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Relations between Math Achievement, Math Anxiety, and the Quality of Parent–Child Interactions While Solving Math Problems

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Abstract: In the current study, we used a multi-method approach to understand the quality of math homework-helping interactions between parents and their children and how parents' and children's own math achievement and math anxiety relate to the quality of the interaction. Forty Canadian parents and their children (ages 10–12 years; grades 5 to 7) completed self-report measures of math and general anxiety. Parents and children completed standardized assessments of math achievement and were then recorded as they engaged in a simulated math homework interaction. Coders assessed parent–child interaction quality during the interaction. Parent–child dyads generally performed well on the simulated math homework task. Nevertheless, task performance was correlated with the quality of the interaction, with high-quality interactions associated with high accuracy on the math task. Furthermore, the variability in the quality of the interaction was associated with parents' and children's math achievement and with the math anxiety of the children, but not the parents. Identifying the elements that influence parent–child interactions in math-related situations is essential to developing effective interventions to scaffold children's math learning and attitudes.

Keywords: math anxiety; math achievement; homework help; parent–child interaction

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1. Introduction

Whether it is making informed risk/reward assessments surrounding public health concerns, understanding changing weather patterns, calculating sale prices, or making financial decisions, math skills are required to lead an informed, successful life. Adverse experiences in mathematics frequently begin during the early school years and have an impact on future academic achievement and financial outcomes [1]. Thus, understanding the factors that relate to children's success in math is imperative. Although many researchers have explored math learning in the classroom, it is also important to understand what happens during homework interactions with parents at home.

According to recent research, parents who reported engaging in general math-related activities at home had children with greater math skills [2]. Likewise, in their meta-analysis, Dancourt et al. [3] found that parents' involvement in math at home and children's math achievement are positively associated. These findings, however, do not consider the role of math anxiety (i.e., the degree of fear, tension, and apprehension that both

parents and children tend to experience on a regular basis [4]). For example, in a study of 311 Chilean second graders and their parents, Guzmán et al. [5] reported that the frequency of home numeracy activities strengthened or diminished the negative relation between math performance and math anxiety as a function of parents' math anxiety. Indeed, other studies have highlighted a positive relationship between children's and parents' math anxiety [6], but this is often mediated or moderated by a range of factors, including parents' gender [7] and parents' engagement with their children's homework [8].

Homework is a regular occurrence in middle childhood. For example, in a study surveying 29 countries, parents reported spending an average of 6.7 h per week helping their children with their homework across all subjects [9]. Although parental involvement in homework is often beneficial (e.g., [10,11]), there are factors that can lead the homework help to be less than optimal [8,12–14]. As such, it is crucial to identify the factors that affect parent–child interactions in math-related situations, such as homework help, to inform the creation of successful parenting interventions to scaffold children's math learning and attitudes.

In the current study, we explored the quality of a simulated math homework interaction in parent–child dyads and its relation to parents' and children's math attitudes and math learning outcomes. Specifically, we explored features of parent–child interactions that have been described in the literature to assess dyadic interaction quality [15] and how these features relate to math anxiety and their performance on a standardized measure of math achievement.

1.1. Quality of Parental Involvement in Homework

The relation between math anxiety and math achievement is well-documented (e.g., [16,17]; see [18] for a meta-analysis). However, fewer studies have examined how the math attitudes of others (i.e., parents or teachers) may influence children's math anxiety and achievement. Drawing from Bronfenbrenner's Ecological Model, parents are their children's first and most crucial socializers in society, with school being the second [19]. Although we often think of the classroom as the environment in which children learn, it is important to consider that parents also play a critical role in their children's learning and education [20]. Indeed, environmental factors, such as parental involvement in math learning, have been found to be associated with children's performance in math (see [21] for a review).

The role of parents in helping their children with math homework is multifaceted. Accordingly, parents' involvement in their children's homework across various subjects has gained attention among researchers seeking to better understand the ways in which student learning and achievement can benefit from parental homework help [11]. Homework involvement provides parents with the opportunity to support their child's development [10]. Effective parent homework involvement incorporates modeling, reinforcement, and dialogue that encourage the development of positive attitudes, knowledge, and behaviors in children [22]. Additionally, studies have shown that an autonomy-supportive approach to homework help (e.g., allowing the child to solve problems on their own with parental scaffolding) can lead children to have a more positive sense of well-being and better academic outcomes [23,24].

Conversely, parental homework helping is sometimes detrimental to children's attitudes and learning [8,12,14]. Parents who exhibit controlling homework behaviors (i.e., regulating the child's behavior, pressuring outcomes by using commands, directives, or love withdrawal) relate to low child academic outcomes [25–27]. Parental overcontrol, overprotection, conflict, rejection, and criticism affect childhood anxiety [28]. Some parents may engage in these controlling behaviors while helping children with their math homework, leading to adverse effects on children's math anxiety and math achievement.

1.2. Parent Math Anxiety and Math Achievement in the Context of Math Homework Help

Little is known about the parental factors that relate to variability within the math homework-helping environment. A study conducted in seven Arab countries revealed that children with parents who are more frequently involved in their math homework have lower math achievement [29]. The researchers suggest that parents may exhibit controlling behaviors that may interfere with children's learning. In considering previous research by Maloney et al. [8], another factor that may contribute to this finding is parents' math anxiety. Specifically, Maloney and colleagues found that when parents with higher math anxiety frequently helped with math homework, their children learned less math than children of parents with lower math anxiety or those who received less frequent homework help. The math anxiety of these children also increased over the course of a school year. Similarly, Cosso et al. [30] demonstrated that the degree to which children's math achievement is influenced by the frequency of parent–child math interactions depended on parents' math anxiety. These studies, however, did not assess the quality of the math interactions. DiStefano and colleagues [31] proposed that one reason the math homework help of parents with higher math anxiety is less beneficial than that of their counterparts with lower math anxiety is that the quality of the math homework interactions involving higher math anxiety is lower [31]. Specifically, parents with higher math anxiety and with lower math achievement reported feeling increased levels of stress, tension, and frustration, as well as feeling more distant from their child when helping with their math homework.

As proposed by Alreshidi and colleagues [29], parents who are frequently involved in their children's math homework may be more intrusive in the process. In line with this, previous research has identified parents' lower math achievement and higher math anxiety as factors that are associated with fewer autonomy-supportive and more controlling-supportive homework-helping behaviors [32]. Although the research reported by DiStefano et al. [31] and Retanal et al. [32] opened the door to the possibility that parents' own levels of math anxiety and math achievement relate to how they help their children with their math homework, the data are comprised solely of self-reports from the parents. As such, it is difficult to know whether children of parents with higher math anxiety also experience their math homework interactions to be less optimal than children of parents with lower math anxiety. It is also difficult to determine whether the quality of the math homework-helping interaction of parents with higher math anxiety is indeed suboptimal (e.g., less autonomy-supportive, more emotionally negative) or if they simply perceive the interactions to be so. To capture the essence of the quality of the math homework-helping interaction, considering both children and parents, we feel it prudent to take into consideration the behavioral observations of trained coders.

1.3. Child's Math Anxiety and Math Achievement in the Context of Math Homework Help

It is important to consider both parent and child factors when assessing individual differences regarding how the math homework-helping interaction unfolds. Drawing from research in the classroom, students in a negative mood are likely to have a worse learning experience than students in a positive mood [33]. Relatedly, Trautwein and colleagues [34] argued that homework is likely to be most effective if students do not typically experience unpleasant emotions while doing their assignments. Indeed, Trautwein and colleagues [34] reported a reciprocal relationship between achievement and homework-related emotions, such that lower academic achievement in children predicted higher levels of unpleasant homework-related emotions, and higher levels of unpleasant homework-related emotions, in turn, predicted lower achievement. In line with this, recent research suggests that when children are having difficulties with their math homework or expressing frustration, the responses of the parents with higher math anxiety during the homework-helping situation are more negative (i.e., more controlling and negatively emotionally charged; see [35,36]). These findings support the notion that when working to understand not only how math homework interactions vary but also what factors relate to this variability, the picture will be more complete if both parent- and child-level factors are taken into consideration.

