Title	Relationship of mathematics homework to mathematics achievement among grade 8 students in Singapore
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RELATIONSHIP OF MATHEMATICS HOMEWORK TO MATHEMATICS ACHIEVEMENT AMONG GRADE 8 STUDENTS IN SINGAPORE

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This study, drawing on data from the Trends in International Mathematics and Science Study (TIMSS) 2007, examined the relationships of the frequency of mathematics homework and the amount of time spent on mathematics homework to student achievement in mathematics among Grade 8 students in Singapore. The authors also explored the relationships of students' attitude toward mathematics, their self-confidence in learning mathematics, and the value they place on mathematics with the amount of time they spent on mathematics homework. Results of ordinary least squares (OLS) regression analyses revealed that the frequency of mathematics homework students were assigned each week and the amount of time they spent on it were significantly positively related to mathematics achievement, after accounting for gender, language spoken at home, and parents' highest level of education. Moreover, students' positive affect toward mathematics and the value they place on mathematics were also significantly positively associated with the amount of time students spent on mathematics homework, after controlling for gender, language spoken at home, and parents' highest level of education. In contrast, students' self-confidence in learning mathematics was significantly negatively associated with the amount of time students spent on mathematics homework. Implications of these findings are discussed for practice and pedagogy.

Keywords: Mathematics homework; Mathematics achievement; Positive affect; Self-confidence; Valuing

INTRODUCTION

Cooper (1989) describes homework as "tasks assigned to students by school teachers that are meant to be carried out during non-school hours" (p. 7). Although there is a growing corpus of research on the relationship between homework and achievement, the findings of hitherto research on the relationship between homework and achievement are a mixed bag. Several studies have documented the positive effects of homework on achievement (see Cooper, Robinson, & Patall, 2006; Dettmers, Trautwein, Lüdtke, Kunter, & Baumert, 2010; Keith & Cool, 1992; Maltese, Tai, & Fan,

2012; Walberg, 1991). However, a small body of research has also demonstrated the negative effects of homework on achievement (see Barber, 1986). Further, a few studies have found little or inconsistent evidence for the effects of homework on achievement (see Bents-Hill, Boswell, Byers, Cohen, Cummings, & Leavitt, 1988; Epstein, 1983).

Given the inconclusive and inconsistent results with regard to the effects of homework on achievement, it is of crucial importance to conduct more studies with a view to unearthing the nuanced relationship between homework and achievement. Moreover, there is a dearth of research on the relationships between students' attitudes towards mathematics and the amount of time they spend on mathematics homework. A better and deeper understanding of the relationships between students' attitudes towards mathematics and the amount of time they spend on mathematics homework may help mathematics educators to formulate appropriate educational interventions with a view to enhancing student achievement in mathematics.

Therefore, the purpose of the present study was two-fold: first, to examine the relationships of the frequency of mathematics homework and the amount of time spent on mathematics homework to student achievement in mathematics; and second, to investigate the relationships of positive affect toward mathematics, self-confidence in learning mathematics, and valuing mathematics with the amount of time spent on mathematics homework. The following two research questions addressed the purpose of the study:

1. How well do the frequency of mathematics homework and the amount of time spent on mathematics homework predict mathematics achievement among Grade 8 students in Singapore, after accounting for gender, home language, and parents' highest level of education?

2. How well do positive affect toward mathematics, self-confidence in learning mathematics, and valuing mathematics predict the amount of time spent on mathematics among Grade 8 students in Singapore, after accounting for gender, home language, and parents' highest level of education?

METHOD

Data

Data for the present study were drawn from the Trends in International Mathematics and Science Study (TIMSS) 2007 database. In Singapore, a total of 4,599 Grade 8 students (male = 2,353; female = 2,246) from 164 schools took part in TIMSS 2007.

Measures

Mathematics Achievement. The TIMSS 2007 Grade 8 mathematics assessment was organized around two dimensions: content dimension (i.e., number, algebra, geometry, and data and chance) and cognitive dimension (i.e., knowing, applying, and reasoning;

Mullis et al., 2008). TIMSS employed item response theory (IRT) techniques to summarize the mathematics achievement of Grade 8 students on a scale with a mean of 500 and a standard deviation of 100 (Mullis et al., 2008).

Mathematics Homework. Mathematics homework was measured using two explanatory variables: the frequency of mathematics homework students were assigned each week (i.e., 1 = *never* to 5 = *every day*) and the amount of time students spent on mathematics homework (i.e., 1 = *zero minutes* to 6 = *more than 90 minutes*).

