
Title	The relationship of private tutoring to student performance in reading, mathematics, and science in 19 countries
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Source	<i>American Educational Research Association (AERA) Annual Meeting, San Francisco, California, 27 April to 1 May 2013</i>

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Paper Title Relationship of Private Tutoring to Student Performance in Reading, Mathematics, and Science in 19 Countries

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Session Title Culture, Diversity, and Academic Performance

Session Type Poster Presentation

Presentation Date 4/30/2013

Presentation Location San Francisco, California

Descriptors Achievement, Tutoring

Methodology Quantitative

Unit SIG-International Studies

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Relationship of Private Tutoring to Student Performance in Reading, Mathematics, and
Science in 19 Countries
Purpose and Significance of the Study

Private tutoring is a global phenomenon (Bray, 2009; Bray & Lykins, 2012).

However, the proportion of school children relying on private tutoring may vary from country to country (Baker, Akiba, LeTendre, & Wiseman, 2001). Private tutoring exists on an enormous scale in parts of South and East Asia (Bray, 2009; Dang, 2007; Kim & Lee, 2010; Kwok, 2010; Mori & Baker, 2010; Stevenson & Baker, 1992), and is now becoming increasingly pervasive in other parts of Asia and in Africa, Europe, and North America (Aurini & Davies, 2003; Baker et al., 2001; Bray, 2011; Bray & Suso, 2008; Davies, 2004; Foondun, 2002; Gurun & Millimet, 2008; Hamid, Sussex, & Khan, 2009; Ireson & Rushforth, 2011; Lee, 2007; Nath, 2008; Pratiche Trust, 2009; Silova, 2009, 2010; Silova, Budiene, & Bray, 2006; Smyth, 2008; Sujatha, 2006).

Although primary, middle, and secondary school children may take part in private tutoring at some point during their time at school, a growing number of primary school children are heavily relying on private tutoring in some countries (Bray & Kwok, 2003; Pratiche Trust, 2009). Given the primary school children's growing dependence on private tutoring, it is critical to examine the relationship of private tutoring to student academic performance. Hence, the purpose of the present study was to examine whether or not participation in private tutoring during primary education had any relations to 15 year-old-students' reading, mathematical, and scientific literacy in 19 countries. Specifically, the study addressed the following research question: What is the relationship between private tutoring and academic achievement, after accounting for student demographic characteristics such as gender, language spoken at home, family structure, and family socio-economic status?

Theoretical Framework

Relationship between Private Tutoring and Academic Achievement

Relatively little research has been conducted on the relationship between private tutoring and academic achievement (Bray, 2006; Ireson & Rushforth, 2011). As a result, the evidence with regard to the effectiveness of private tutoring in terms of student academic performance is limited, and the findings are mixed (Dang & Rogers, 2008; Ireson, 2004; Ireson & Rushforth, 2011). Hitherto research on the relationship of private tutoring to student academic performance can be classified into studies that controlled for the endogeneity of private tutoring and studies that did not control for the endogeneity of private tutoring (Dang & Rogers, 2008).

Studies that did not control for the endogeneity of private tutoring found a positive association between private tutoring and academic achievement in Germany (Mischo & Haag, 2002), Japan (Stevenson & Baker, 2001), Kenya (Buchmann, 2002), and Vietnam (Ha & Harpham, 2005), and a negative association between private tutoring and academic achievement in Korea (Lee, Kim, & Yoon, 2004) and Singapore (Cheo & Quah, 2005). However, the results of these studies should be treated with caution because these studies did not control in some credible way for the endogeneity of private tutoring, thereby producing inconsistent and unreliable results (Dang & Rogers, 2008).

Studies that controlled for the endogeneity of private tutoring as well found a positive relationship between private tutoring and academic achievement in India (Banerjee, Akiba, LeTendre, & Wiseman, 2007), England (Ireson & Rushforth, 2005), South Korea (Kang, 2006), Turkey (Tansel & Bircan, 2005), the United States (Briggs, 2001; Jacob & Lefgren, 2004), and Vietnam (Dang, 2007). In contrast, Smyth (2008) found no significant effects of private tutoring on student academic performance in Ireland when key variables were statistically controlled.

Nevertheless, the lion's share of the empirical studies that examined the relationship between private tutoring and student academic performance was not based on nationally representative data, thereby limiting the generalizability of results. Therefore, it is imperative to conduct more research on the relationship between private tutoring and academic achievement employing nationally representative data.