1.4. Assessments of the Math Homework-Helping Interaction

As discussed, much of what is known about the quality of math homework interactions comes from survey data in which parents or children are asked to report on how they feel about doing math homework. It is rare that comparisons are made of how parents and children report on the same interactions. It has been argued that evaluations of dyad-focused features (e.g., dyadic synchrony, coordination, emotional reciprocity, etc.) provide more information about the quality of parent–child interactions than evaluations that are only centered on the parent or child alone [37]. Moreover, although self-reports provide an understanding of how parents and children perceive the interaction, self-reports do not allow researchers to directly observe what is happening during the math homework-helping interaction. Hunt and Maloney [38] provide evidence to suggest that variations in how adults appraise previous math experiences are related to math anxiety and attitudes. This evidence strengthens the case for behavioral observations. In the current study, observations of parent–child dyads interacting were coded in a simulated math homework interaction to garner a richer understanding of the behavior that occurs when parents and children work to solve math problems.

2. The Present Study

The first objective of the current study was to provide a general description of the math homework-helping interaction of our sample. We used a multi-method approach to obtain a deeper understanding of the math homework-helping environment than what has to date been reported in the literature. The second objective was to investigate how parents' and children's own math achievement and math anxiety relate to the quality of the interaction. Specifically, using self-report, we assessed parents' and children's levels of math and general anxiety. Further, standardized assessments of parents' and children's math achievement were obtained. Parents and children were then recorded engaging in a simulated math homework interaction, which was coded by trained coders who assessed the quality of the interaction. Finally, we sought to describe whether the performance on this simulated math homework task varied as a function of the observed quality of the interaction.

We hypothesized that the success in the math homework task would be related to the quality of the homework-helping interaction, in that a higher quality of the interaction would be associated with a higher score for the math task (Hypothesis 1). We further hypothesized that the parent–child interaction would be overall more positive for higher math-achieving parents (Hypothesis 2A) and children (Hypothesis 2B). Similarly, we expected that the homework-helping interaction would be overall more positive for parents (Hypothesis 3A) and children (Hypothesis 3B) with lower math anxiety.

3. Method

3.1. Participants

Prior to the beginning of the COVID-19 pandemic, 41 parent–child dyads (children in grades 5 to 7) were recruited and participated in the present study. The middle childhood age range was chosen as our target population because it represents a critical period for the development of academic skills that warrants additional empirical focus [10]. Moreover, the middle childhood range is a period when children spend more time on homework compared to younger years (i.e., 40.4 to 53.6 min per day) and still rely on their parents for homework assistance [39].

Participants were recruited through online advertisements (i.e., Facebook and Twitter), community centers (e.g., summer camps and recreational centers), advertisements through an Eastern Ontario school board, and a participant pool from a Canadian university using flyers with a brief description of this study. To be eligible to participate in this study, children had to be in grade 5, 6, or 7, both children and parents were required to be fluent in English, and parents were required to be their child's primary homework helper. Non-biological caretakers (e.g., adoptive parents or stepparents) were also invited to take part

in this study. Parents were given $20 CAD, and children were given the choice between a small toy and a $5 Tim Horton's gift card as compensation for participating in the study.

One dyad was removed from the sample because of an audio error. All 40 parents (n = 34 women; M_{age} = 43.5 years) reported that they were the primary math homework-helping parents. Parents reported a range of education levels: some college with no diploma (15%); college diploma (25%); bachelor's degree (32.5%); master's degree (22.5%); and doctoral degree (5%). The median education level was a bachelor's degree. As for the children, 13 were in Grade 5 (n = 10 girls; M_{age} = 10.0 years), 21 were in Grade 6 (n = 13 girls; M_{age} = 11.0 years), and 6 were in Grade 7 (n = 2 girls; M_{age} = 11.8 years).

3.2. Materials

3.2.1. Mathematics Anxiety

Parents' and children's math anxiety was measured using the nine-item Abbreviated Math Anxiety Scale (AMAS) [40], a widely used scale measuring math anxiety among children, adolescents, and adults. Additionally, AMAS has been used in previous studies of children and/or parents (e.g., [16,31,32,41]). Participants were required to rate how anxious they felt in a variety of math-related situations (e.g., "Having to use the tables in the back of a math book" and "Listening to a lecture in math class") on a five-point Likert scale ranging from 1 = Lower Anxiety to 5 = Higher Anxiety. Good to excellent internal consistency (α = 0.83 to 0.90) and good test–retest reliability (r = 0.83; four-month time frame) have been reported for this measure [40]. Strong convergent validity has been shown between the original Math Anxiety Rating Scale Revised and the AMAS (r = 0.85), the AMAS-learning math anxiety subscale (r = 0.70), and the AMAS math evaluation anxiety subscale (r = 0.81). In general, moderate associations were obtained among the AMAS total and subscale scores, with other anxiety measures (r = 0.20–0.54) indicating some level of divergent validity with these measures [40].

3.2.2. Generalized Anxiety

Given that math anxiety shares some variance with general anxiety [42], we included a measure of generalized anxiety as a control variable. To assess parents' general trait anxiety, the State-Trait Anxiety Inventory Form Y (STAI-Y) [43] was used. This 20-item self-report measure includes items such as "I worry too much over something that really doesn't matter" and "I am content; I am a steady person" [43]. The items were rated on a four-point scale ranging from "Almost Never" to "Almost Always," with higher scores indicating greater anxiety. Good to excellent internal consistency (α = 0.86 to 0.95) has been reported for this measure, and test–retest reliability coefficients have ranged from 0.65 to 0.75 over a two-month interval [44]. Content validity has been measured with other measures of anxiety, including the Taylor Manifest Anxiety Scale and the Cattell and Scheier's Anxiety Scale Questionnaire (r = 0.73 and 0.85, respectively; [45]).

In addition, children completed the Trait-Anxiety subscale from the State-Trait Anxiety Inventory for Children (STAIC) [46]. For each of the 20 statements, participants indicated how they generally feel on a three-point scale ranging from "hardly ever" to "often" (e.g., "I feel unhappy" and "I have trouble deciding what to do"), with higher scores indicating greater anxiety. Acceptable to good internal consistency (α = 0.78 and 0.81; males and females, respectively) and acceptable test–retest reliability (r = 0.65 and 0.71; males and females, respectively) have been reported for this measure [44]. The concurrent validity of the STAIC has been supported by high correlations with similar measures, such as the Children's Manifest Anxiety Scale (r = 0.75), the General Anxiety Scale for Children (r = 0.63), and the Hamilton Anxiety Rating Scale Interview (r = 0.58) [47].

3.2.3. Mathematics Achievement

A composite of the Math Facts Fluency and Calculation assessments from the Woodcock–Johnson IV (WJ-IV; copyrighted) [48] was used as a measure of mathematics achievement. The WJ-IV is a standardized, nationally norm-referenced achievement test appropriate

for individuals aged 2 to 90 years old. For this study, all parents were administered the WJ-IV Tests of Achievement Form A, and all children were administered the WJ-IV Tests of Achievement Form B.

Math Facts Fluency

Participants were provided a booklet of 160 single-digit arithmetic problems (i.e., addition, subtraction, and multiplication). All participants began with Item 1 and were given three minutes to complete as many calculations as possible. Participants were scored on the total number of correct responses. This task has test–retest reliabilities of 0.95 for children aged 7 to 9 years and for adults [49].

Calculation

Participants were provided with a booklet of 57 math problems of increasing difficulty. Depending on age-appropriateness, items included numerical operations (i.e., addition, subtraction, multiplication, and division), geometric, trigonometric, logarithmic, and calculus operations. Children in grades 5 and 6 began with Item 19; children in grade 7 began with Item 23, and adults began with Item 27. Once participants successfully completed six items in a row (i.e., they reached the basal criterion), testing proceeded until the six highest-numbered items administered were responded to incorrectly (i.e., they had reached the ceiling criterion), or until Item 57 was administered. Participants were scored on the total number of correct responses. This task has a median reliability of 0.93 for 5- to 19-year-olds and for adults [49].