Positive Affect toward Mathematics. TIMSS created an index of Grade 8 students' positive affect toward mathematics based on students' responses to three statements about mathematics: I enjoy learning mathematics; mathematics is boring; and I like mathematics (Mullis et al., 2008). Students were asked to indicate if they *agreed a lot*, *agreed a little*, *disagreed a little*, or *disagreed a lot* with each statement. Items were reverse scored for IRT scaling.

Self-confidence in Learning Mathematics. TIMSS created an index of Grade 8 students' self-confidence in learning mathematics based on students' responses to four statements about their mathematics ability: I usually do well in mathematics; Mathematics is harder for me than for many of my classmates; I am just not good at mathematics; and I learn things quickly in mathematics (Mullis et al., 2008). Students were asked to indicate if they *agreed a lot*, *agreed a little*, *disagreed a little*, or *disagreed a lot* with each statement. Items were reverse scored for IRT scaling.

Valuing Mathematics. The TIMSS index of students valuing mathematics is based on Grade 8 students' responses to four statements about mathematics: I think learning mathematics will help me in my daily life; I need mathematics to learn other school subjects; I need to do well in mathematics to get into the university of my choice; and I need to do well in mathematics to get the job I want (Mullis et al., 2008). Students were asked to indicate if they *agreed a lot*, *agreed a little*, *disagreed a little*, or *disagreed a lot* with each statement. Items were reverse scored for IRT scaling.

Control Variables. Gender (1 = female; 0 = male), students' reports of how frequently they spoke the language of the TIMSS test at home (1 = *never* to 4 = *always*), and parents' highest level of education (1 = *lower secondary education* to 5 = *university degree*) were entered in the analyses as confounding variables.

RESULTS

The descriptive statistics (i.e., mean [*M*], standard error [*SE*], and standard deviation [*SD*]) for all variables in the study are presented in Table 1. The bivariate correlations are presented in Table 2.

Table 1: Descriptive statistics

	M	*SE*	*SD*
Math achievement	592.79	3.81	92.96
Gender	0.49	0.01	0.50
Language spoken at home	2.64	0.02	0.93
Parents' highest level of education	3.51	0.02	1.17
Frequency of math homework	3.88	0.03	0.90
Time spent on math homework	3.65	0.02	0.95
Positive affect toward math	2.41	0.02	0.80
Self-confidence in learning math	2.61	0.02	0.80
Valuing math	2.73	0.01	0.53

Table 2: Correlations

	Math Achievement	Time Spent on Math Homework
Gender	0.03*	0.07***
Language spoken at home	0.20***	0.01
Parents' highest level of education	0.32***	0.02
Frequency of math homework	0.15***	-
Time spent on math homework	0.08***	-
Positive affect toward math	-	0.02
Self-confidence in learning math	-	0.06***
Valuing math	-	-0.07***

Ordinary least squares (OLS) regression analyses were conducted to examine the relationships of the frequency of mathematics homework and the amount of time spent on mathematics homework to mathematics achievement (see Table 3). Mathematics achievement was the dependent variable. The frequency of mathematics homework and the amount of time spent on mathematics homework were the independent variables. Gender, students' reports of how frequently they spoke the language of the TIMSS test at home, and parents' highest level of education were the control variables. The IEA International Database (IDB) Analyzer (Version 3.0) was used to run the OLS regression analyses.

Table 3: Ordinary least squares (OLS) regression analyses predicting mathematics achievement

	Model 1				Model 2			
	B	*SE*	*β*	*SE*	*B*	*SE*	*β*	*SE*
Gender	11.20	4.33	0.06*	0.02	6.24	3.92	0.04	0.02
Language spoken at home	9.36	2.34	0.10*	0.02	7.91	3.92	0.08**	0.02
Parents' highest level of education	21.22	1.57	0.28***	0.02	20.87	1.40	0.28***	0.02
Frequency of math homework					12.48	2.76	0.12**	0.03
Time spent on math homework					6.10	1.97	0.07*	0.02
Adjusted R^2			0.11				0.13	

*$p < .05$. **$p < .01$. ***$p < .001$.

The frequency of mathematics homework was a statistically significant positive predictor of mathematics achievement ($β = 0.12$, $p < .01$), after accounting for gender, language spoken at home, and parents' highest level of education. Moreover, the amount of time spent of mathematics homework was also a statistically significant positive predictor of mathematics achievement ($β = 0.07$, $p < .05$), after controlling for gender, language spoken at home, and parents' highest level of education.

