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Article

# Controlling-Supportive Homework Help Partially Explains the Relation between Parents' Math Anxiety and Children's Math Achievement

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**Abstract:** Previous research has shown that math homework help of higher-math-anxious parents impedes children's math learning and facilitates the development of math anxiety. In the present study, we explored a possible explanation for this phenomenon by examining the relations between parents' math anxiety, their math homework-helping styles (i.e., autonomy- and controlling-supportive), and their child's math achievement. Parents of children ages 11 to 14 completed an online survey. Using path analysis, we examined the relations among parental factors (i.e., math anxiety, math ability, and homework-helping styles) and child math achievement. Parents' math anxiety was positively related to both autonomy-supportive and controlling-supportive math homework-helping styles. Notably, controlling-supportive style partially mediated the relation between parents' math anxiety and their children's math achievement. Thus, it is possible that the use of a controlling-supportive math homework-helping style may explain why the homework help offered by higher-math-anxious parents is detrimental to their children's math learning. Identifying negative relations between parent factors and children's math outcomes is crucial for developing evidence-based math learning interventions.

**Keywords:** math anxiety; parental involvement; homework help; autonomy support; control; self-determination theory



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## 1. Introduction

Math anxiety, which can be defined as feelings of apprehension, tension, and/or fear about math, has a negative effect on math success (for a review see [1]). Students who are math anxious are more likely than their non-math-anxious peers to score lower on tests of math achievement and to avoid coursework, degrees, and career paths that involve math [2–4].

Not only does one's math anxiety relate to their own achievement in math, but the math anxiety of a mentor can negatively impact the math achievement and math anxiety of their mentees. In the context of the school environment, negative relations have been found between early elementary teachers' math anxiety and their students' math achievement such that when teachers are higher in math anxiety, their students learn less math [5–7]. While many interventions and policies aimed at improving math education focus on classroom and school-level factors [8], they often overlook the crucial role that parents play in their child's math education [9]. Indeed, parents' attitudes towards math can have important implications for their children's math learning and math attitudes [10].

Maloney and colleagues demonstrated that when parents who are themselves anxious about math frequently help their children with their math homework, their children learn

less math and experience increased levels of math anxiety over the school year relative to children whose parents are lower in math anxiety or who do not help frequently with math homework [10]. While it is not evident why the math homework help of higher-math-anxious parents is less optimal, the fact that parents' math anxiety is only negatively related to their children's math learning when the parents frequently help with math homework highlights the importance of the homework interaction itself. This further suggests that math-anxious parents may be employing different, and potentially harmful, homework-helping styles relative to their lower-math-anxious counterparts. In the present study, we aimed to understand how the math homework-helping interactions between the parent-child dyad differ as a function of parents' math anxiety, with a focus on different homework-helping styles.

## 2. Parental Involvement in Homework

Educational and developmental psychologists have long been interested in the relation between parenting styles and children's academic achievement [11]. Over the decades, researchers have proposed various frameworks of parenting styles (e.g., [12–19]) which have generally considered two fundamental components: a supportive component and a controlling component [20]. These components are tightly aligned with Self-Determination Theory (SDT; [21]), which posits that humans have three core psychological needs; specifically, that of autonomy, competence, and belonging. A core tenant of SDT is that activities that allow us to fulfill either our need for autonomy, competence, or belonging will be associated with increased intrinsic motivation and, in turn, positive outcomes. Any activity in which our needs for autonomy, competence, or belonging are thwarted will result in a decrease in intrinsic motivation, an increase in extrinsic motivation, and negative outcomes [21]. With respect to parental involvement in homework, the quality of the homework-support is typically assessed with respect to SDT with autonomy-supportive homework support being considered beneficial and controlling-supportive homework-help bring considered detrimental. Indeed, recent literature highlights the positive and negative effects that autonomy-supportive and controlling-supportive involvement, respectively, can have on children's academic outcomes [22–24]. Given these findings, one possible explanation as to why higher-math-anxious parents' homework involvement is less optimal for children's math achievement may be rooted in the homework-helping styles they are employing.

## 3. Homework-Helping Styles

### 3.1. *Autonomy Support*

According to Self-Determination Theory (SDT; [21]), one critical dimension of parenting in general is engaging in autonomy-supportive behaviors. Autonomy-supportive behaviors are similar to the behaviors exhibited by parents who adopt an authoritative parenting style (i.e., high demands and high emotional responsiveness [25,26], and facilitate children's needs for autonomy, competence, and belonging [23,27]. Parents who adopt autonomy-supportive homework-helping styles allow their children to explore their environment, initiate their own behavior, and encourage their children to take an active role in problem solving [27,28]. Moreover, the parent is readily available to assist, while allowing the child to lead the interaction and decide when assistance is needed. In an interaction surrounding homework, for example, a parent engaging in autonomy support might ask for their child's input, try to understand their child's perspective on approaches for solving the homework assignment, and encourage their child to work in their own way. In general, autonomy-supportive parental involvement has been demonstrated to increase children's positive emotions [29], intrinsic homework motivation [30], and academic achievement [31,32]. Drawing from the literature on teachers, autonomy-supportive practices have been demonstrated to both directly (e.g., [33]) and indirectly (e.g., [34]) lead to higher math achievement in students.