3.2.4. Math Homework Task

Parent–child dyads were given one of three paper booklets with nine math questions. The booklet provided depended on the grade of the child (i.e., Grade 5, 6, or 7). The questions created for the simulated math homework interaction reflected the five strands of mathematics from the Ontario Mathematics Curriculum [50]. The five strands include (1) number sense and numeration, (2) measurement, (3) geometry and spatial sense, (4) patterning and algebra, and (5) data management and probability. These questions were developed by a mathematics school curriculum consultant and were designed to be appropriate for students in grades 5–7 (ages 10–12). To score the participants' performance on the math task, 1 point was given for each correct answer. A percentage was then computed to conduct statistical analyses. All questions are provided in the Supplementary Materials.

3.2.5. Quality of the Homework-Helping Interaction

To assess the quality of the parent–child simulated math homework-helping interaction, three two-minute increments at the beginning, middle, and end of the 30-min video recordings were assessed. The interactions within these three two-minute increments were coded using a modified version of the Parent–Child Interaction Scale for the Preschool and School Periods [15,51]. The instrument consists of ten subscales reflecting different dimensions of parent–child interactions. Three of the subscales were classified as "Parental Behavior," and seven subscales as "Dyadic Interaction." In the Parental Behavior category, the scales included: Parental Sensitivity; Respect for the Child's Rhythm; and Parental Effort. In the Dyadic Interaction category, scales included: Relaxation; Neutrality–Joy; Intimacy; Coordination, Appropriate Role; Synchronized Emotions; and Attention Centred on the Task. Each subscale is assigned a score on a continuum ranging from 1 (absence of the dimension's characteristics) and 4 (most optimal quality of the interaction). For example, on the "Parental Sensitivity" scale, a score of 1 would indicate insensitivity characterized by a rigid and controlling behavior pattern of the parent, whereas a score of 4 would reflect a flexible parent who fully supports their child's need for autonomy.

The Parent–Child Interaction Scale was originally developed to assess parent–child interactions in middle childhood during snack time [15] and has since been used in a variety of contexts, including a playful interaction task [52]. Although this study is the first

to use the scale in an education-related context, it is nonetheless ideal because it captures the elements that are important in parent–child relationships. Additionally, this scale has revealed a link between academic performance in children and the quality of parent–child interaction in contexts such as snack time [53].

Training on the Parent–Child Interaction Scale is required prior to using the coding system. The coders participated in an official training session and were certified to code the current sample. Inter-rater reliability (Pearson's intraclass correlations, *rICC*) for each dimension was calculated for eight randomly selected videos, which represented 20% of the total sample. All the scales demonstrated good to excellent inter-rater reliability: Parental Sensitivity (*rICC* = 0.73); Respect for the Child's Rhythm (*rICC* = 0.87); Parental Effort (*rICC* = 0.89); Relaxation (*rICC* = 0.82); Neutrality–Joy (*rICC* = 0.74); Intimacy (*rICC* = 0.87); Coordination (*rICC* = 0.96); Appropriate Role (*rICC* = 0.78); Synchronized Emotions (*rICC* = 0.78); and Attention Centred on the Task (*rICC* = 1.00). Coders debated any discrepancies for the entire sample until they came to an agreement. Given that reliability was initially poor for the Relaxation (*rICC* = 0.44) and Neutrality-Joy (*rICC* = 0.50) subscales, an additional 12 videos were subsequently double coded, accounting for 50% of the total sample.

3.3. Procedure

As part of a larger study, children participated in a two-hour video-recorded session with their primary homework-helping parent. Participants had the option to participate in this study in the lab or at their homes, in which case the research assistants traveled with the necessary testing materials. After completing parental consent and child assent, the parents and children completed a series of tasks: the simulated math homework-helping task; the completion of an online questionnaire; and the WJ-IV. Each task was administered in a counterbalanced order for each dyad (i.e., all six possible orders of task administration were used, counterbalanced across participants) in order to evenly distribute the effects of the task sequence.

Experimenters explained to the dyad that the objective of the simulated math homework-helping task was for the child to solve each math problem. The parent was informed that they were allowed to help their child with the task where they saw fit, as they would normally if this were a regular homework assignment. The child and parent were given 30 minutes to work on the task, with the instruction that it did not matter if they did not complete every question within the allotted time. Dyads were given the option to work directly in the booklet or use a whiteboard to work through the math problems. Final answers were to be recorded directly in the booklet.

After completing the homework-helping task, one experimenter asked the parent to follow them into a separate testing room, and the other experimenter stayed in the room with the child. Both parent and child were asked to complete the questionnaires on a computer. Additionally, the parents and children separately completed subtests of the WJ-IV in individual rooms to assess participants' mathematical achievement.

4. Results

Descriptive statistics and correlations among parent and child measures are shown in Tables 1 and 2, respectively. Zero-order correlations between all variables included in this study can be found in Appendix A, Table A1. In general, parents and children reported experiencing "moderate anxiety" surrounding math-related events specified in the AMAS. There was a significant and positive correlation between parent's and child's math anxiety, $r(39) = 0.44$, $p < 0.01$. All math achievement analyses were conducted using participants' W scores, given that they are the recommended metric for statistical analyses [54]. W scores are created by converting raw scores into Rasch-scale scores with equal intervals. W scores are standardized to a mean of 500, representing the average performance of a 10-year-old within the normative sample [50]. Parents' mean W score of 537.37 (SD = 14.78) indicates that, on average, parents' math achievement was equivalent

to approximately the average performance of individuals older than 21 years old within the normative sample. Children's mean W score of 490.61 (SD = 17.50) indicates that, on average, children's math achievement was equivalent to approximately the average performance of 9-year-olds within the normative sample. The correlation between the parent's and child's math achievement was not significant, $r(39) = 0.11$, $p = 0.48$. Parents' math anxiety was significantly correlated with parents' math achievement, as expected. However, children's math anxiety was not correlated with their math achievement.

Table 1. Descriptive Statistics for All Measures.

	Parents			Children		
	Mean	**SD**	**Range**	**Mean**	**SD**	**Range**
General Anxiety	1.96	0.55	1.05–3.55	1.67	0.40	1.10–2.65
Math Anxiety	2.25	0.96	1.00–4.67	2.31	0.86	1.22–4.44
Math Achievement	536.95	14.72	503.00–565.00	490.93	17.60	450.00–526.00
Math Task Score	80.58	22.87	18.20–100	80.75	22.61	18.20–100
Parental Behavior						
Parental Sensitivity	2.96	0.59	1.50–4.00			
Respect for Child's Rhythm	3.23	0.79	1.00–4.00			
Parental Effort	3.58	0.53	2.00–4.00			
Dyadic Interaction						
Relaxation [a]	3.19	0.71	1.00–4.00	3.19	0.71	1.00–4.00
Neutrality–Joy [a]	2.83	0.50	1.50–4.00	3.28	0.63	1.50–4.00
Intimacy [a]	3.15	0.59	2.00–4.00	3.15	0.59	2.00–4.00
Coordination [a]	3.08	0.68	2.00–4.00	3.07	0.68	2.00–4.00
Appropriate Roles [a]	3.26	0.72	1.50–4.00	3.26	0.72	1.50–4.00
Synchronized Emotions [a]	3.28	0.63	1.50–4.00	3.28	0.63	1.50–4.00
Attention Centred on Task [a]	3.34	0.62	1.50–4.00	3.33	0.62	1.50–4.00

Note. [a] applies to both parent and child.

Table 2. Correlations Among Parent and Child Measures.

	1	**2**	**3**	**4**	**5**	**6**
1. Parent's General Anxiety	–	0.19	0.14	0.14	−0.02	−0.16
2. Parent's Math Anxiety		–	−0.37 *	0.28	0.44 **	−0.22
3. Parent's Math Achievement			–	0.07	−0.20	0.14
4. Child's General Anxiety				–	0.75 **	−0.25
5. Child's Math Anxiety					–	−0.09
6. Child's Math Achievement						–

Note. * $p < 0.05$, ** $p < 0.01$.

4.1. Describing the Quality of the Simulated Math Homework Task Interaction

We evaluated the quality of the parent–child interaction during the simulated math homework task based on the levels of parental sensitivity, respect for the child's rhythm, parental effort, relaxation, neutrality–joy, intimacy, coordination, appropriate roles, emotional synchronization, and attention centered on task. As shown in Appendix A, Table A1, most of the subscales were significantly positively correlated (r values: 0.31 to 0.84). Figure 1 illustrates the distribution of each subscale of the quality of the homework-helping interaction in parent–child dyads, further described below.