Method

Data

Data for the study were drawn from the fourth cycle of the Programme for International Student Assessment (PISA). The Organization for Economic Cooperation and Development (OECD) conducts PISA, which for 2009 sampled approximately 475,000 students from 64 countries. PISA assesses knowledge and life skills of 15-year-olds attending Grade 7 or higher in an educational institution within each country. Students completed assessments on reading literacy, mathematical literacy, and scientific literacy, and answered questions about their background. One of the student background questionnaires, educational career questionnaire, was an international option. Of the 64 participating countries, only 20 countries administered the questionnaire on educational career. One of the questions in the educational career questionnaire was on students' participation in private tutoring on a one-to-one basis in test language and/or other subjects during their primary education. One of the 20 countries, Austria, did not have data on private tutoring. Hence, Austria was excluded from the current study. Table 1 lists the remaining 19 countries included in the current study.

Variables and Measures

The outcome variables were reading, mathematical, and scientific literacy. The reading, mathematical, and scientific literacy measures were scaled with the Rasch model and the performance of students was denoted with plausible values (OECD, 2012). For each scale, five plausible values per student were included. To aggregate these measures, we used

the software—International Database (IDB) Analyzer for PISA—provided by the International Association for the Evaluation of Educational Achievement (IEA). PISA used two-stage stratified sampling, with schools sampled first (with probability proportional to size) and approximately 35 students within each school sampled second (OECD, 2012). To account for these sampling procedures, as well as for the plausible value methodology employed for the achievement scores, the IDB Analyzer for PISA uses appropriate sampling weights and all five plausible achievement scores to ensure accurate population estimates for countries.

The independent variable was private tutoring (1 = yes, 0 = no). The control variables were gender (1 = female, 0 = male), language spoken at home (1 = language of test, 0 = another language), family structure (1 = single-parent family, 0 = nuclear and/or mixed family), and family socio-economic status (SES). The PISA 2009 index of economic, social, and cultural status (ESCS), an index of SES derived from parental occupation, parental education, and home possessions (OECD, 2012), was used as an SES measure in the current study.

Results

Private Tutoring and Academic Achievement

The descriptive statistics for the selected variables and measures are presented in Table 2. The correlations between outcome and predictor variables are presented in Table 3. Separate multiple regression analyses were conducted for each country to examine the relationships of private tutoring with reading, mathematical, and scientific literacy (see Tables 4-6). Student demographic characteristics such as gender, language spoken at home, family structure, and family socio-economic status were entered into the regression equation first, followed by private tutoring. Participation in private tutoring during primary education was negatively associated with 15-year-old-students' reading, mathematical, and scientific literacy

in 18 countries. In other words, students who took part in private tutoring during primary education scored statistically significantly lower on the PISA reading, mathematics, and science assessments than their peers who did not participate in private tutoring during primary education.

Given the statistically significant negative association between private tutoring and academic achievement across countries, the percentages of students at each PISA proficiency level on the reading, mathematics, and science scales were computed to examine whether or not the majority of students who took part in private tutoring during primary education were at-risk in reading, mathematics, and science (see Tables 7-9). In most countries, the majority of students scored at or above the PISA baseline level of proficiency in reading (≥ 407.47 score points), mathematics (≥ 420.07 score points), and science (≥ 409.54 score points), suggesting that the lion's share of students who received private tutoring during primary education were not at-risk in reading, mathematics, and science.

The reading, mathematics, and science mean scores of students who received private tutoring and students who did not receive private tutoring during primary education were also examined. Students who received private tutoring during primary education scored statistically significantly lower on the PISA reading and mathematics assessments than their peers who did not participate in private tutoring during primary education in all 19 countries (see Table 10). Moreover, Students who received private tutoring during primary education scored statistically significantly lower on the PISA science assessment than their peers who did not participate in private tutoring during primary education in all countries, except Singapore. No statistically significant differences were found between students who received private tutoring during primary education and students who did not receive private tutoring during primary education with regard to scientific literacy in Singapore.

Discussion

The present study aimed to examine the relationship between private tutoring and academic achievement. The results of the study, contrary to popular belief, revealed that private tutoring was negatively associated with reading, mathematical, and scientific literacy among 15-year-old students in all 19 countries. Furthermore, although students who received private tutoring during their primary education scored at or above the PISA baseline proficiency level in reading, mathematics, and science, students who took part in private tutoring during primary education scored significantly lower on the PISA reading, mathematics, and science assessments than did their peers who did not participate in private tutoring during primary education.

