Time spent on homework, mathematics anxiety and mathematics achievement: Evidence from a US sample

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This study investigated the effect of time spent on homework and mathematics anxiety on mathematics achievement. Data from a nationally representative US sample consisting of 4,978 cases was used to predict mathematics achievement from time spent on homework and mathematics anxiety while controlling for demographic differences such as gender, grade, race, and socioeconomic status. Multiple regression results showed that both maths anxiety and time spent on homework had a significant effect on maths achievement. The implications are discussed.

Introduction

Homework has always been one of the most prominent features and an integral part of instruction in most educational systems. The traditional definition of homework is that it is any task or assignment that an instructor requires the student to complete during non-school hours (Cooper, Robinson, & Patall, 2006). However, given the fact that many students, especially secondary school students, nowadays engage in homework-related tasks while still at school, this somewhat limiting definition of homework has been challenged recently. A more appropriate way to define homework is that it encompasses all activities that a teacher requires her students to conduct during non-instructional time (Harris Cooper, as cited in Bembenutty, 2011).

Although a wealth of literature in the field of education exists on the link between time spent on homework and academic achievement, many of the prior studies based their findings on samples that do not readily generalise to national populations. Even in nationally representative studies, results are not always in agreement across sub-populations. For instance, using the American National Educational Longitudinal Study of 1988, comprising a sample of 18,352 eighth grade students from 1,052 schools, Mau and Lynn (2000) showed the existence of significant positive correlations between time spent on homework and achievement scores in maths, reading, and science. These correlations ranged between .17 and .36. Furthermore, they showed that such correlations differed significantly between males and females with the correlations for females exceeding those for males. These differences suggest that homework plays a more important role in the achievement scores of females than those of males. This positive association between homework and achievement is not unique to the US education system. Walberg (1991) looked at a survey of eighth-graders in eleven countries and observed that countries where students on average spent more time on homework had higher achievement scores. The US was located at the bottom of this list. The positive link between time spent on homework and achievement has been challenged by some studies. For instance, in a recent study, Kitsantas, Cheema, and Ware (2011) showed that more time spent on maths homework does not necessarily translate into higher test scores in maths. Using a sample of 5,200 fifteen year old high school US students from a national survey, they showed that a negative and weak but significant association exists between proportion of time spent on maths homework and maths achievement. They also showed that the gender gap in achievement ceased to exist once one controlled for important predictors of achievement such as self-efficacy, and demographic differences such as race and socioeconomic status. Unlike Mau and Lynn (2000), Kitsantas et al. (2011) did not find any significant difference between males and females in terms of the effect of time spent on homework on academic achievement.

The apparent contrast between the findings of Mau and Lynn (2000) and Kitsantas et al. (2011) presented as examples above should not be taken as absolute evidence of a lack of consensus in current literature regarding the relationship between time spent on homework and academic achievement. An extensive meta-analysis of literature spanning the 1987-2003 period by Cooper et al. (2006) established a convincing link between homework and achievement even though their review of variables that moderate the relationship between homework and achievement remained inconclusive. Examples of other studies that support the existence of a homework-achievement link include Cooper, Lindsay, Nye and Greathouse (1998), Keith (1982), Mulhenbruck, Cooper, Nye and Lindsay (1999), and Pezdek, Berry and Reno (2002).

In context of schoolwork, anxiety is the feeling of helplessness, tension, and/or psychological distress that occurs when a student finds it difficult to cope with the said schoolwork. In general, such anxiety is expected to be negatively associated with achievement (Suinn, Taylor & Edwards, 1988). Unfortunately, studies investigating anxiety in the context of maths tend to look at either test anxiety or anxiety in general. Studies that investigate the component of anxiety which occurs specifically due to maths are scarce. A meta-analysis of 26 studies on the relationship between maths anxiety and maths achievement by Ma (1999) found an average correlation of -.27, with the relationship being consistent across gender, grade level (grades 4-6, grades 7-9, grades 10-12), and race/ethnicity. Using a sample of 324 Israeli students, ages 13, 14, and 16, Milgram and Toubiana (1999) administered an instrument of maths homework anxiety based on ten items which had a reliability of .93. They found that students tended to exhibit lower anxiety for homework as compared to other forms of assessment such as exams. They also reported that students who were more anxious about their homework tended to complete it faster than those who were less anxious. Although they did not include maths achievement in their analysis, the relationship between time spent on homework and anxiety suggests that the possibility of an interaction effect should be considered whenever these two variables occur together. Milgram and Toubiana's study (1999) was the only one we could find which used a homework-specific measure of anxiety. For a more involved discussion of non-homework-specific maths anxiety we refer the reader to Ma (1999).