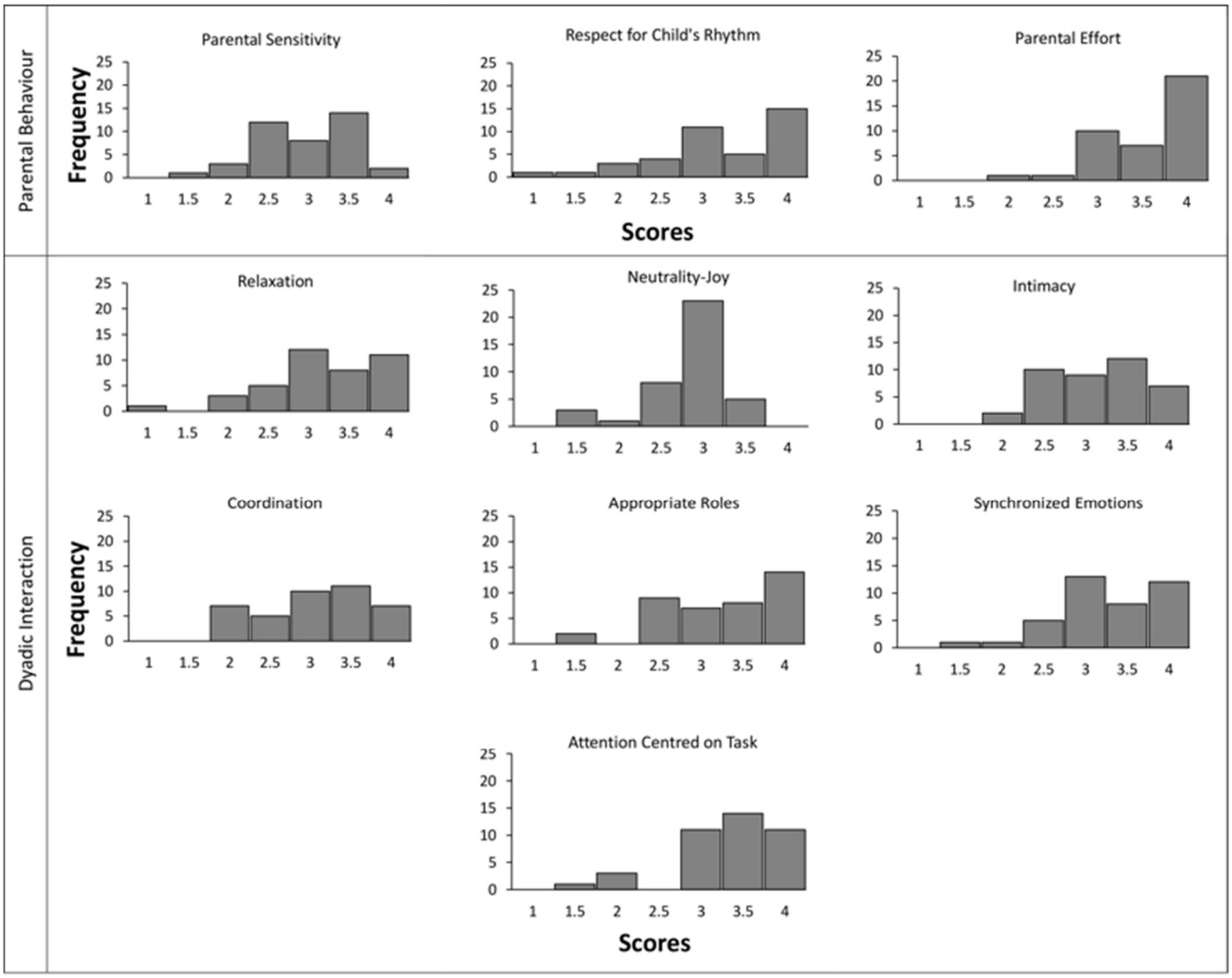

Figure 1. Distribution of ratings across the Quality of Math Interaction subscales. $N = 40$.

4.1.1. Parental Behavior

Parental Sensitivity. Parents across the sample displayed autonomy-supportive behaviors, such as allowing their child to lead the homework activity, paying attention to the child, and offering help and encouragement when needed. Nevertheless, there was variability in the frequency of autonomy-supportive behaviors ranging from 1.5 (i.e., the parent very rarely supported the child's need for autonomy or provided help when needed, and the parent displayed a rigid behavior pattern) to 4 (i.e., the parent was flexible in their approach and fully supported the child's need for autonomy). Most scores fell between 2.5 (i.e., rarely to sometimes supported the child's need for autonomy) and 3.5 (i.e., sometimes to fully supported the child's need for autonomy). Parents' mean score was 2.96 (SD = 0.59), indicating that, on average, parents sometimes to mostly exhibited sensitive behaviors toward their child.

Respect for Child's Rhythm. In general, parents respected the rhythm of the child (i.e., they were not overly intrusive) during the simulated math homework task (M = 3.23; SD = 0.79). Although parents' intrusion scores ranged from 1 (i.e., the parent took over the task) to 4 (i.e., the parent followed the rhythm of the child), most parents scored a 3 or 4 (i.e., the parent temporarily lost a little of the child's rhythm). That is, most parents allowed their child to lead the math task (e.g., determining which question to solve first or the way to solve the question).

Parental Effort. Parental availability to help on the task ranged from 2 (i.e., the parent appeared unsure how to help the child with the homework task, but help was sometimes made available) to 4 (i.e., the parent continually tried to help their child with their homework when needed and remained available to their child whether or not the child was committed to doing the task). No score of 1 was observed in the sample, meaning that all parents were available to help with the task at some point during the interaction. A total of 21 out of 40 dyads scored a 4 on the scale, with the remaining dyads ranging between scores of 3 and 4. Overall, the participants' mean score was 3.58 (SD = 0.53), indicating that, on average, parents made themselves available to help their child with their homework for the majority of the interaction.

4.1.2. Dyadic Interaction

Relaxation. In total, 31 of the 40 dyads scored a 3 or greater (out of 4) on the scale, and the mean score was 3.19 (SD = 0.71), suggesting that, overall, interactions were more relaxed than tense. A score of 3 or greater indicates that most dyads were relaxed, with slight levels of anxiety and the presence of rigidity, but with no apparent nervousness. Only one dyad's interaction scored a 1, meaning that the interaction was rigid with many nervous behaviors and activities (e.g., overexcited).

Neutrality–Joy. Generally, dyadic interactions were neutral rather than negative or fun. No dyad scored a 1 (i.e., negative) or 4 (i.e., fun). The lowest score given for this subscale was 1.5, meaning that the dyad interacted with some negativity from one of the partners. Further, 23 of the 41 dyads scored a 3 (i.e., neutral), with the remaining dyads mostly scoring around 3 (2.5 or 3.5). Indeed, the mean score was 2.83 (SD = 0.50); meaning, on average, the parent–child dyads' effect appeared neutral, indicating that they displayed no overt signs of negativity or pleasure.

Intimacy. With respect to the level of distance/intimacy, interactions were more intimate than distant. The lowest score recorded was a 2 (of 4) for two dyads, indicating that there was a marked use of distance and proximity in an uncomfortable way (e.g., the child did not appear at ease sitting beside their parent or was unable to ask their parent for help) between the parent and child, but it did not characterize the whole interaction. The rest of the dyads' scores were distributed from 2.5 to 4. The mean score was 3.15 (SD = 0.59), indicating that, on average, the dyads appeared generally comfortable in proximity, and the child was generally comfortable asking their parent for help on the task. Additionally, the parent and child often appeared comfortable talking to each other, and the tone of voice was occasionally positive (vs. neutral).

Coordination. Generally, the dyads were more coordinated than not during the interaction. Dyads' scores ranged from 2 (i.e., indicating non-collaboration from a member of the dyad) to 4 (i.e., coordination throughout the interaction). The mean score was 3.08 (SD = 0.68), indicating that, on average, the communication between the parent–child dyad was generally clear, direct, and appropriate, though short episodes that lacked coordination (e.g., little flexibility, confused activities and messages, and uncomfortable silences) were observed.