In line with the SDT [21], autonomy support is believed to be beneficial to student learning outcomes as it fulfills students' basic psychological needs (autonomy, competence,

and belonging), consequently enhancing their intrinsic motivation for learning [21,35], which, in turn, fosters student engagement and achievement [34,36,37]. Indeed, studies have shown a positive association between parental autonomy support and students' math intrinsic motivation (i.e., the enjoyment and interest in math) [38,39]. Further, in a sample of 637 adolescent students, Wang and colleagues [34] found that students' math intrinsic motivation mediated the relation between teachers' autonomy support and students' math engagement. Researchers have also shown that math intrinsic motivation predicts students' math school grades [39,40], SAT math scores [40], and growth in math performance over time [41,42].

### 3.2. Controlling Support

In contrast, a parent engaging in controlling support might tell the child exactly how to do the homework and ask for little, if any, input from the child in the discussion. Controlling-supportive behaviors are similar to the behaviors exhibited by parents who adopt authoritarian parenting styles (i.e., high demands on the child via commands and directives with low emotional responsiveness [25,26]). When parents adopt controlling-supportive homework-helping styles, they dominate the interaction by exerting excessive control and/or pressure on the child [22,27,36]. The parent may try to regulate the child through excessive use of demand or instruction, restrict the child's attempts at autonomous problem-solving, and maintain a parent-centric perspective [43,44]. An important aspect of controlling-supportive behavior is intrusion [45]. Parents may engage in intrusive behaviors during homework help, such as monitoring the child's work when not asked to do so and offering unwanted solutions or assistance [22,23,44]. In addition, controlling support has been linked to children's lower math intrinsic motivation [27] and lower math achievement [27,46]. According to SDT, the adverse influence of controlling support stems from its potential to diminish children's sense of autonomy and competence [21,47,48], thus ultimately thwarting the expected link between intrinsic motivation and achievement when needs for competence and autonomy are fulfilled. Unfortunately, children who are struggling in school are more likely to prompt controlling-supportive help from their parents [47,49], perpetuating the negative cycle of parental controlling support and reduced academic achievement.

While there has been some debate in the literature regarding the relation between autonomy support and controlling support, research indicates that we should consider these constructs not as opposite ends of a continuum, but rather as distinct constructs [50]. Indeed, research by Vansteenkiste and Ryan [51] reported that parental autonomy support and controlling support are related but not merely diametrical constructs. It is rare for children to enjoy complete autonomy [52], and it is more realistic to expect that children enjoy different degrees of autonomy and control from their parents simultaneously. In other words, parents can simultaneously be high in or low in both autonomy support and controlling support [22,35], and the absence of one support strategy does not necessarily indicate the presence of another [53]. Further, the terms used to describe these constructs in the context of the homework environment have been inconsistent in previous literature. While some researchers consider the terms "support" or "supportive" to be synonymous with autonomy styles exclusively (e.g., [23,27,49,54,55]), others use the term "support" to refer to the act of parental engagement in the homework-helping interaction in general [22,44]. As such, even intrusive and controlling behavior would be considered "supportive" parenting styles. In line with the latter, we conceptualize a controlling homework-helping style as being a form of well-intentioned support, even if it is maladaptive. In this paper, we refer to controlling and intrusive styles as "controlling support".

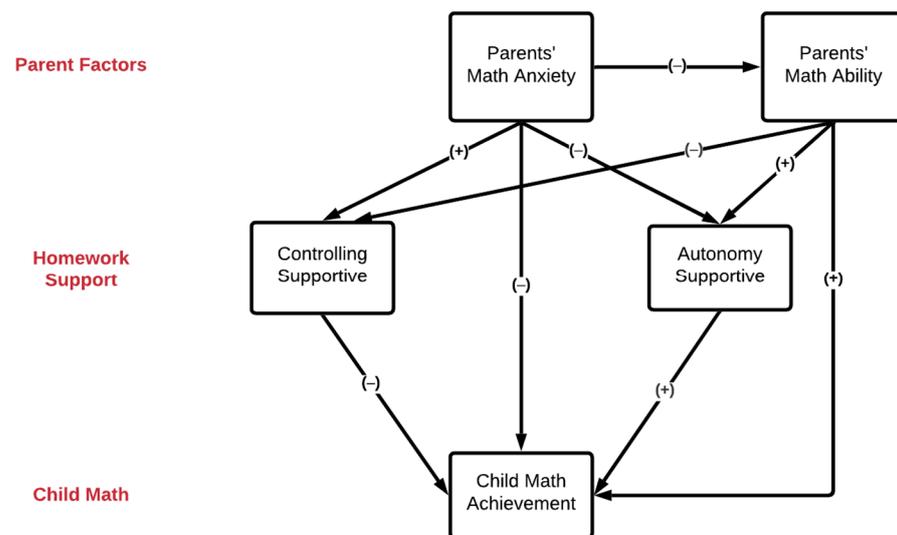
### 3.3. Influence of Math Anxiety on Homework-Helping Styles