The primary motivation for this study came from a meta-analysis by Cooper, et al. (2006) where they encouraged future research on the homework-achievement link to use, preferably within a single analytical model, different grade levels, control for demographic factors such as socioeconomic status and gender, and look at other subject areas in addition to maths and reading. In order to obtain a clearer picture of the homework-achievement relationship, we have tried to follow as many of those recommendations as were feasible within the constraints imposed by our dataset.

The main objective of this study is to look at the effect of maths anxiety and time spent on homework, on maths achievement. The contribution of our study is that we use a measure of maths anxiety which includes an item that measures anxiety specifically due to maths homework, and amount of time spent on homework simultaneously as predictors of maths achievement. In addition, in order to improve the reliability of our analytical results and conclusions derived from those results, unlike most other studies investigating the homework-achievement relationship, we employ multivariate tools that simultaneously look at the effects of anxiety and homework on achievement while allowing us to control for important demographic differences such as gender, race, grade, and socioeconomic status. Most past studies investigating the homework-achievement link employed samples that did not allow generalisation of statistical results (Cooper et al., 2006). We intend to use a nationally representative sample that allows our findings to be projected to the entire population of 15-year old high school students in the US.

Our hypothesis is that both maths anxiety and time spent on homework are significant predictors of maths achievement after we control for demographic differences such as gender, race, socioeconomic status and grade. More specifically, we expect anxiety to have a negative effect and time spent on homework to have a positive effect on achievement. In the next section of this paper we describe our sample, variables, and analytical method. This is followed by a presentation of empirical results in section three, and a discussion of those results in section four. Section four also describes the limitations of our study and provides guidance for future research.

Method

Sample

The data were obtained from the Program for International Student Assessment (PISA) 2012 student survey. PISA is an international assessment of fifteen year old students that was administered in more than 60 countries in 2012. It assesses literacy in four areas: mathematics, reading, science, and problem solving (OECD, 2006). PISA assessment is repeated in three year cycles with one of the three areas, mathematics, reading, and science receiving primary focus in each cycle. Although there are other sources of achievement data for US students, such as the National Assessment of Educational Progress (NAEP) and the Trends in International Mathematics and Science Study (TIMSS), they are generally not suitable for our purposes given the unavailability of key variables such as maths anxiety and time spent on homework which are used as primary determinants of achievement in this study.

In the US the PISA 2012 survey was administered by the National Center for Education Statistics (NCES, 2014). The sample consisted of 4,978 students sampled from 166 schools across the US and are representative of 3,538,783 students in 31,091 schools. This sample comprised 2,440 girls and 2,538 boys from five grade levels, 8 (n = 13), 9 (n = 585), 10 (n = 3545), 11 (n = 825), and 12 (n = 10). Of these 4,978 students, 2,537 identified themselves as White, 639 as Black, 1237 as Hispanic, 236 as Asian, 230 as Multiracial, and the rest as belonging to Other races.

Measures

Maths achievement

PISA reports only scaled scores that are derived from student responses on a number of assessment items administered in formats such as multiple choice question and constructed response, and are designed to have a mean of 500 and standard deviation of 100 in OECD member countries. Maths scores were reported as sets of five plausible values for each student who represented random draws from the distribution of all possible scores attributable to that student (Wu, 2005). Following Brown and Mickelwright (2004) we chose one plausible value at random for our analysis. Since our sample contained students from only one country, in order to aid interpretation of parameter estimates and their standard errors, we rescaled the achievement scores to have a mean 0 and a standard deviation of 1 in our sample. Since this rescaling is based on a linear transformation of original values it does not affect unit-independent statistics such as correlations and R^2, and results of tests of hypotheses. The rescaled scores ranged between -3.44 and 3.82 in our sample.