Appropriate Roles. Most dyads assumed appropriate roles during the task. The lowest score recorded was 1.5 for two dyads, which indicates that role reversal was present. That is, the child took on the role of the caregiver (e.g., the child gave direction to the adult, cared too much about the adult's well-being, or the child entertained the adult). The remaining dyads scored between 2.5 (i.e., the child tried to control) to 4 (i.e., appropriate roles). The mean score was 3.26 (SD = 0.72), indicating that, on average, the parent had more control over the situation than the child for most of the interaction. That is, the parent was able to establish limits and reward desired behaviors.

Synchronized Emotions. There was more emotional sharing than emotional imbalance between the dyads during the interaction. Dyads' scores ranged from 1.5 (i.e., significant mood fluctuations were observed between the dyad and/or there was a stark mismatch between parent and child affect) to 4 (i.e., emotional reciprocity between parent and child

dyad; no abrupt changes in the emotional quality of the interaction). Most scores fell between 2.5 (i.e., parent and child rarely shared the same emotions) to 4. The dyad's mean score was 3.28 (SD = 0.63), indicating that, on average, the emotional quality of the interaction in this sample occasionally changed throughout the interaction (e.g., from a neutral interaction to a negative interaction) or that the parent and child mostly showed the same emotion, but sometimes did not.

Attention Centred on the Task. Overall, dyads were observed as being focused on the math homework task rather than distracted. The sample's scores ranged from 1.5 (i.e., both the parent and child were distracted from the task for most of the interaction; infrequent eye contact) to 4 (i.e., the parent and child were almost always on task and focused on the homework). The sample's scores predominantly fell between 3 (i.e., mostly on task and focused on the homework) to 4. The mean score was 3.33 (SD = 0.62), indicating that, on average, the parent and child were usually on task and focused on the homework but sometimes discussed topics unrelated to the task.

4.2. Hypotheses

4.2.1. Hypothesis 1: The Quality of the Interaction and Simulated Math Homework Task Performance

We next examined how the dyads' math task performance varied in association with the quality of the interaction. Task accuracy scores within the sample ranged from 18.20% to 100% (see Figure 2), indicating that all the dyads attempted at least one problem on the task. Overall, most parent–child dyads performed well on the task, and 58% of the dyads scored 90 or higher on the task (M = 80.75; SD = 22.61). As shown in Table 3, the simulated math homework task performance was positively correlated with eight of the interaction quality subscales: appropriate role; relaxation; neutrality–joy; intimacy; coordination; synchronized emotions; parental sensitivity; and parental respect for the child's rhythm (*r* values: 0.73 to 0.37). Thus, overall, higher-quality interactions were associated with better performance on the math task.

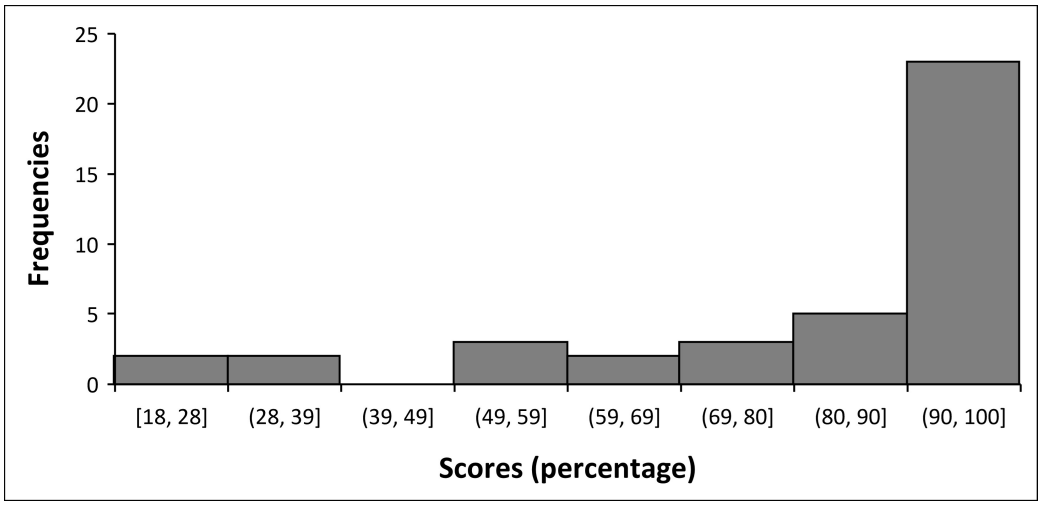

Figure 2. Distribution of Parent–Child Dyads' Performance on the Simulated Math Homework Task. *N* = 40.

Table 3. Correlations between Quality of Interaction and Individual Differences.

Subscales	Task Performance	Math Achievement		Math Anxiety	
		Parent	Child	Parent [a]	Child [b]
Parental Behavior					
Parental Sensitivity	0.56 **	0.37 *	0.37 *	−0.21	−0.46 **
Respect for Child's Rhythm	0.59 **	0.46 **	0.03	−0.24	−0.49 **

Table 3. *Cont.*

Subscales	Task Performance	Math Achievement		Math Anxiety	
		Parent	Child	Parent [a]	Child [b]
Parental Behavior					
Parental Effort	−0.02	0.07	−0.16	−0.03	−0.19
Dyadic Interactions					
Relaxation	0.54 **	0.31 *	0.13	0.01	−0.35 *
Neutrality–Joy	0.73 **	0.17	0.34 *	−0.27	−0.45 **
Intimacy	0.51 **	0.42 **	0.11	−0.03	−0.33 *
Coordination	0.61 **	0.44 **	0.22	−0.23	−0.50 **
Appropriate Roles	0.37 *	0.34 *	0.17	−0.22	−0.42 **
Synchronized Emotions	0.59 **	0.32 *	0.26	−0.06	−0.39 *
Attention Centred on Task	−0.03	0.02	0.07	−0.06	−0.09

Note. [a] partial correlations controlling for parents' general anxiety; [b] partial correlations controlling for children's general anxiety; * $p < 0.05$, ** $p < 0.01$.

4.2.2. Hypothesis 2: The Quality of the Interaction and Math Achievement

Hypothesis 2A: The interaction is more positive for higher math-achieving parents. There was a positive correlation between parents' math achievement and seven of the interaction quality subscales: relaxation; intimacy; coordination; appropriate roles; synchronized emotions; parental sensitivity; and parental respect for the child's rhythm observed during the math-related task interaction (r values: 0.44 to 0.31; see Table 3). That is, the dyads were more likely to assume their appropriate roles, and the interaction was more relaxed, intimate, coordinated, and emotionally synchronized for parents with higher math achievement compared to parents with lower math achievement. Parents with higher math achievement also had higher parental sensitivity scores and lower parental intrusion scores than parents with lower math achievement.

Hypothesis 2B: The interaction is more positive for higher math-achieving children. In contrast to our findings between the quality of the interaction and parents' math achievement, we found that children's math achievement was only related to the degree of neutrality–joy and parental sensitivity displayed during the simulated math homework task (r = 0.34 and 0.37, respectively; see Table 3). Specifically, higher child's math achievement was associated with a more neutral–joyful interaction and more sensitive parental engagement.

4.2.3. Hypothesis 3: The Quality of the Interaction and Math Anxiety

Hypothesis 3A: The interaction is more positive for parents with lower math anxiety. When controlling parents' generalized anxiety, there was no significant correlation between parents' math anxiety and any of the subscales measuring the quality of the interaction during the simulated math homework task.

Hypothesis 3B: The interaction is more positive for children with lower math anxiety. When controlling for children's general anxiety, there were significant negative correlations between children's math anxiety and eight of the interaction quality subscales, relaxation, neutrality-joy, intimacy, coordination, appropriate role, synchronized emotions, parental sensitivity, and parental respect for the child's rhythm (r values: −0.33 to −0.50; see Table 3). That is, the interactions of children with lower levels of math anxiety were more relaxed, more intimate, more coordinated, more emotionally synchronized, and characterized by fewer role reversal patterns relative to parent–child interactions where the children had higher levels of math anxiety. Further, parents of children with lower math anxiety levels were higher in sensitivity and lower in intrusion during the interaction than parents of children with higher math anxiety.