Whether parents' math anxiety influences the type of homework-helping style that they use when helping their children with math homework remains an empirical question. However, we can draw from research on teachers' math anxiety and pedagogical strategies

to generate testable hypotheses. For example, Karp [56] found that elementary school teachers who were anxious about math relied heavily on rigid instruction such as rote learning (i.e., based on rules and memorization) and teacher-centric instruction (i.e., dominating the teaching process and proceeding without student contribution). Conversely, teachers who were less anxious about math used more flexible instruction such as conceptual learning (i.e., based on reasoning and concepts) and student-centric instruction, both of which encourage students to take the lead in the learning process and discover mathematical concepts rather than passively applying mathematical rules [56]. In this sense, the teaching strategies that higher-math-anxious teachers use in math instruction resemble the controlling support that some parents provide, wherein parents dominate the interaction and restrict children's attempts at autonomous problem-solving. Meanwhile, the strategies that lower-math-anxious teachers use more closely resemble the autonomy support that some parents provide, wherein children can explore and initiate their own solution method even though it may deviate from the solution process taught in class. Against this background, we posit that, akin to what is seen in teachers, parents who are higher in math anxiety will also engage in less autonomy-supportive and more controlling-supportive pedagogical strategies when helping their children with math.

#### 4. The Present Study

The overarching objective of this study was to investigate the relations between parents' math anxiety, their homework-helping styles, and their children's math achievement (see Figure 1). The homework-helping styles used by parents to help their children with homework can either be beneficial (e.g., via autonomy support) or detrimental (e.g., via controlling support). Further, because recent work reported that parents' math anxiety may indirectly influence children's math achievement through homework-helping interactions [10] and that the quality of interactions is more important than the quantity [23,57], we theorize that one reason that parents' math anxiety is negatively related to children's math achievement is because higher-math-anxious parents are less likely to engage in autonomy-supportive homework help and are more likely to engage in controlling-supportive homework help. From this theory, the following hypotheses emerged: (1) Parents who report higher math anxiety will have children with lower math achievement; (2a) Parents who report higher math anxiety will also report engaging in more controlling-intrusive homework-help and (2b) less autonomy-supportive homework help; (3a) The degree to which parents engage in autonomy-supportive homework-helping styles will partially mediate the negative relation between parents' math anxiety and children's math achievement; (3b) the degree to which parents engage in controlling-supportive homework-helping styles will partially mediate the negative relation between parents' math anxiety and their child's math achievement. Given that there is a moderate correlation between math anxiety and math achievement [58–60], we felt it prudent to take parents' math ability into consideration when examining the relations between parents' math anxiety, their homework-helping styles, and their children's math achievement.



**Figure 1.** Theoretical Model Summarizing Expected Relations Among Parent Factors, Homework-Helping Styles and Child Math Achievement. Note. (+) and (−) indicate predicted positive and negative pathways, respectively.

## 5. Method

### Participants

Although math anxiety can be observed in children as young as 6 years of age [61], when looking across studies of students from primary school to post-secondary education, some of the strongest negative relations between math anxiety and math achievement have been found during the middle school years [62]. For this reason, we recruited North American parents of children in grades 6 to 8 ( $N = 429$ ; child ages ranging from 11 to 14) through social media (i.e., Facebook, Twitter, Instagram), a database from a university in Canada, and Amazon’s Mechanical Turk (MTurk) to participate in the present study. We collected data from December 2020 to March 2021. We offered participants recruited through social media or the university database a \$5 gift card as compensation for participation. We compensated participants recruited through MTurk at a rate of \$8 USD per hour. We only invited MTurk users with a history of high-quality responses (i.e., a HIT Approval Rate  $\geq 99\%$  and at least 500 approved HITs) to participate in this study. We excluded participants who failed either of the two gatekeeping questions designed to prevent fraudulent respondents from accessing the survey (i.e., bots;  $n = 103$ ). We excluded participants who did not meet eligibility criteria for the study, that is, people who said they are not a parent/guardian of a child in grades 6, 7, or 8 ( $n = 31$ ) or are not the parent/guardian who most frequently helps with homework ( $n = 7$ ). We removed participants who completed 15% or less of the survey ( $n = 25$ ) or who completed the survey in under eight minutes ( $n = 5$ ), as the survey was designed to take roughly 30 minutes to complete. Moreover, we removed participants who responded incorrectly to two or more of the three manipulation checks in the survey ( $n = 9$ ; e.g., “Please select from the options, such as Low Anxiety and High Anxiety, to indicate your response. If you are paying attention, select ‘Some Anxiety’”) [63]. We identified and removed participants who used the same response category, consecutively, on measures that require reverse scoring (i.e., the State Trait Anxiety Inventory-Trait;  $n = 2$ ) [64]). Though it has been recommended to remove participants who provide the same response category equal to or greater than half the total length of the scale [65], we elected to use a less conservative cut-off of consistent responses equal to or greater than three quarters of length of the scale (i.e., 15 or more items). The final sample size ( $N = 247$ ) is sufficient for our research purposes, as correlations tend to stabilize at a sample size of 200 [66].