Maths anxiety

This scale is based on five items (see Table 1) that measured a student's anxiety related to performing mathematics-related tasks. A sample item included, "How much do you agree or disagree with the following statement about how you feel when studying mathematics? I get very tense when I have to do mathematics homework." The response choice for all items were 1 (strongly agree), 2 (agree), 3 (strongly disagree), and 4 (disagree). The scale scores were derived by applying a partial credit item response theory-based model that estimated an anxiety score for each student based on her responses to the five underlying items (Masters, 1982; OECD, 2006). The scale was constructed in such a way that higher scale scores indicate greater maths anxiety. The reliability of this scale was .88 in our sample, and its standardised values ranged from a minimum of -2.21 to a maximum of 2.53 (M = 0, SD = 1).

Time spent on homework

This variable measured the average number of hours spent by a student per week including the weekend on homework or other material assigned by teachers. In our sample the values of this variable ranged between 0 and 30 hours (M = 6.61, SD = 5.49).

Mathematics anxiety

Table 1: Items comprising the PISA mathematics anxiety scale

How much do you disagree or agree with the following statements about how you feel when studying mathematics?
1. I often worry that it will be difficult for me in mathematics classes.
2. I get very tense when I have to do mathematics homework.
3. I get very nervous doing mathematics problems.
4. I feel helpless when doing a mathematics problem.
5. I worry that I will get poor marks in mathematics.

Notes: N = 4978, Cronbach's alpha = .88. Response choices for each item were 1 (strongly agree), 2 (agree), 3 (disagree), and 4 (strongly disagree). Source: OECD (2012).

Demographic controls
The following variables were used as controls for individual differences.

- Gender. This nominal variable has two categories, male and female.
- Grade. Students in our sample belonged to five grade levels, 8, 9, 10, 11 and 12. This variable thus took the form of an ordinal variable with five categories.
- Race. Each student was classified as belonging to one of the six races, White, Black, Hispanic, Asian, Multiracial, and Other.
- Socioeconomic status. Socioeconomic status is a composite of three sub-scales, parental education, parental occupation, and number of home possessions. Highest parental education and highest parental occupation were used in the construction of this measure. This variable is labeled as the index of economic, cultural, and social status in PISA and has been shown to have a reliability coefficient ranging between .63 and .69 in samples of 15-year old students from the US standardised values of this variable ranged between -4.08 and 3.01 (M = 0, SD = 1) in our sample.

Analytical method

We computed summary statistics and correlations for all variables. In order to examine the effect of time spent on homework and maths anxiety on maths achievement, we estimated a series of ordinary least squares linear multiple regression models with maths achievement as the outcome. The first model predicted maths achievement from control variables: gender, grade, race, and socioeconomic status. The second model retained all earlier predictors and added the two primary predictors, time spent on homework and maths anxiety, to the regression equation. Any significant difference in percentage of explained variation between models one and two will thus be evidence that time spent on homework and maths anxiety are important predictors of maths achievement. We also estimated a third model that augmented model two by including all possible two way interactions that involved either of our primary predictors. In order to avoid clutter we re-estimated the third model after including only those interactions that were statistically significant. Our three regression models are given by expressions (1)–(3).

(1) $$Y_i = \beta_0 + \sum_{k=1}^{10} \beta_k X_{ki} + \beta_{11} SES + \varepsilon_i$$

(2) $$Y_i = \gamma_0 + \sum_{k=1}^{10} \gamma_k X_{ki} + \gamma_{11} SES + \gamma_{12} Anxiety + \gamma_{13} Time + \nu_i$$

(3) $$Y_i = \lambda_0 + \sum_{k=1}^{10} \lambda_k X_{ki} + \lambda_{11} SES + \lambda_{12} Anxiety + \lambda_{13} Time + \sum_{k=14}^{23} \lambda_k \left(Anxiety \times X_k \right) + \sum_{k=24}^{33} \lambda_k \left(Time \times X_k \right) + \pi_i$$

where Y_i is the maths achievement score of student *i*; β's, γ's, and λ's are regression coefficients; X's are k = 10 dummy variables that represent grade, gender, and race (four for grade, one for gender, and five for race); *SES* = socioeconomic status; *Time* = time spent on homework; and ε, ν, and π are student-specific error terms.