5. Discussion

In the present study, parent–child dyads were recorded engaging in a simulated math homework interaction, which was then coded to assess the quality of the homework-helping interaction. Further, parents' and children's levels of math and general anxiety were obtained using self-reported measures, and standardized assessments of parents' and children's math achievement were administered. We found that, overall, the quality of the interaction for the sample was more positive than negative. Interestingly, the quality of the interactions did vary, and portions of this variability were associated with performance on the simulated homework task, parents' and children's math achievement, and children's math anxiety.

5.1. Relations between the Quality of Interaction and Task Performance

Generally, participants performed well on the simulated math homework task, with more than half of the dyads (23 of 40) scoring greater than 90%. However, the dyads' performance on the math task varied in relation to the quality of the interaction. That is, dyads who obtained higher scores on the simulated math task were observed to be more relaxed, neutral-joyful, intimate, coordinated, and emotionally synchronized, and they exhibited appropriate roles. Further, dyads who obtained higher scores on the simulated math homework task had parents who were observed to be more sensitive and respectful of their child's rhythm. Because of the correlational nature of analyses, one cannot conclude from the present data set whether the higher-quality interaction led to better performance on the simulated math homework task or whether performing well on the simulated math homework task led the dyads to engage in high-quality interactions. Nevertheless, these results suggest that the quality of parent–child interactions is a relevant factor for understanding how the home environment is related to children's academic performance.

5.2. Relations between the Quality of the Interaction and Math Achievement

We found that the quality of dyadic interactions between parents and children in a simulated math homework interaction was more relaxed, intimate, coordinated, and emotionally synchronized for parents with higher math achievement compared to parents with lower math achievement. Moreover, higher math-achieving parents were more sensitive to their child's needs, respectful of their child's rhythm, and were able to take on an appropriate parental role during the homework intervention. It is possible that parents who are higher in math achievement simply have higher quality interactions with their children across other domains, such as science and language arts, as well. It is, however, more reasonable to hypothesize that having a higher level of domain-specific expertise (here, math) allows a parent to be more comfortable and confident in that domain, which, in turn, allows them to facilitate higher quality domain-specific interactions with their child.

With respect to children, the dyadic interactions of children with higher math achievement were more neutrally joyful, and they had parents who showed higher levels of sensitivity compared to those dyads in which the children had lower math achievement scores. These findings align with those reported by Trautwein et al. [34], who reported that lower achievement in children is related to less pleasant homework-related emotions.

5.3. Relations between the Quality of the Interaction and Math Anxiety

We also explored the relationship between parents' and children's math anxiety (controlling for their general anxiety) and the quality of their interactions. In previous research, Maloney et al. [8] showed that when math-anxious parents frequently helped their child with their math homework, their child learned less math and became more math anxious than children of math-anxious parents who did not frequently help their child with math homework. To explain Maloney et al.'s findings [8], DiStefano et al. [31] and Retanal et al. [32] hypothesized that parents' math anxiety contributes to a poorer quality of math homework-helping interactions (i.e., more negatively charged and with more parental control), which, in turn, leads to less optimal math outcomes in children. Our findings did

not support this hypothesis. Specifically, although we found that parents' and children's math anxiety were positively related (i.e., parents who had higher math anxiety tended to have children who also had higher math anxiety); parental math anxiety was not related to the quality of the math homework interaction.

The current findings, along with those of DiStefano et al. [31], who reported that parents with higher levels of math anxiety perceive the math homework-helping environment to be more negative (i.e., more distant/cold, frustrating, conflict-ridden, and stressful), suggest that although parents with higher math anxiety levels perceive their math homework-helping interactions as more negative than parents with lower levels of math anxiety, those interactions are not rated as more negative by trained coders. Thus, adults with higher levels of math anxiety may generally perceive math-related experiences more negatively than adults with lower levels of math anxiety. This conclusion is consistent with the findings of Hunt and Maloney [38], who found that adults' math anxiety was related to their appraisals of previous math experiences.

On the other hand, children's math anxiety was negatively related to the quality of the math homework-helping interactions. Specifically, the dyads with lower math-anxious children displayed more relaxation, neutrality/joy, intimacy, coordination, and emotional synchronization. Further, parents of children with lower math anxiety exhibited higher sensitivity to their child's needs and more respect for their child's rhythm, and these dyads were less frequently found to have inverse roles in their relationship. Again, because these data are correlational, we cannot infer whether lower-quality math-related interactions between parents and their children occur as a result of children having increased math anxiety or whether lower-quality math-related interactions result in children developing math anxiety. It is also, of course, possible that a reciprocal relationship exists between children's math anxiety and the quality of their math-related interactions with their parents.

Taken together, the results of the present study suggest that, although parent–child dyads generally performed well on the simulated math homework task, task performance varied in relation to the quality of the interaction: higher quality interactions were associated with higher accuracy on the math task. Furthermore, the variability in the quality of the interaction was associated with parents' and children's math achievement and children's, but not parents', math anxiety. These results contradict the notion that parents' math anxiety contributes to poorer quality math homework-helping interactions, in turn leading to less optimal math outcomes in children (cf. [31,32]). These results, however, are consistent with previous research on childhood anxiety more generally, in which mothers of anxious children displayed more negativity during an interaction in which the child was asked to complete cognitive tasks [55]. Although these data may lend some support to the link between children's anxiety and parents' negativity, it is not yet known whether parents' negativity is a response to their child's math anxiety or whether parents' negativity causes children to become more math anxious.

6. Limitations and Future Research

This study offers novel insights into the quality of homework-like math interactions between parents and their 10- to 12-year-old children. We identified several factors (i.e., parents' and children's math achievement and children's math anxiety) that were associated with the variability in the quality of the homework-helping interaction and accuracy of the homework task. We acknowledge, however, that this study has limitations. Data from this study were derived from a small sample (n = 40), and thus, the findings should be interpreted with caution. In addition, this study was conducted using a Canadian sample. As such, readers should be cautious about extrapolating the present findings to parent–child math homework-helping interactions in other parts of the world. Future research should aim to explore cross-cultural differences among dyadic homework-helping practices.

Because this study was correlational and the data were collected at a single time point, inferences cannot be made about the causal direction of the observed relations. In future research, a longitudinal design may provide more information about whether children's

math anxiety develops because of the negative quality of the homework-helping interaction or if, rather, higher math-anxious children's engagement with their parents affects how the quality of the interaction unfolds. It is also possible that there are reciprocal relations between children's math anxiety and their experiences in homework interactions. For example, Else-Quest et al. [56] found that mothers were more likely to show negative emotions (i.e., contempt) toward their child during math homework-helping interaction if their child performed poorly in a prior math task. Further, the emotions that mothers and their child displayed when working on mathematics problems at home were found to be significantly positively correlated, regardless of the emotional valence. The researchers posited that this relation might show how parents influence their child's emotions during homework-helping interactions. In line with those findings, the use of dyadic data analysis to investigate reciprocal relations may be an interesting avenue for future research.

Further, in the present study, we focused on the primary math homework-helping parent and their child. We did not consider other factors that may account for variability in the quality of the interaction between parents and their children. For example, children may have access to resources (e.g., school support, tutoring, help from other members of the household, etc.), which could influence their approach to math-related activities. Given that recent research highlighted a relation between a lower frequency of home numeracy activities and higher levels of math anxiety in children [5], future research should take the time parents spend engaging in math activities with their children into account to provide context for the homework-helping interaction.

7. Implications and Conclusions

One major strength of this study is that we measured both parent and child factors and directly observed dyadic interactions to explore the relations between math anxiety, math achievement, and math homework-helping interaction. Understanding the factors that influence the interactions between parents and children in a math-related situation is essential to developing effective interventions to scaffold children's learning, especially given the emphasis on the role of parental involvement in children's education (see [57]). We demonstrated that the accuracy of a simulated math homework-helping task is related to the variability in the quality of the interaction, such that higher-quality interactions were associated with greater performance. Further, we showed that the variability in the quality of the interaction related to the math achievement of both parents and children, such that the stronger parents and children were in math in general, the higher the quality of their math-related interaction. The quality of parent–child interactions was also related to the math anxiety of children, but not of parents, such that the overall quality of the interactions was more negative when children were higher in math anxiety.