Only five participants reported that they were not the parent of a child (i.e., aunt, uncle, grandparent), but reported acting as the primary homework-helper in the home. Thus, for the purposes of this study, we refer to all primary caregivers as parents. Of the 247 parents ( $n = 168$  women), 108 reported that their child was in Grade 6 ( $n = 58$  girls), 80 reported that their child was in Grade 7 ( $n = 34$  girls; 1 undisclosed), and 59 reported that their child was in Grade 8 ( $n = 29$  girls). Parents reported a range of education levels: high school diploma (17.8%), college diploma (13.4%), bachelor's degree (44.1%), or graduate degree (24.7%). The median education level was a bachelor's degree.

## 6. Measures

### 6.1. Homework-Helping Styles

We assessed parents' use of different homework-helping styles using the 30-item Parental Involvement Scale, which is designed to assess parents' perceived behaviors during a homework-helping interaction [22]. The measure assesses four aspects of parental homework involvement: autonomy support (8 items;  $\alpha = 0.84$ ), cognitive engagement (8 items;  $\alpha = 0.69$ ), interference (7 items;  $\alpha = 0.70$ ), and control (7 items;  $\alpha = 0.90$ ). Parents reported the frequency of different homework behaviors on a scale ranging from 1 (Never) to 5 (Always). In the present study, we asked parents to think specifically about math homework interactions. We used only the autonomy support, interference, and control scales in the present study because these measures are centered upon the homework interaction specifically, whereas the cognitive engagement subscale focusses on parents' educational efforts outside of the homework context (i.e., additional enrichment, informal learning activities). Cronbach's alphas for the current sample were 0.80, 0.83, and 0.84 for autonomy support, interference, and control, respectively.

### 6.2. Math Anxiety

We measured parents' math anxiety using the nine-item Abbreviated Math Anxiety Scale (AMAS; [67]). Participants rated how anxious they would feel in situations involving math (e.g., having to use the tables in the back of a math book) on a scale ranging from 1 (Low anxiety) to 5 (High anxiety). Hopko et al. [67] have reported good to excellent internal consistency ( $\alpha = 0.83$ – $0.90$ ) and good test-retest reliability ( $r = 0.83$ ) for this measure. Cronbach's alpha for the current sample was 0.92.

### 6.3. General Anxiety

We measured parents' general anxiety using the 20-item trait subscale of the State-Trait Anxiety Inventory (STAI-T; [68]). Participants rated their endorsement of positive (e.g., I am content) and negative (e.g., I lack self-confidence) statements on a scale ranging from 1 (Not at all) to 4 (Very much so). We reverse-coded positive statements and combined them with negative statements such that higher scores indicate higher levels of trait anxiety. Vitasari et al. [69] (2011) reported acceptable internal consistency ( $\alpha = 0.78$ ) and good test-retest reliability ( $r = 0.85$ ) for this measure. Cronbach's alpha for the current sample was 0.94.

### 6.4. Math Ability

We measured parents' math ability using the 10-item Brief Math Assessment 3 (BMA-3; [70]). The BMA-3 consists of arithmetic and algebra computation procedures and is correlated ( $r = 0.66$ ) with the Wide Range Achievement Test 4 (WRAT4; [71]). Steiner and Ashcraft [70] reported acceptable internal consistency ( $\alpha = 0.69$ ) and test-retest reliability ( $r = 0.66$ ) for this measure. Cronbach's alpha for the current sample was 0.70.

### 6.5. Child Math Achievement

Parents reported their child's grades in math which served as an indicator of math achievement. We recorded grades on a 13-point scale as follows: 1(F), 2 (D-), 3(D), 4(D+), 5(C-), 6 (C), 7(C+), 8 (B-), 9 (B), 10 (B+), 11 (A-), 12 (A), 13 (A+). Participants in the current sample reported grades ranging from D (3) to A+ (13). The median grade was a B+.

### 6.6. Procedure

The survey began with two gatekeeping questions designed to be easy for human respondents but difficult for bots (see [72] for a review on bots). Participants needed to correctly respond to both items to gain access to the survey. Parents first completed a series of demographic questions about themselves and their middle school-aged child, then completed the parent factor measures in the following order: STAI-T, AMAS, BMA-3, Parental Involvement Scale.