In order to retain sample representativeness without inflating sample size, we employed normalised sampling weights in all of our computations. We evaluated underlying theoretical assumptions for each estimated regression model, evaluated tests of hypotheses at .05 level of significance, employed single random imputation as missing data handling method, and used Cohen's (1992) cutoffs for interpretation of effect sizes.

Results

Descriptive statistics and correlations

Descriptive statistics and correlations for maths achievement and its predictors are presented in Tables 2 and 3 respectively. The unadjusted marginal means presented in Table 2 suggest that in our sample, boys had a slightly higher mean maths score as compared to girls; on average the maths score improved as grade level increased; and that relative to mean maths score for the overall sample, Asian, White, and Multiracial students had above average maths scores relative to the remaining racial groups. For anxiety, girls had higher mean scores (more anxious); in general, mean anxiety decreased with increase in grade; and White and Multiracial students tended to be on average less anxious than the remaining racial groups. For time spent on homework, higher values were observed for girls, students in higher grades, and Asian and Multiracial students. Finally, the self-reported socioeconomic status was slightly higher for girls, generally increased with increase in grade level, and was above average for White, Asian, and Multiracial students.

The pattern of correlations presented in Table 3 suggests that maths achievement had moderate correlations with maths anxiety, time spent on maths homework, socioeconomic status, and grade. Although many of the reported inter-predictor correlations were significant, none of them were larger than .2 suggesting small or trivial effect sizes.

Table 2: Descriptive statistics for math achievement and its predictors

			Maths achievement		Maths anxiety		Time spent on homework		Socioeconomic status	
Factor		*n*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Gender	Female	2440	-0.04	0.98	0.08	1.02	7.40	5.74	-0.01	1.01
	Male	2538	0.03	1.04	-0.09	0.97	5.85	5.12	-0.02	0.99
Grade	8	13	-1.44	0.81	0.10	0.57	3.65	2.92	-1.65	0.52
	9	585	-0.81	0.84	0.20	0.94	4.53	4.28	-0.42	0.96
	10	3545	0.06	0.96	-0.01	0.99	6.70	5.34	0.05	0.99
	11	825	0.30	1.02	-0.09	1.02	7.75	6.39	0.00	0.98
	12	10	1.01	1.71	-1.25	0.96	7.77	8.44	0.46	1.03
Race	White	2537	0.26	0.94	-0.03	1.01	6.57	5.07	0.29	0.87
	Black	639	-0.72	0.89	0.02	0.98	5.61	5.35	-0.11	0.86
	Hispanic	1237	-0.30	0.92	0.06	0.96	6.42	5.36	-0.65	1.02
	Asian	236	0.76	1.01	0.01	1.03	10.60	7.30	0.17	1.10
	Multiracial	230	0.10	0.94	-0.16	1.00	6.95	6.43	0.13	0.89
	Other	99	-0.54	0.83	0.06	0.84	6.12	6.68	-0.04	0.94

Notes: $N = 4978$. Math achievement, math anxiety, and socioeconomic status are standardised variables with $M = 0$, $SD = 1$. Time spent on homework is measured as number of hours per week.