These data not only highlight the importance of understanding how cognitive and emotional factors can relate to the quality of dyadic math-related interactions but also the importance of using multiple study methods. Indeed, the story revealed by the self-report data did not align perfectly with that shown in the experimenter observations. Thus, multiple approaches will help researchers to garner a rich understanding of the various factors at play. This study is the first, to our knowledge, to have taken this innovative approach to studying the relationship between parents' and children's math anxiety, math achievement, and interactions within a math-related context.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/educsci13030307/s1.

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Appendix A

Table A1. Simple Correlations Among All Variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Parent's General Anxiety	–	0.14	0.19	−0.02	0.14	−0.15	0.27	0.02	0.05	−0.15	−0.20	0.14	0.13	0.03	−0.05	0.07	0.15
2. Child's General Anxiety		–	0.28	0.75 **	0.07	−0.25	−0.03	−0.06	−0.20	−0.04	−0.28	−0.12	−0.00	−0.16	−0.13	−0.20	0.09
3. Parent's Math Anxiety			–	0.44 **	−0.36 *	−0.22	−0.27	−0.20	−0.23	−0.06	−0.03	−0.24	−0.01	−0.22	−0.22	−0.04	−0.03
4. Child's Math Anxiety				–	−0.20	−0.09	−0.33 *	−0.35 *	−0.46 **	−0.16	−0.43 **	−0.38 *	−0.22	−0.44 **	−0.37 *	−0.33 *	0.01
5. Parent's Math Achievement					–	0.14	0.49 **	0.37 *	0.47 **	0.07	0.32 *	0.17	0.42 **	0.44 **	0.34 *	0.33 *	0.02
6. Child's Math Achievement						–	0.31	0.37*	0.03	−0.16	0.13	0.34 *	0.11	0.22	0.18	0.26	0.07
7. Math Task Score							–	0.56 **	0.59 **	−0.02	0.54 **	0.73 **	0.51 **	0.61 **	0.37 *	0.59 **	−0.03
8. Parental Sensitivity								–	0.67 **	0.40 *	0.56 **	0.69 **	0.69 **	0.84 **	0.69 **	0.61 **	0.30
9. Respect for Child's Rhythm									–	0.14	0.74 **	0.60 **	0.75 **	0.78 **	0.62 **	0.62 **	0.32 *
10. Parental Effort										–	0.22	0.10	0.31 *	0.42 **	0.34 *	−0.01	0.29
11. Relaxation											–	0.58 **	0.60 **	0.76 **	0.60 **	0.75 **	0.14
12. Neutrality–Joy												–	0.53 **	0.76 **	0.51 **	0.64 **	0.28
13. Intimacy													–	0.82**	0.54 **	0.52 **	0.50 **
14. Coordination														–	0.73 **	0.70 **	0.47 **
15. Appropriate Roles															–	0.52 **	0.33 *
16. Synchronized Emotions																–	0.20
17. Attention Centered on Task																	–

Note. * $p < 0.05$, ** $p < 0.01$.

References

1. Duncan, G.J.; Dowsett, C.J.; Claessens, A.; Magnuson, K.; Huston, A.C.; Klebanov, P.; Pagani, L.S.; Feinstein, L.; Engel, M.; Brooks-Gunn, J.; et al. School Readiness and Later Achievement. *Dev. Psychol.* **2007**, *23*, 1428. [CrossRef] [PubMed]
2. Hart, S.A.; Ganley, C.M.; Purpura, D.J. Understanding the home math environment and its role in predicting parent report of children's math skills. *PLoS ONE* **2016**, *11*, e0168227. [CrossRef] [PubMed]
3. Daucourt, M.C.; Napoli, A.R.; Quinn, J.M.; Wood, S.G.; Hart, S.A. The Home Math Environment and Math Achievement: A Meta-Analysis. *Psychol. Bull.* **2021**, *147*, 565. [CrossRef] [PubMed]
4. Ashcraft, M.H. Math anxiety: Personal, educational, and cognitive consequences. *Curr. Dir. Psychol. Sci.* **2002**, *11*, 181–185. [CrossRef]
5. Guzmán, B.; Rodríguez, C.; Ferreira, R.A. Effect of parents' mathematics anxiety and home numeracy activities on young children's math performance-anxiety relationship. *Contemp. Educ. Psychol.* **2023**, *72*, 102140. [CrossRef]
6. Soni, A.; Kumari, S. The Role of Parental Math Anxiety and Math Attitude in Their Children's Math Achievement. *Int. J. Sci. Math. Educ.* **2017**, *15*, 331–347. [CrossRef]
7. Szczygieł, M. When does math anxiety in parents and teachers predict math anxiety and math achievement in elementary school children? The role of gender and grade year. *Soc. Psychol. Educ.* **2020**, *23*, 1023–1054. [CrossRef]
8. Maloney, E.A.; Ramirez, G.; Gunderson, E.A.; Levine, S.C.; Beilock, S.L. Intergenerational effects of parents' math anxiety on children's math achievement and anxiety. *Psychol. Sci.* **2015**, *26*, 1480–1488. [CrossRef]
9. The Varkey Foundation. Global Parents' Survey. 2018. Available online: https://www.varkeyfoundation.org/media/4340/vf-parents-survey-18-single-pages-for-flipbook.pdf (accessed on 7 March 2023).