## 7. Analysis Plan

The goal of this study was to understand the relations among parent math anxiety, homework-helping styles, and children's math achievement. To investigate these relations, we tested the theoretical model shown in Figure 1 using path analysis. We conducted all analyses using Mplus software [73]. Path analysis is closely related to multiple regression and allows for simultaneous testing of both direct and indirect effects with multiple independent and dependent variables. With path analysis, estimates of the magnitude and statistical significance of hypothesized connections among variables can be determined [74]. The hypothesized paths are displayed in a path diagram (see Figure 1). Although a causal model, path analysis cannot determine the direction of causality; we can only establish conclusions about the presence of relations among variables.

Parents completed all measures, but occasionally no response was recorded for an item (<2%). To confirm that data were missing completely at random (MCAR), we performed Little's MCAR test; nonsignificant results indicate that the data are MCAR,  $\chi^2(668) = 648.61$ ,  $p = 0.698$ . To replace missing values, we conducted multiple imputation with a maximum of 50 iterations. Model fit was examined using a combination of the comparative fit index (CFI > 0.90), root mean square error of approximation (RMSEA < 0.08), and standardized root mean square residual (SRMR < 0.08; [75]).

## 8. Results

### *Descriptive Statistics and Correlations*

Descriptive statistics and correlations for all measures are shown in Table 1. There was no evidence of problematic skew in the data (i.e., all values < |1.00|). There was a moderate correlation between parents' general anxiety and parents' math anxiety ( $r = 0.35$ ,  $p < 0.001$ ). In the model, we controlled for general anxiety to better capture anxiety that is specific to math. Moreover, given that parent education was moderately correlated with parents' math ability ( $r = 0.26$ ,  $p < 0.05$ ) and child math achievement ( $r = 0.33$ ,  $p < 0.001$ ), and parent gender was significantly correlated with homework-helping styles (intrusion;  $r = -0.22$ ,  $p < 0.05$ ), we controlled for both parent education and parent gender in the subsequent analyses. Child gender was not significantly correlated with any of the variables and thus we did not control for child gender. Although child's grade in school was significantly correlated with parents' general anxiety ( $r = -0.15$ ,  $p < 0.05$ ) and math anxiety ( $r = -0.22$ ,  $p < 0.001$ ), it was only weakly correlated with two homework-helping styles (intrusion  $r = -0.16$ ,  $p < 0.05$ ; control  $r = -0.16$ ,  $p < 0.05$ ) and it was not significantly correlated with child math achievement ( $r = 0.02$ ,  $p > 0.05$ ); thus, we did not include it in the subsequent analyses.

**Table 1.** Correlations and Descriptive Statistics for All Measures.

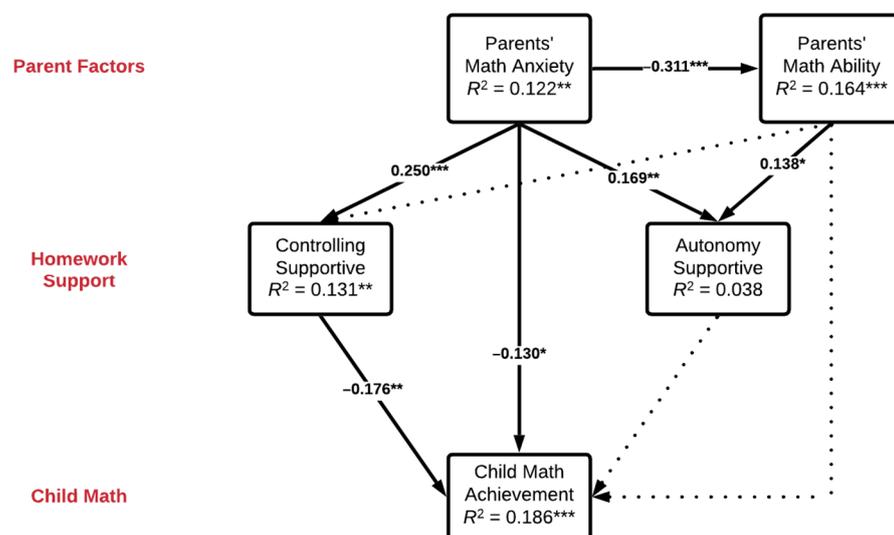
	1	2	3	4	5	6	7	8	9	10	11
1. Parent Gender <sup>a</sup>	–	–0.11	0.09	0.08	0.15 *	0.09	–0.16 *	0.06	–0.10	–0.22 *	0.03
2. Parent Education		–	–0.06	–0.16 *	0.01	–0.02	0.26 *	0.06	–0.01	0.11	0.33 ***
3. Child Gender <sup>a</sup>			–	–0.05	0.02	0.06	–0.01	–0.03	–0.12	–0.06	0.01
4. Child Grade in School				–	–0.15 *	–0.22 ***	0.15 *	0.01	–0.16 *	–0.16 *	0.02
5. Parents' General Anxiety <sup>b</sup>					–	0.35 ***	–0.02	–0.00	–0.01	0.11	–0.03
6. Parents' Math Anxiety <sup>b</sup>						–	–0.32 ***	0.13 *	0.25 ***	0.24 ***	–0.20 **
7. Parents' Math Ability <sup>b</sup>							–	0.07	–0.14 *	–0.15 *	0.20 **
8. Autonomy Supportive <sup>c</sup>								–	0.56 ***	0.31 ***	–0.09
9. Control <sup>c</sup>									–	0.68 ***	–0.21 **
10. Intrusion <sup>c</sup>										–	–0.17 **
11. Child Math Achievement											–
N per measure	247	247	247	247	247	247	247	247	247	247	246
Mean	1.68	2.79	1.50	6.80	1.85	2.25	0.63	3.54	2.77	1.97	10.08
SD	0.47	1.07	0.51	0.80	0.56	0.91	0.19	0.68	0.85	0.76	2.15
Skew	–0.78	–0.31	0.10	0.37	0.49	0.58	–0.13	–0.29	0.06	0.84	–0.76
Minimum	1.00	1.00	1.00	6.00	1.00	1.00	0.18	1.00	1.00	1.00	3.00
Maximum	2.00	5.00	3.00	8.00	3.70	4.78	1.00	5.00	4.71	4.29	13.00
Possible Range	1–2	1–5	1–2	6–8	1–5	1–5	0–1	1–5	1–5	1–5	1–13