OLS regression analyses were also conducted to examine the relationships of positive affect toward mathematics, self-confidence in learning mathematics, and valuing mathematics with the amount of time spent on mathematics homework (see Table 4). The amount of time spent on mathematics homework was the dependent variable.

Positive affect toward mathematics, self-confidence in learning mathematics, and valuing mathematics were the independent variables. Gender, students' reports of how frequently they spoke the language of the TIMSS test at home, and parents' highest level of education were the control variables. The IEA IDB Analyzer (Version 3.0) was used to run the OLS regression analyses.

Table 4: Ordinary least squares (OLS) regression analyses predicting the amount of time spent on mathematics homework

	Model 1				Model 2			
	B	*SE*	*β*	*SE*	*B*	*SE*	*β*	*SE*
Gender	0.13	0.04	0.07*	0.02	0.11	0.04	0.06*	0.02
Language spoken at home	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02
Parents' highest level of education	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.02
Positive affect toward math					0.08	0.03	0.07*	0.02
Self-confidence in learning math					-0.14	0.03	-0.12**	0.02
Valuing math					0.11	0.04	0.06*	0.02
Adjusted R^2		0.01				0.02		

*$p < .05$. **$p < .01$. ***$p < .001$.

Students' positive affect toward mathematics was a statistically significant positive predictor of the amount of time spent of mathematics homework ($β = 0.07$, $p < .05$), after accounting for gender, language spoken at home, and parents' highest level of education. Further, valuing mathematics was also a statistically significant positive predictor of the amount of time spent of mathematics homework ($β = 0.06$, $p < .05$), after controlling for gender, language spoken at home, and parents' highest level of education. In contrast, students' self-confidence in learning mathematics was a statistically significant negative predictor of the amount of time spent of mathematics homework ($β = -0.12$, $p < .01$), after accounting for gender, language spoken at home, and parents' highest level of education.

DISCUSSION

The purpose of the present study was to examine: i) the relationships of frequency of mathematics homework and the amount of time spent on mathematics homework to student achievement in mathematics; and ii) the relationships of students' positive affect toward mathematics, self-confidence in learning mathematics, and valuing mathematics with the amount of time they spent on mathematics homework.

The results of the study revealed that the frequency of mathematics homework students were assigned each week was positively associated with mathematics achievement, suggesting that average mathematics achievement was significantly higher among students whose mathematics teachers frequently assigned them mathematics homework. Furthermore, the amount of time students spent on mathematics homework was also positively associated with mathematics achievement, suggesting that average mathematics achievement was higher among students who spent more time doing mathematics homework. Thus, consistent with the findings of previous research (e.g., Cooper et al., 2006; Walberg, 1991), the results of the present study indicate that homework is positively associated with achievement gains. Hence, mathematics teachers may need to place more emphasis on mathematics homework, which, in turn, may help enhance student achievement in mathematics.

The results of the study also suggested that students' positive affect toward mathematics was significantly positively associated with the amount of time students spent on mathematics homework. In other words, students who reported higher levels of positive affect toward mathematics spent significantly more time on mathematics homework than did their peers who reported lower levels of positive affect toward mathematics. Given the positive association between the amount of time spent on mathematics homework and mathematics achievement, mathematics teachers may need to play a key role in boosting and sustaining students' positive affect toward mathematics.

Moreover, the value students place on mathematics was significantly positively associated with the amount of time students spent on mathematics homework. Put another way, students who placed a higher value on mathematics spent significantly more time on mathematics homework than did their counterparts who placed a lower value on mathematics. Indeed, mathematics teachers' values, beliefs, and reflections with regard to mathematics teaching and learning may help students to value learning mathematics and to discover the joy of learning mathematics.

Finally, students' self-confidence in learning mathematics was significantly negatively associated with the amount of time students spent on mathematics homework. Students who reported higher levels of self-confidence in learning mathematics spent significantly less time on mathematics homework than did their peers who reported lower levels of self-confidence in learning mathematics. This finding is not surprising because students with higher mathematics self-efficacy may need less time to complete the mathematics homework.

In conclusion, the findings of the present study provide empirical support that mathematics homework is positively associated with mathematics achievement. Furthermore, the findings of the study also suggest that students' attitudes towards mathematics are linked to the amount of time students spend on mathematics homework. Well-formulated and consistent educational interventions targeted for students with lower levels of academic self-concept and academic self-efficacy in mathematics seem to be imperative for mathematics homework completion and for improving mathematics achievement.

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