (education)	-2.28	1.92	-.26	-1.19	.25
gender	10.76	5.42	.34	1.98	.06
MQ	-.15	.16	-.16	-.90	.37
MPQ	-.24	.21	-.23	-1.12	.28
MIQ	.40	1.13	.07	.35	.73
MRQ	-.97	.75	-.27	-1.29	.21
NMQ	1.01	.74	1.24	1.37	.19
NMPQ	-1.03	.86	-.87	-1.20	.24
NMIQ	-1.08	.95	-.54	-1.14	.27
NMRQ	1.88	1.23	.38	1.53	.14

a Dependent Variable: W applied problem; NMQ=total non-math questions use; NMPQ= non-math pedagogical question use; NMIQ=non-math information-seeking question use; NMRQ=non-math rhetorical question use

Discussion

This study had two objectives; the primary objective was to observe math-related parent-child interaction, particularly the use of different types of questions by parents. The secondary objective was to investigate the relationship between math pedagogical questions and children's math achievement and to determine whether other variables (such as gender difference) were also associated with children's W scores.

In the preceding section, we discussed the paucity of research on low-SES families and the significance of observing interactions in the low-SES families for educational equity. After analyzing and observing the interaction of thirty-three families of low-SES, we reached the following conclusions:

First and foremost, 37% of all utterances were in the form of questions. Among the various types of questions, pedagogical questions were the most prevalent: more than half of the questions

were pedagogical questions. Consistent with the hypothesis of Yu et al. (2018), parents routinely used pedagogical questions with their children in daily life, and these questions were an integral part of parent-child interactions. In this manner, parents motivated their children to learn and grow by offering them explicit instructions and asking them questions to which the parents already knew the answers.

When comparing math and non-math questions, parents asked more information-seeking questions for the latter. This may be attributable to the fact that the function of information-seeking questions was to assess the status and enquire about the child's current state (physical/emotional/cognitive), opinions, or needs (Yu et al., 2018). Most status checking was regarding the children's emotional and personal state; therefore, parents were more likely to use information-seeking questions in the context of non-math questions.

In addition, parents' use of math and non-math questions varied across tasks; to illustrate, parents asked more math-related questions during the produce stand task than they did during the weather report task. Consequently, the context and subject matter of the conversation may influence the proportion of math and non-math questions raised by parents. Given the greater accessibility of mathematical resources and the relative ease with which parents could formulate questions they reasonably assumed would help their children learn, it is possible that parents made greater use of mathematical questions in certain contexts. For instance, the weather report task contained more science elements than math information. There were different symbols representing the weather condition and advanced terminology such as "precipitation." Therefore, parents may have devoted more time to explaining these terms and teaching their children about non-math concepts by asking non-math questions. In contrast, the produce stand may have been easier and more familiar, and

therefore parents may have asked more math-related questions.

Furthermore, the gender of the child did not affect parents use of questions, either math or non-math related. However, parents were significantly more likely to make statements to girls than boys, it is possible that parents were more elaborative with girls than with boy due to math gender-stereotypes, but this would need to be examined in a larger study in order to assess its replicability.

Our secondary objective was to explore whether there was a correlation among the W score, math pedagogical questions, and gender. We found that children's gender marginally predicted their math W score. This finding consistent with the conclusion of past studies that there is a gender gap in students' math achievement (Fryer & Levitt, 2009; Di Tommaso et al., 2016). In Fryer and Levitt's article, they found that children did not differ by gender in math achievement when they first started school, but this gender gap gradually increment during the school years and after six years of school girls lose more than two-tenths of a standard deviation comparing to boys. Therefore, the reason why our data showed only a marginal effect of gender on predicting math achievement might be that the math achievement was measured in children's first year of school.

We found no significant correlation among children's math achievement and parental use of math pedagogical questions. There were a few possible explanations.

First of all, the sample size was relatively limited, rendering it unsatisfactory for producing solid predictions. Secondly, since the data were collected on children's achievement at the beginning of the school year while the study was conducted during the school year, it was unlikely that the correlation would be observed immediately. Thirdly, longitudinal studies may be more relevant for observing the relationship between parental interactions and children's achievement as they allow researchers to observe how parent-child interaction evolve over time and how these changes related

to children's long-term math performance.

Although we found no reliable relation of question-asking to W score, we did discover a strong positive correlation between parental income and the W score. Consistent with past studies, family economic resource has an effect on children's math achievement (Starkey et al., 2004; Galindo & Sonnenschein, 2015) and other developmental outcomes as well (Taylor et al., 2004). Likewise, parental education level and income were observed to be positively correlated, which was also in line with earlier findings (Houthakker, 1959).

We did find that total number of questions asked and the number of questions asked specifically in the category of math information-seeking were positively correlated with the parental level of education. This may be due to the fact that parents with a higher level of education were more aware of the value of question-asking in children's learning and development and, as a result, increased the frequency with which they posed questions to their children. These parents were also more likely to check on the progress of their children. Dimosthenous et al. (2019) in their study concluded that the home learning environment has a long-term effect on the achievement of elementary school students. They found a relationship not only at the end of the first grade, but also at the end of the third grade. This research result led us to speculate that parental question asking behavior may have a long-term effect on children's performance in mathematics. Therefore, future research directions should focus on the long-term effects of parental question asking on children's achievement.

This study provides data on parent-child math related interactions when common scenarios are used as tasks. These results contributed to the essential data for observing the early education provided to children in low-SES families. We found that pedagogical questions were important

components of parent-child interaction in low-SES families and that parents adapt their question-asking strategies depending on different tasks. Although we were not able to observe a relationship between W-score and parental questioning behavior and child gender, we confirmed previous findings in past studies that child achievement is positively related to parental income, and parental income is positively related to educational level. These results added to the critical data for observing the early education children in low-SES families receive. For future research direction, we suggested that researchers should focus on the long-term effects of parental involvement, specifically question asking behavior, on children's academic achievement.

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