The unique characteristics of PISA can probably shed some light on the negative association between private tutoring and student academic performance. PISA, unlike the Trends in International Mathematics and Science Study (TIMSS), is not a curriculum-driven study because the link between achievement and curricula is not regarded as the main objective of the study (Wu, 2010). Hence, PISA has a weaker link to curriculum frameworks, and it does not seek to measure students' mastery of specific knowledge, skills, and concepts. Moreover, PISA is designed to measure literacy broadly; therefore, the content of PISA is drawn from broad content areas (Wu, 2010). Students who take part in private tutoring may not be receiving lessons in PISA measured literacies because the focus of private tutoring lessons may often be on school-based curriculum.

The quality of private tutoring may also offer a possible explanation for the negative association between private tutoring and student academic performance. As Bray (2011, p. 8) opines, "Much tutoring is of low pedagogic value. It teaches to the test and is dominated by past examination papers, tips on likely questions, and strategies for answering questions within the time constraints." Private tutoring of questionable quality may not even help

enhance students' academic performance in school, let alone the PISA measured literacies assessing the 15-year-old students' ability to use their knowledge and skills to meet real-life challenges.

In conclusion, the findings of the present study suggest that private tutoring during primary education is negatively linked to 15-year-olds' knowledge and life skills. Because PISA assesses the extent to which 15-year-olds have acquired the wider knowledge and skills in the three domains of reading literacy, mathematical literacy, and scientific literacy that they will need in adult life, private tutoring may not be helpful for young adults in their preparation to meet the challenges of the future. Since the focus of the current study was on the relationship between private tutoring and PISA measured literacies, further research is warranted to explore the nuanced relationship between private tutoring and academic achievement in countries across the globe. As Bray (2010, p. 3) posits, "Research on shadow education has considerably increased in volume and has helped to improve understanding of the scale, nature, and implications of the phenomenon. However, the field is still in its infancy."

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Table 1
OECD Countries and Partner Countries/Economies

OECD countries	Partner countries/economies
Australia Belgium Hungary Iceland Ireland Italy Mexico New Zealand Poland Portugal Slovak Republic Slovenia	Croatia Hong Kong-China Latvia Macao-China Serbia Singapore Trinidad and Tobago

Table 2
Descriptive Statistics

Gender	Language at home	Family structure	ESCS	Private tutoring	Reading literacy	Mathematical literacy	Scientific literacy									
							SE	M	SE	M	SE	M	SE	M	SE	M
Australia							0.0	0.1	0.0	521.6	2.2	520.		533.8	2.4	
							0.36	1	7	0	8	3	08	2.47	0	3
Belgium							0.0	0.1	0.0	516.4	2.1	525.		518.5	2.1	
							0.26	2	3	0	0	5	41	2.01	8	9
Hong Kong- China							-	0.0	0.3	0.0	534.5	2.1	555.		550.4	2.7
							0.80	4	1	1	9	9	79	2.78	3	8
Croatia							-	0.0	0.1	0.0	479.5	2.7	463.		489.9	2.8
							0.16	2	6	1	5	9	50	3.14	5	4
Hungary							-	0.0	0.1	0.0	495.1	3.1	491.		503.4	3.1
							0.18	3	9	1	4	3	12	3.44	7	0
Ireland							0.0	0.0	0.0	502.8	2.7	493.		514.6	3.1	
							0.06	3	8	0	6	2	28	2.52	4	1
Iceland							0.0	0.1	0.0	504.8	1.4	510.		499.1	1.4	
							0.73	2	0	1	5	4	70	1.37	7	3
Italy							-	0.0	0.1	0.0	488.5	1.5	485.		491.4	1.7
							0.07	1	0	0	1	2	13	1.82	5	3
Latvia							-	0.0	0.2	0.0	485.9	2.9	483.		495.2	3.0
							0.12	3	0	1	1	2	84	3.05	5	7
Macao-China							-	0.0	0.3	0.0	487.3	0.8	525.		511.8	1.0
							0.71	1	1	1	4	9	85	0.93	2	5
Mexico							-	0.0	0.2	0.0	431.0	1.8	423.		421.1	1.7
							1.15	3	5	0	8	9	64	1.83	6	5