Table 3: Correlations among math achievement and its predictors

	Correlation, *r*					
Variable	1	2	3	4	5	6
1. Math achievement	–					
2. Math anxiety	-.39***	–				
3. Time spent on homework	.34***	-.11***	–			
4. Socioeconomic status	.39***	-.15***	.20***	–		
5. Grade	.26***	-.08***	.14***	.10***	–	
6. Gender	.03*	-.09***	-.14***	~0	-.08***	–

Notes: $N = 4978$. Reported *r* is rank biserial correlation between grade and gender; Spearman's rank correlation between grade and continuous variables (achievement, anxiety, time spent on homework and socioeconomic status); point biserial correlation between gender and continuous variables; and Pearson correlation between continuous variables.
Cohen's (1992) cutoffs for *r* : small effect, .1; medium effect, .3; large effect, .5.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$

We note that number of students sampled from grades 8 and 12 (see Table 2) is somewhat small. However, we carefully examined the distribution of maths achievement scores in our sample and found it to be approximately normally distributed (see Figure 1). This observed distribution makes it very unlikely that maths achievement is not normally distributed in our target population. It is well known that for a normally distributed variable samples as small as 3 are sufficient to ensure normality in the sampling distribution of sample means (McClave, Benson & Sincich, 2005). For this reason we decided not to discard cases belonging to grades 8 and 12. Excluding these cases entailed the risk of our sample not remaining representative of its target population.

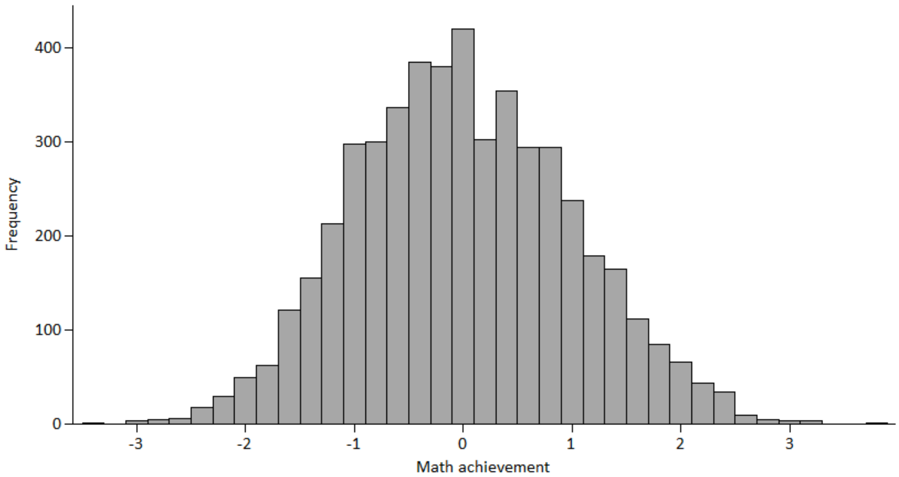

Figure 1: Distribution of math achievement scores in the sample, n = 4978

Multiple regression results

Results for multiple regression models 1 and 2 are presented in Table 4, and those for model 3 are presented in Table 5. Results for model 1 suggest that all four control variables, gender, grade, race, and socioeconomic status had a significant effect on maths achievement. This model explained approximately 30.3% (f 2 = 0.43, large effect) of the total variation in maths achievement. Results for model 2 indicate that the pattern of significance observed for model 1 remained more or less the same with inclusion of maths anxiety and time spent on homework as predictors. This model explained 14.5% of the total variation in maths achievement over and above that explained by model 1. The total amount of variation thus explained by predictors included in model 2 was 44.5% (f 2 = 0.80, large effect). The results for model 2 suggested that with all else held constant, 1 SD increase in maths anxiety was associated with 0.30 SD decrease in maths achievement; 1 SD increase in socioeconomic status was associated with an increase of 0.21 SD in maths achievement; and when time spent on homework per week increased by 1 hour, maths achievement increased by 0.04 SD. In standardised terms, a 1 SD increase in time spent on homework was associated with a 0.21 SD increase in maths achievement. Our results for model 2 further indicated a significant gender gap in maths achievement favouring boys, higher mean maths achievement scores at higher grade levels, and large racial achievement gaps. Based on adjusted marginal means for race, the six race categories included in our sample can be arranged in an order of decreasing means as follows: Asian (M = 0.39), White (M = 0.08), Multiracial (M = -0.06), Hispanic (M = -0.22), Other (M = -0.53), and Black (M = -0.72).