Note. <sup>a</sup> Dichotomous variable 1 = male, 2 = female; <sup>b</sup> Mean scores; <sup>c</sup> Methods of homework help; \*  $p < 0.05$ . \*\*  $p < 0.01$ . \*\*\*  $p < 0.001$ .

The three types of homework-helping styles were significantly correlated. Notably, math anxiety (but not general anxiety) was significantly correlated with the homework-helping styles. Both control and intrusion were significantly correlated with child math achievement, whereas autonomy support was not. The focus of the present study was to compare the beneficial (i.e., autonomy-supportive) from detrimental (i.e., controlling-supportive) homework-helping styles. Thus, using principal component analysis (PCA), one factor (i.e., *controlling support*)—which explained 83.87% of the variance—was created from the mean responses to the control and intrusion-related items. The loadings for each factor were 0.92. Correlations between controlling support and parents' math anxiety ( $r = 0.27, p < 0.001$ ), parents' math ability ( $r = -0.16, p < 0.05$ ), and child math achievement ( $r = -0.20, p < 0.01$ ) were comparable to the correlations observed when we considered control and intrusion separately (see Table 1). Thus, we used the controlling support factor obtained through PCA in subsequent analyses.

### 9. Path Analysis

The final path analysis model is shown in Figure 2. Based on the fit criteria outlined above, the model had good fit,  $\chi^2(10) = 11.037, p = 0.355$ , SRMR = 0.032, CFI = 0.995, RMSEA = 0.020 (0.000, 0.074). With respect to the associations for the control variables with parent factors and child math achievement, parent gender was not related to autonomy-supportive homework help ( $\beta = 0.068, p = 0.280$ ), but it was negatively related to controlling-supportive homework help ( $\beta = -0.217, p < 0.001$ ), whereby parents who identified as men were more likely to provide controlling-supportive help. Further, parents' level of education was positively related to parents' math ability ( $\beta = 0.260, p < 0.001$ ) and children's math grades ( $\beta = 0.328, p < 0.001$ ). Parents' general anxiety was also positively related to parents' math anxiety ( $\beta = 0.349, p < 0.001$ ). For readability, control variables are not included in Figure 2.



**Figure 2.** Path Model predicting relations among Parent Factors, Homework-Helping Styles, and Child Math Achievement. Note. Model fit statistics  $\chi^2(10) = 11.037, p = 0.355$ , SRMR = 0.032, CFI = 0.995, RMSEA = 0.020 [0.000, 0.074]. Solid lines represent significant paths (<sup>\*\*\*</sup>  $p < 0.001$ ; <sup>\*\*</sup>  $p < 0.01$ ; <sup>\*</sup>  $p < 0.05$ ); dashed lines represent tested paths that were not significant.

Numbers on direct paths are standardized coefficients. Solid lines represent significant paths (<sup>\*\*\*</sup>  $p < 0.001$ ; <sup>\*\*</sup>  $p < 0.01$ ; <sup>\*</sup>  $p < 0.05$ ); dashed gray lines represent tested paths that were not significant. Not shown in the figure are the control variables. We controlled for the effect of parents' general anxiety on parents' math anxiety, parents' gender on

homework-helping styles, and parents' level of education on parents' math ability and child math achievement.