New Zealand		0.8	0.0	0.1	0.0		0.0	0.1	0.0	525.5	2.2	523.		537.1	2.4
	0.01	6	1	9	1	0.09	2	7	1	8	7	08	2.29	9	3
Poland		0.9	0.0	0.1	0.0	-	0.0	0.0	0.0	504.8	2.5	498.		511.9	2.3
	0.01	9	0	4	1	0.26	2	5	0	0	8	51	2.85	3	8
Portugal		0.9	0.0	0.1	0.0	-	0.0	0.1	0.0	493.8	2.9	491.		496.7	2.8
	0.01	8	0	6	1	0.29	4	5	1	7	9	55	2.89	7	6
Singapore		0.4	0.0	0.1	0.0	-	0.0	0.4	0.0	528.1	1.1	564.		544.0	1.3
	0.00	1	1	1	0	0.41	1	2	1	5	0	76	1.43	0	9
Serbia		0.9	0.0	0.1	0.0		0.0	0.2	0.0	445.2	2.3	446.		445.6	2.2
	0.01	8	0	2	1	0.09	2	0	1	0	6	05	2.90	7	8
Slovak Republic		0.9	0.0	0.1	0.0	-	0.0	0.1	0.0	479.6	2.4	500.		493.4	2.8
	0.02	5	1	5	1	0.07	2	1	1	3	9	10	2.95	6	1
Slovenia		0.9	0.0	0.1	0.0		0.0	0.1	0.0	486.6	1.0	504.		515.8	1.2
	0.01	5	0	2	1	0.10	1	3	1	7	8	27	1.34	1	8
Trinidad and Tobago		0.9	0.0	0.2	0.0	-	0.0	0.3	0.0	428.4	1.5	423.		421.7	1.5
	0.01	7	0	7	1	0.52	2	1	1	5	9	95	1.51	0	5

Note. ESCS = Economic, social, and cultural status.

Table 3
Correlations between Outcome and Predictor Variables/Measures

	Reading Literacy	Mathematical Literacy	Scientific Literacy											
	Language at home	Family Structure	ESCS	Private tutoring	Gender	Language at home	Family structure	ESCS	Private tutoring	Gender	Language at home	Family structure	ESCS	Private tutoring
Australia	0.17*													
Belgium	0.01	-0.09*	0.35*	-0.06*	-0.07*	-0.04*	-0.11*	0.37*	-0.06*	-0.02*	0.02*	-0.10*	0.36*	-0.08*
Hong Kong-China	0.14*	-0.09*	0.42*	-0.14*	-0.13*	0.12*	-0.11*	0.43*	-0.15*	-0.07*	0.12*	-0.11*	0.42*	-0.14*
Croatia	0.18*	-0.05*	0.21*	-0.05*	-0.08*	0.15*	-0.07*	0.26*	-0.07*	-0.02	0.17*	-0.07*	0.22*	-0.05*
	0.02	0.02	0.32*	-0.14*	-0.09*	0.04*	-0.01	0.32*	-0.21*	0.03*	0.03*	-0.01	0.32*	-0.16*

Mexico	* 0														
	. 1														
	3			0.38										0.39	
	* 0.17*	-0.06*		* -0.15*	-0.11*	0.14*	-0.09*	0.38*	-0.15*	-0.06*	0.15*	-0.07*	* -0.15*		
New Zealand	0														
	. 2														
	1			0.41										0.41	
	* 0.18*	-0.09*		* -0.11*	-0.07*	0.14*	-0.11*	0.45*	-0.09*	0.00	0.18*	-0.10*	* -0.11*		
Poland	0														
	. 2														
	6			0.37										0.38	
	* 0.06*	-0.07*		* -0.17*	-0.05*	0.02	-0.10*	0.39*	-0.12*	0.01	0.06*	-0.10*	* -0.13*		
Portugal	0														
	. 2														
	1			0.40										0.44	
	* 0.04*	0.00		* -0.22*	-0.08*	0.03*	-0.03*	0.45*	-0.24*	0.01	0.05*	0.00	* -0.20*		
Singapore	0														
	. 1														
	5			0.39										0.40	
	* 0.29*	-0.10*		* -0.03*	-0.04*	0.23*	-0.08*	0.38*	-0.04*	-0.01	0.27*	-0.09*	* -0.01		
Serbia	0														
	. 2														
	2			0.31										0.31	
	* 0.05*	0.00		* -0.06*	-0.09*	0.04*	-0.02	0.33*	-0.12*	-0.02	0.03*	-0.01	* -0.09*		
Slovak	0														
	0	0.16*	-0.04*	0.37	-0.04*	-0.02	0.12*	-0.07*	0.41*	-0.07*	0.00	0.15*	-0.04*	0.38	-0.06*