Table 4: Multiple regression results predicting math achievement: Models 1 and 2

Parameter			*B*	*t*	*p*	95% CI	
						LL	*UL*
a. Model 1	Intercept		0.38	1.46	.145	-0.13	0.90
	Grade	8	-1.83	-5.31	< .001	-2.50	-1.15
		9	-1.37	-5.36	< .001	-1.87	-0.87
		10	-0.73	-2.89	.004	-1.23	-0.24
		11	-0.46	-1.82	.068	-0.96	0.04
	Gender		-0.13	-5.47	< .001	-0.17	-0.08
	Race	White	0.60	7.40	< .001	0.44	0.76
		Black	-0.20	-2.38	.018	-0.37	-0.04
		Hispanic	0.34	4.07	< .001	0.18	0.50
		Asian	1.08	11.36	< .001	0.90	1.27
		Multiracial	0.49	5.08	< .001	0.30	0.68
	Socioeconomic status		0.30	23.50	< .001	0.27	0.32
b. Model 2	Intercept		-0.18	-0.76	.447	-0.64	0.28
	Grade	8	-1.45	-4.73	< .001	-2.06	-0.85
		9	-0.92	-4.02	< .001	-1.37	-0.47
		10	-0.39	-1.72	.085	-0.83	0.05
		11	-0.19	-0.82	.412	-0.63	0.26
	Gender		-0.12	-5.83	< .001	-0.16	-0.08
	Race	White	0.59	8.12	< .001	0.45	0.73
		Black	-0.20	-2.66	.008	-0.35	-0.05
		Hispanic	0.28	3.77	< .001	0.13	0.43
		Asian	0.94	10.97	< .001	0.77	1.11
		Multiracial	0.41	4.72	< .001	0.24	0.58
	Socioeconomic status		0.21	18.17	< .001	0.19	0.23
	Maths anxiety		-0.31	-29.66	< .001	-0.33	-0.29
	Time spent on homework		0.04	18.93	< .001	0.03	0.04

Notes: N = 4978. CI = confidence interval. *LL* = lower limit. *UL* = upper limit. R^2 is 30.3% for model 1 and 44.5% for model 2. Math achievement, math anxiety, and socioeconomic status are standardised variables with $M = 0$, $SD = 1$. Time spent on homework is measured as number of hours per week. Reference category is Grade 12 for grade, Male for gender, and Other for race. Cohen's (1992) cutoffs for d: small effect (S), .2; medium effect (M), .5; large effect (L), .8.

Regression model 3 augmented model 2 by adding all possible two way interactions that included either maths anxiety or time spent on maths homework. A clean version of this model obtained after discarding interactions that were entirely insignificant (i.e. insignificant for all levels of a categorical variable) is presented in Table 5. The results presented in this model suggest that although some interactions were significant, the magnitudes of their partial slope coefficients were small, and inclusion of these interactions added only .3% to the percentage of explained variation in maths achievement. For these reasons these interactions were not examined any further.

Table 5: Multiple regression results predicting math achievement: Model 3

Parameter		*B*	*t*	*p*	95% CI	
					LL	*UL*
Intercept		-0.11	-0.45	.650	-0.59	0.37
Grade	8	-1.42	-4.61	< .001	-2.03	-0.82
	9	-0.91	-3.95	< .001	-1.35	-0.46
	10	-0.37	-1.64	.102	-0.82	0.07
	11	-0.17	-0.74	.458	-0.62	0.28
Gender		-0.12	-5.85	< .001	-0.16	-0.08
Race	White	0.51	5.16	< .001	0.32	0.71
	Black	-0.28	-2.67	.008	-0.49	-0.08
	Hispanic	0.20	1.92	.055	0.00	0.40
	Asian	0.76	5.99	< .001	0.51	1.01
	Multiracial	0.15	1.21	.225	-0.09	0.38
Socioeconomic status		0.21	18.15	< .001	0.19	0.23
Math anxiety		-0.34	-22.21	< .001	-0.37	-0.31
Time spent on homework		0.02	2.03	.042	0.00	0.04
Interactions	Time spent on homework x White	0.01	1.17	.242	-0.01	0.04
	Time spent on homework x Black	0.01	1.15	.252	-0.01	0.04
	Time spent on homework x Hispanic	0.01	1.24	.214	-0.01	0.04
	Time spent on homework x Asian	0.02	1.85	.065	0.00	0.05
	Time spent on homework x Multiracial	0.04	2.91	.004	0.01	0.06
	Math anxiety x Gender	0.04	2.11	.035	0.00	0.08
	Math anxiety x Socioeconomic status	-0.03	-2.75	.006	-0.05	-0.01