### 9.1. Parent Math Anxiety, Homework-Helping Styles, and Child Math Achievement

Of most interest in our model were the relations among parents' math anxiety, homework-helping styles, and child math achievement. There was a direct, negative relation between parent math anxiety and child math achievement ( $\beta = -0.130, p = 0.036$ ). On average, parents who reported higher levels of math anxiety had children with lower math achievement. Recall that our theory generated the hypothesis that this relation would be partially mediated by the degree to which parents engage in both autonomy-supportive and controlling-supportive homework-helping styles. Contrary to the predictions generated by our theory, the degree to which parents engage in autonomy-supportive homework-helping during math does not mediate the relation between their math anxiety and their children's math achievement. On the other hand, there was a significant indirect relation between parents' math anxiety and child math achievement through controlling-supportive homework help ( $\beta = -0.044, p = 0.029$ ). Indeed, as parent's math anxiety increases, they are more likely to engage in controlling-supportive homework-help ( $\beta = 0.250, p < 0.001$ ) and the more that they engage in controlling-supportive homework help, the less well their children do in math in school ( $\beta = 0.169, p = 0.009$ ). Thus, consistent with our theory, detrimental homework-helping styles partially mediated the relation between parents' math anxiety and child math achievement.

### 9.2. Parent Math Ability, Homework-Helping Styles, and Child Math Achievement

In the above analyses, we examined the relations between math anxiety, homework-helping styles, and children's math achievement, taking into consideration parents' math ability and controlling for parents' general anxiety. This was because we felt it prudent to ensure that any observed relations are due to math anxiety and not math ability or anxiety in general. Notably, significant relations have been reported between math anxiety and math ability [58–60] and parents' math ability and children's math ability [76]. Accordingly, we felt it was imperative that these variables be considered in the model. However, to our knowledge, there is no literature linking parents' math ability to homework-helping styles during math homework. Thus, we opted to explore the potential relations between parents' math ability, their homework-helping styles, and their children's math achievement. There was no significant relation between parents' math ability and controlling-supportive homework-helping style ( $\beta = -0.112, p = 0.074$ ). There was, however, a direct, positive path between parents' math ability and autonomy-supportive homework-helping styles ( $\beta = 0.138, p = 0.035$ ). On average, parents with higher math ability reported using more autonomy-supportive homework-helping styles. There was no direct relation between parents' math ability and child math achievement ( $\beta = 0.046, p = 0.479$ ).

## 10. Discussion

Maloney and colleagues [10] reported that when higher-math-anxious parents frequently help their children with math homework, their children learn less math over the course of the school year. While this finding provided compelling evidence to suggest that parents' math anxiety negatively influences the math achievement of their children, it remained unclear, however, why the math homework-help of higher-math-anxious parents hindered their children's math learning. Although to the best of our knowledge there are currently no studies that have looked directly at parents' math anxiety and their math homework helping strategy, research on teachers have shown that higher-math-anxious teachers are more likely to use instruction methods that resembles controlling supportive style when teaching math [56]. As such, it is reasonable to predict that higher-math-anxious parents are likely to employ more controlling supportive and less autonomy supportive math homework helping styles. Thus, here, we tested the hypothesis that the relation between parents' math anxiety and children's math achievement may be partially explained

by parents' use of specific homework-helping styles during math homework interactions with their children. We demonstrated that higher-math-anxious mothers and fathers reported using both beneficial (i.e., autonomy-supportive) and detrimental (i.e., controlling-supportive) styles more so than their lower-math-anxious counterparts. As we predicted, controlling-supportive homework help was directly related to children's math achievement, and partially mediated the relation between parents' math anxiety and children's math achievement. Interestingly, and counter to what we predicted, autonomy support was not linked to children's academic achievement. While this finding was inconsistent with what we predicted based on literature in which teachers' autonomy-supportive practices can lead to higher math achievement in their students (see [33,34]), other researchers have also reported the absence of a direct link between autonomy-supportive homework help from parents and children's math achievement [22,27]. Thus, it seems that parental autonomy support in the context of math homework may be less beneficial for children's math achievement than their level of controlling support is detrimental.

Consistent with previous research, we also demonstrated that parents' math anxiety and math ability are inversely related (see [59,60]). However, parents' math abilities were correlated with, but not uniquely predictive of, children's math achievement. In other words, while parents' math ability is significantly correlated with children's math achievement at the level of zero-order correlations, this relation was not significant in our model after taking into consideration the control variables (i.e., parent's level of education) and other variables in our model. Similarly, we also observed a significant negative zero-order correlation between parent math ability and controlling support, but this relation did not remain significant in the model that we tested using path analysis after taking into consideration the control variables (i.e., parent's gender) and other variables in our model. Lastly, while there was a significant positive relation between parent's math ability and the degree to which they engaged in autonomy-supportive math homework-help in our model, this was not related to children's math achievement.