Republic	.														
	2														
	9														
	*			*										*	
Slovenia	0														
	.														
	3														
	0			0.37										0.34	
	*	0.10*	0.00	*	-0.24*	-0.02	0.11*	-0.03*	0.38*	-0.28*	0.06*	0.14*	0.00	*	-0.26*
Trinidad and Tobago	0														
	.														
	2														
	4			0.32										0.34	
	*	0.08*	-0.11*	*	-0.11*	0.02	0.07*	-0.16*	0.35*	-0.13*	0.05*	0.07*	-0.15*	*	-0.12*

Note. ESCS = Economic, social, and cultural status.

* $p < 0.05$.

Table 4
Multiple Regression Analyses Predicting Reading Literacy

	Model 1										
	Constant	Gender	Language at home	Family structure	ESCS	R^2					
	<i>B</i>	<i>SE</i>		<i>B</i>	<i>SE</i>	<i>B</i>	<i>SB</i>	<i>SE</i>	<i>B</i>	<i>SE</i>	
Australia	493.86*	7.86		33.43*	2.36	-2.45	7 -5.52	2.47	43.92*	1.82	0.16
Belgium	488.14*	4.40		23.53*	3.26	14.61*	4 -8.76*	2.82	42.59*	1.52	0.20
Hong Kong-											
China	480.06*	8.67		31.66*	3.74	60.28*	8 -8.38	3.84	17.56*	1.67	0.12
Croatia	452.22*	14.90		47.94*	4.00	10.38	1 9.06	3.68	30.70*	1.96	0.19
Hungary	426.44*	22.70		39.10*	3.21	60.79	2 -1.98	3.50	47.14*	2.00	0.31
Ireland	465.05*	11.70		37.87*	3.49	21.37	1 -10.83	4.66	37.83*	1.91	0.18
Iceland	418.44*	11.58		43.22*	2.84	50.17*	1 -6.39	4.95	25.09*	1.93	0.12
Italy	448.74*	2.88		40.04*	2.16	35.18*	2 -1.04	2.31	27.68*	0.96	0.18
Latvia	462.18*	6.82		44.78*	2.64	7.71	7 -0.76	2.88	29.70*	2.55	0.19
Macao-											
China	435.13*	2.55		32.96*	1.74	55.91*	2 -0.59	2.78	16.78*	1.21	0.12
Mexico	389.29*	7.78		23.91*	1.52	63.97*	7 -10.72*	1.87	22.94*	0.86	0.19
New Zealand	468.93*	4.77		41.46*	2.99	39.83*	4 -3.80	4.45	49.67*	2.11	0.23
Poland	435.11*	18.64		46.39*	2.50	59.83*	1 -11.54*	3.98	36.56*	1.86	0.22
Portugal	452.82*	7.90		38.56*	2.33	31.60*	7 2.78	3.87	29.24*	1.58	0.22
Singapo re	523.10*	2.42		27.60*	2.37	29.19	2 -16.36*	4.57	37.94*	1.84	0.20
Serbia	411.46*	10.97		37.71*	2.81	14.63*	1 2.97	3.51	26.39*	1.42	0.15
Slovak Republi	417.04*	8.96		52.49*	3.55	43.18*	8 -1.92	4.20	38.59*	2.42	0.24

c												
Slovenia	437.30*	5.49		54.59*	2.63	22.40*	5	4.18	3.89	36.49*	1.47	0.24
Trinidad and Tobago	383.04*	13.85		52.79*	3.82	51.73*	1	-22.49*	4.73	36.52*	1.88	0.18

Note. ESCS = Economic, social, and cultural status.

* $p < 0.05$.