Notes: N = 4978. CI = confidence interval. *LL* = lower limit. *UL* = upper limit. R^2 = 44.8%. Math achievement, math anxiety, and socioeconomic status are standardised variables with M = 0, SD = 1. Time spent on homework is measured as number of hours per week. Reference category is Grade 12 for grade, Male for gender, and Other for race. Cohen's (1992) cutoffs for d: small effect (S), .2; medium effect (M), .5; large effect (L), .8.

Discussion

This study investigated the effect of time spent on homework and maths anxiety on maths achievement. Data from a nationally representative US sample consisting of 4,978 cases was used to predict maths achievement from time spent on homework and maths anxiety while controlling for demographic differences such as gender, grade, race and socioeconomic status. Multiple regression results showed that both maths anxiety and time spent on homework had a significant effect on maths achievement. Our statistical results have some important implications.

First, our results suggest that maths anxiety and time spent on homework are both important predictors of maths achievement. A one standard deviation increase in maths anxiety was associated with a decrease of almost a third of a standard deviation in maths achievement. A similar increase in time spent on homework on the other hand was associated with an increase in maths achievement of more than a fifth of a standard deviation. Of the total variation in maths achievement that we were able to explain, a third came from these two variables. This is a considerable effect size, and suggests that any serious study of maths achievement should not ignore these two variables. Excluding these variables can results in a model specification bias that can negatively affect parameter estimates and their standard errors.

Second, we observe that time spent on maths homework and anxiety have opposite effects on maths achievement. Thus, for maths achievement the negative effect of increase in anxiety can be (at least partially) countered by increasing the number of hours spent on homework. This can be an important tool for teachers who feel that anxiety is affecting their students' achievement scores in maths. For example, a half a standard deviation increase in maths anxiety can be countered by increasing number of hours of homework by four hours per week. Given that we did not find evidence of a significant interaction between maths anxiety and time spent on homework, we expect more time spent on homework to equally benefit less anxious and more anxious students.

Third, although control variables appeared in our models of maths achievement in order to account for individual differences and did not motivate the purpose of this study, we note that the gender gap in achievement always favoured boys and that this gap expanded when we controlled for other individual differences such as grade, race, and socioeconomic status. Although small in magnitude this observed gender gap did not disappear with the introduction of maths anxiety and time spent on homework in our models of maths achievement. Our results thus support the position that on average boys tend to have higher scores as compared to girls in mathematics. This finding is in line with recent findings based on similar large scale assessments of 13 and 17 year old US students (NCES, 2013). We also note that like gender, socioeconomic status and race also had significant effects on maths achievement. These results are also in line with findings reported by past research based on US PISA samples (e.g. Cheema & Galluzzo, 2013; Kitsantas, Cheema & Ware, 2011).

Although our study revealed several significant results, caution should be exercised when generalising our findings to (1) non-US populations, (2) subjects other than mathematics, and (3) populations of students that are very different from the one represented by our sample. For example, since our sample was based on high school students, our findings may not be generalisable to students enrolled in colleges or universities. Furthermore, some of our measures such as maths anxiety, socioeconomic status, and race were self-reported by students. Although it is unlikely that there was large scale misreporting in a data set of the size used in our study, any findings based on self-reported data are accurate only to the extent that such data were accurately reported. Future research in this area can proceed in several directions such as (1) replicating our study with samples from other countries, (2) looking at the relationship of anxiety and homework with achievement in subjects other than mathematics, and (3) examining this relationship in populations other than 15-year old students.

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