10. Doctoroff, G.L.; Arnold, D.H. Doing homework together: The relation between parenting strategies, child engagement, and achievement. *J. Appl. Dev. Psychol.* **2017**, *48*, 103–113. [CrossRef]
11. Gonida, E.N.; Cortina, K.S. Parental involvement in homework: Relations with parent and student achievement-related motivational beliefs and achievement. *Br. J. Educ. Psychol.* **2014**, *84*, 376–396. [CrossRef]
12. Cooper, H.; Lindsay, J.J.; Nye, B. Homework in the home: How student, family, and parenting-style differences relate to the homework process. *Contemp. Educ. Psychol.* **2000**, *25*, 464–487. [CrossRef] [PubMed]
13. Epstein, J.L.; van Voorhis, F.L. More than minutes: Teachers' roles in designing homework. *Educ. Psychol.* **2001**, *36*, 181–193. [CrossRef]
14. Wilder, S. Effects of parental involvement on academic achievement: A meta-synthesis. *Educ. Rev.* **2014**, *66*, 377–397. [CrossRef]
15. Moss, E.; Humber, N.; Roberge, L. *Grille D'interactions Parent-Enfant Pour les Périodes Préscolaire et Scolaire*; Unpublished Manuscript; Université du Québec à Montréal: Montreal, QC, Canada, 1996.
16. Barroso, C.; Ganley, C.M.; McGraw, A.L.; Geer, E.A.; Hart, S.A.; Daucourt, M.C. A meta-analysis of the relation between math anxiety and math achievement. *Psychol. Bull.* **2021**, *147*, 134–168. [CrossRef]
17. Namkung, J.M.; Peng, P.; Lin, X. The relation between mathematics anxiety and mathematics performance among school-aged students: A meta-analysis. *Rev. Educ. Res.* **2019**, *89*, 459–496. [CrossRef]
18. Zhang, J.; Zhao, N.; Kong, Q.P. The relationship between math anxiety and math performance: A meta-analytic investigation. *Front. Psychol.* **2019**, *10*, 1613. [CrossRef]
19. Bronfenbrenner, U. Ecology of the family as a context for human development: Research perspectives. *Dev. Psychol.* **1986**, *22*, 723. [CrossRef]
20. Eccles, J.S. Families, schools, and developing achievement-related motivations and engagement. In *Handbook of Socialization: Theory and Research*; Grusec, J.E., Hastings, P.D., Eds.; The Guilford Press: New York, NY, USA, 2007; pp. 665–691.
21. Boonk, L.; Gijselaers, H.J.M.; Ritzen, H.; Brand-Gruwel, S. A review of the relationship between parental involvement indicators and academic achievement. *Educ. Res. Rev.* **2018**, *24*, 10–30. [CrossRef]
22. Hoover-Dempsey, K.V.; Sandler, H.M. Parental involvement in children education: Why does it make a difference? *Teach. Coll. Rec.* **1995**, *97*, 311–331. [CrossRef]
23. Hoover-Dempsey, K.V.; Battiato, A.C.; Walker, J.M.T.; Reed, R.P.; DeJong, J.M.; Jones, K.P. Parental involvement in homework. *Educ. Psychol.* **2001**, *36*, 195–209. [CrossRef]
24. Dumont, H.; Trautwein, U.; Nagy, U.G.; Nagengast, B. Quality of parental homework involvement: Predictors and reciprocal relations with academic functioning in the reading domain. *J. Educ. Psychol.* **2014**, *106*, 144. [CrossRef]
25. Chen, C.; Stevenson, H.W. Homework: A cross-cultural examination. *Child Dev.* **1989**, *60*, 551–561. [CrossRef] [PubMed]
26. Hill, N.E.; Tyson, D.F. Parental involvement in middle school: A meta-analytic assessment of the strategies that promote achievement. *Dev. Psychol.* **2009**, *45*, 740–763. [CrossRef] [PubMed]
27. Pomerantz, E.M.; Eaton, M.M. Maternal intrusive support in the academic context: Transactional socialization processes. *Dev. Psychol.* **2001**, *37*, 174–186. [CrossRef] [PubMed]
28. Ginsburg, G.S.; Schlossberg, M.C. Family-based treatment of childhood anxiety disorders. *Int. Rev. Psychiatry* **2002**, *14*, 143–154. [CrossRef]
29. Alreshidi, A.M.; Alsharif, K.M.; Kandeel, R.A.A. Five important parental involvement variables that affect young children's mathematical achievements: A comparative study. *Educ. Urban Soc.* **2022**, *54*, 187–195. [CrossRef]
30. Cosso, J.; Finders, J.K.; Duncan, R.J.; Schmitt, S.A.; Purpura, D.J. The home numeracy environment and children's math skills: The moderating role of parents' math anxiety. *J. Exp. Child Psychol.* **2023**, *227*, 105578. [CrossRef]
31. DiStefano, M.; O'Brien, B.; Storozuk, A.; Ramirez, G.; Maloney, E.A. Exploring math anxious parents' emotional experience surrounding math homework-help. *Int. J. Educ. Res.* **2020**, *99*, 101526. [CrossRef]
32. Retanal, F.; Johnston, N.B.; di Lonardo Burr, S.M.; Storozuk, A.; Distefano, M.; Maloney, E.A. Controlling-supportive homework help partially explains the relation between parents' math anxiety and children's math achievement. *Educ. Sci.* **2021**, *11*, 620. [CrossRef]
33. Leone, C.M.; Richards, H. Classwork and homework in early adolescence: The ecology of achievement. *J. Youth Adolesc.* **1989**, *18*, 531–548. [CrossRef]
34. Trautwein, U.; Niggli, A.; Schnyder, I.; Lüdtke, O. Between-teacher differences in homework assignments and the development of students' homework effort, homework emotions, and achievement. *J. Educ. Psychol.* **2009**, *101*, 176–189. [CrossRef]
35. Oh, D.D.; Barger, M.M.; Pomerantz, E.M. Parents' math anxiety and their controlling and autonomy-supportive involvement in children's math learning: Implications for children's math achievement. *Dev. Psychol.* **2022**, *58*, 2158–2170. [CrossRef] [PubMed]
36. Wu, J.; Barger, M.M.; Oh, D.; Pomerantz, E.M. Parents' daily involvement in children's math homework and activities during early elementary school. *Child Dev.* **2022**, *93*, 1347–1364. [CrossRef]
37. Dubois-Comtois, K.; Cyr, C.; Moss, E. Attachment behavior and mother-child conversations as predictors of attachment representations in middle childhood: A longitudinal study. *Attach. Hum. Dev.* **2011**, *13*, 335–357. [CrossRef] [PubMed]
38. Hunt, T.E.; Maloney, E.A. Appraisals of previous math experiences play an important role in math anxiety. *Ann. N. Y. Acad. Sci.* **2022**, *1515*, 143–154. [CrossRef] [PubMed]
39. Cameron, L.; Bartel, L. Homework Realities: A Canadian Study of Parental Opinions and Attitudes. 2008. Available online: https://policycommons.net/artifacts/1228088/homework-realities/1781157/ (accessed on 7 March 2023).

40. Hopko, D.R.; Mahadevan, R.; Bare, R.L.; Hunt, M.K. The Abbreviated Math Anxiety Scale (AMAS): Construction, validity, and reliability. *Assessment* **2003**, *11*, 178–182. [CrossRef] [PubMed]
41. Ma, M.; Li, D.; Zhang, L. Longitudinal prediction of children's math anxiety from parent-child relationships. *Learn. Individ. Differ.* **2021**, *88*, 102016. [CrossRef]
42. Wang, Z.; Hart, S.A.; Kovas, Y.; Lukowski, S.; Soden, B.; Thompson, L.A.; Plomin, R.; McLoughlin, G.; Bartlett, C.W.; Lyons, I.M.; et al. Who is afraid of math? Two sources of genetic variance for mathematical anxiety. *J. Child Psychol. Psychiatry* **2014**, *55*, 1056–1064. [CrossRef]
43. Spielberger, C.D. State-Trait Anxiety Inventory for Adults. *APA Psyc. Tests.* **1983**. [CrossRef]
44. Spielberger, C.D. *State-Trait Anxiety Inventory: Bibliography*, 2nd ed.; Consulting Psychologists Press: Palo Alto, CA, USA, 1989.
45. Julian, L.J. Measures of anxiety: State-Trait Anxiety Inventory (STAI), Beck Anxiety Inventory (BAI), and Hospital Anxiety and Depression Scale-Anxiety (HADS-A). *Arthritis Care Res.* **2011**, *63*, S467–S472. [CrossRef]
46. Spielberger, C.D.; Lushene, R.E.; Montuori, J.; Platzek, D. *The State-Trait Anxiety Inventory for Children (Preliminary Manual)*; Consulting Psychologists Press: Palo Alto, CA, USA, 1973.
47. Kirisci, L.; Clarck, D.B. Reliability and validity of the State-Trait Anxiety Inventory for Children in an adolescent sample: Confirmatory factor analysis and item response theory. *J. Child Adolesc. Subst. Abuse* **1992**, *5*, 57–70. [CrossRef]
48. Schrank, F.A.; Wendling, B.J. The Woodcock-Johnson IV: Tests of cognitive abilities, tests of oral language, tests of achievement. In *Contemporary Intellectual Assessment: Theories, Tests and Issues*, 1st ed.; The Guilford Press: New York, NY, USA, 2018; pp. 383–451.
49. Mather, N.; Wendling, B.J. *Examiner's Manual: Woodcock Johnson IV Tests of Achievement*; Rolling Meadows: Riverside, IL, USA, 2014.
50. Ontario Ministry of Education. The Ontario Curriculum, Grades 1–8: Mathematics. 2005. Available online: https://www.edu.gov.on.ca/eng/document/curricul/elementary/math1-8e.pdf (accessed on 7 March 2023).
51. Bureau, J.F.; Yurkowski, K.; Schmiedel, S.; Martin, J.; Moss, E.; Pallanca, D. Making children laugh: Parent-child dyadic synchrony and preschool attachment. *Infant. Ment. Health J.* **2014**, *35*, 482–494. [CrossRef] [PubMed]
52. Bureau, J.F.; Trepiak, P.; Deneault, A.A.; Boulerice, K. Stability of father- and mother-child synchrony in a playful setting from preschool to middle childhood: Associations with children's behavior problems. *Early Child Res. Q.* **2021**, *57*, 167–177. [CrossRef]
53. Moss, E.; St-Laurent, D. Attachment at school age and academic performance. *Dev. Psychol.* **2001**, *37*, 863–874. [CrossRef] [PubMed]
54. McGrew, K.S.; LaForte, E.M.; Schrank, F.A. *Technical Manual*; vol. Woodcock-Johnson IV; Rolling Meadows: Riverside, IL, USA, 2014.
55. Hudson, J.L.; Rapee, R.M. Parent-child interactions and anxiety disorders: An observational study. *Behav. Res. Ther.* **2001**, *39*, 1411–1427. [CrossRef]
56. Else-Quest, N.M.; Hyde, J.S.; Hejmadi, A. Mother and child emotions during mathematics homework. *Math. Think. Learn.* **2008**, *10*, 5–35. [CrossRef]
57. Ministry of Education. Stay Involved in your Child's Education. Government of Ontario. 2022. Available online: https://www.ontario.ca/page/stay-involved-your-childs-education (accessed on 7 March 2023).