Taken together, the results of the present study lend support to the theory that one reason why the math-homework help of higher-math-anxious parents backfires may be because higher-math-anxious parents are more controlling in the homework support that they provide. When parents provide controlling support, they are likely to direct children's behavior and solve problems for them, resulting in fewer opportunities for child engagement and guided self-discovery (e.g., [47]). Further, if parents are solving math problems for their children, this may lead children to feel less competent in mathematics (i.e., the child may think that their parents are solving the problem for them because they themselves are not capable of doing so) [77]. Based on SDT, this lack of opportunity for the child to satisfy their needs for autonomy and competence negatively affects their active engagement during learning opportunities [78]. As a result, excessive parental control can decrease intrinsic motivation, self-regulation, and academic performance (for reviews, see [77]). Indeed, previous research has shown a negative relation between controlling support and child performance across different age groups [24,79] and contexts (for reading, see [23]; for math, see [27,46]; for language development, see [80–82]).

Given that the results of the current study suggest that parent homework-helping style may explain, at least in part, why the math homework help of higher-math-anxious parents can backfire, intervention aimed at severing the link between parents' math anxiety and their children's math achievement may benefit from a focus on teaching parents to be less controlling in their help. While we are not aware of any such interventions with parents, there have been success in implementation of interventions with teachers that resulted in less controlling-support within their teaching practice [83]. Whether such an intervention will work with parents and further, whether decreasing the degree of controlling-support that higher-math-anxious parents provide will translate into higher math achievement for their children remains an empirical question.

### 10.1. Limitations and Future Research

This study offers one possible explanation as to why the homework help offered by higher-math-anxious parents may be detrimental to their children's math learning. Using path analysis, we identified direct and indirect relations among parental factors, homework-helping methods, and child math achievement. However, we acknowledge that the study has its limitations. Though we collected data from a relatively large sample, all participants lived within North America at the time of the study. Thus, we feel it prudent to caution against overgeneralizations of these findings to regions outside of North America. There are, undoubtedly, cultural differences in how parents approach homework help, and whether these patterns hold outside of a North American population was not illustrated in this study.

Further, we only collected survey data and parents responded to items on Likert-type scales. Although use of survey data allowed us to reach a larger number of parents and conduct path analyses, we could not distinguish between the perceived homework-helping interaction, as opposed to the objective interaction. In future research, long-answer questions, interviews, and in vivo observations of homework-helping interactions would provide further insights into how the homework environment influences children's math achievement and attitudes towards math when their parents are higher in math anxiety. Moreover, longitudinal studies would allow researchers to examine how math anxiety, math achievement, and the homework environment develop and change over time.

Additionally, given that the primary focus of this study was to better understand the factors that influence how parents are involved in their children's homework, we only collected data from parents. Future studies should include children's input to provide additional information about the math homework-helping environment. For example, the completion of a math assessment by the children could strengthen the relations we observed between parents' math anxiety, maladaptive (i.e., controlling-supportive) homework-helping methods, and children's math achievement. Moreover, the inclusion of scales that assess children's academic development in a more holistic manner (e.g., scales assessing academic self-efficacy and task persistence) would provide an increased understanding of how the adoption of different homework-helping methods by parents influences their children beyond solely their academic achievement.

Finally, more broadly, in the present study we focused on the parents as major socializers of their children, but we did not take into consideration the differing resources parents may receive from their children's schools. Evidently, it is not enough to simply tell parents to 'get involved', a message which is heavily pushed by North American governments [84,85]. Despite parents being well intentioned when becoming involved with their children's math homework, their help can fall short if they do not know how to engage in adaptive homework-helping practices. However, placing sole responsibility on schools to educate parents on beneficial homework-helping methods creates unfeasible expectations for educators. Instead, we argue that there is a need for increased research into easily accessible interventions and techniques that will help parents of middle school children become involved in their children's math education in a way that will garner positive outcomes.

One interesting avenue would be the promotion of apps, which can facilitate positive communication and problem-solving interactions between parents and their children. For example, Berkowitz et al. [86] studied the effectiveness an iPad app, which was used to guide the math homework interaction between parents and their children as they worked together on numerical math story problems. Not only was this app demonstrated to increase students' academic achievement over the school year [86], but it also facilitated number-based conversation between the parent and child, independent of the parents' pre-existing knowledge or confidence in math. Our study demonstrates the importance of continuing to assess and create similar interventions that will help parents foster positive math learning experiences for their children, regardless of the parents' own math ability or math anxiety.

## 10.2. Implications and Conclusions

The present study highlighted an important area of research within parental involvement in math homework. Understanding how individual differences in parents' own attitudes towards and beliefs about math influence their method of involvement in their children's math homework is crucial to develop targeted interventions that can facilitate more positive homework-helping interactions. In the current paper, we demonstrated how parents with higher math anxiety may be using maladaptive homework-helping styles which, in turn, have a negative influence on the math learning of their children. This furthers the primary goal of our study, which was to increase understanding about why math-anxious parents have children with lower math ability and higher math anxiety when these parents are highly involved in their child's math homework [10]. Additionally, this study highlighted the need for interventions designed to reduce parents' math anxiety and controlling-supportive homework help to improve children's math achievement. Understanding the process through which adults transmit their math anxiety from one generation to the next is integral in creating evidence-based interventions aimed at enhancing math learning in both the home and classroom environment.

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