Table 4 (continued)
Multiple Regression Analyses Predicting Reading Literacy

Model 2													
Constant	Gender	Language at home	Family structure	ESCS	Private tutoring	R^2							
	<i>B</i>	<i>SE</i>	<i>B</i>	<i>SE</i>	<i>B</i>	<i>SE</i>	<i>B</i>	<i>B</i>	<i>SE</i>	<i>B</i>	<i>SE</i>		
Australia												- 2 1. 5 6	
	500.46*	7.94	33.83*	2.41	-6.25	7.44	-5.32	44.61*	1.82	*	2.78	0.16	
Belgium												- 3 8. 5 6	
	493.01*	4.37	24.23*	3.18	14.25*	4.02	-8.34*	42.64*	1.47	*	2.98	0.22	
Hong Kong-China												- 1 6. 1 8	
	486.42*	8.42	32.05*	3.75	59.71*	8.52	-8.01	18.87*	1.68	*	2.78	0.13	
Croatia												1 3 3. 6 2	
	457.48*	14.41	48.15*	3.93	10.27	13.87	9.43	30.97*	1.90	-	3.38	0.21	

Hungary										*		
										-		
										2		
										8.		
										1		
	434.94	22.1	39.34	3.2		22.5			1.9	6		
	*	4	*	3	57.57	9	-1.96	47.26*	5	*	3.62	0.33
Ireland										-		
										3		
										7.		
										8		
	469.44		37.40	3.4					1.9	9		
	*	11.51	*	9	20.32	11.17	-10.79	38.55*	2	*	6.94	0.19
Iceland										-		
										6		
										5.		
										0		
	436.99		43.39	2.9	37.52				1.9	3		
	*	11.68	*	6	*	11.45	-4.55	24.80*	3	*	5.39	0.16
Italy										-		
										4		
										9.		
										0		
	454.49		39.46		34.54				0.9	4		
	*	2.83	*	2.11	*	2.51	0.03	27.82*	5	*	2.31	0.21
Latvia										-		
										2		
										7.		
										1		
	468.32		45.13	2.7					2.5	2		
	*	6.88	*	2	6.70	7.24	-0.62	30.16*	1	*	3.17	0.21
Macao-China	442.95	2.63	33.02	1.7	56.59	2.79	-0.50	17.98*	1.2	-	2.35	0.14

									2	4.		
									4.			
									4.			
									4.			
	*		*	7	*				2	*		
Mexico										-		
										2		
										9.		
										1		
	402.24		23.51	1.4	58.97				0.8	7		
	*	7.78	*	9	*	7.58	-10.28*	23.51*	4	*	1.67	0.21
New Zealand										-		
										3		
										3.		
										9		
	478.21		41.89	3.0	35.24				2.1	5		
	*	4.83	*	0	*	4.66	-3.48	51.23*	7	*	4.19	0.25
Poland										-		
										5		
										8.		
										4		
	438.13	18.3	43.95	2.5	60.75	18.2			1.8	4		
	*	0	*	0	*	6	-10.08	36.67*	5	*	4.92	0.24
Portugal										-		
										4		
										4.		
										8		
	467.24		38.80	2.2	23.25				1.5	6		
	*	8.24	*	6	*	7.86	2.47	28.25*	6	*	3.33	0.25
	529.27	2.67	27.97	2.3	28.84	2.75	-16.26*	38.81*	1.8	-	2.59	0.20
	*		*	4	*				4	1		
Singapore										3.		

									8			
									3			
									*			
Serbia									-			
									1			
									8.			
									3			
	416.20		38.29	2.8		10.8			1.3	1		
	*	11.06	*	2	13.17	9	3.38	26.99*	8	*	3.35	0.16
Slovak Republic										-		
										1		
										8.		
										0		
	420.45		52.54	3.5	41.58				2.4	6		
	*	8.81	*	0	*	8.81	-0.92	39.23*	3	*	4.41	0.24
Slovenia										-		
										5		
										4.		
										8		
	448.21		53.23	2.5	19.32				1.4	5		
	*	5.39	*	5	*	5.47	4.20	35.48*	4	*	3.66	0.28
Trinidad and Tobago										-		
										2		
										9.		
										5		
	392.66	14.0	53.27	3.7	51.17	14.2			1.8	3		
	*	7	*	1	*	2	-21.44*	37.48*	4	*	4.31	0.19

Note. ESCS = Economic, social, and cultural status.

* $p < 0.05$.

Table 5
Multiple Regression Analyses Predicting Mathematical Literacy

	Model 1										
	Constant	Gender	Language at home	Family structure	ESCS	R^2					
	<i>B</i>	<i>SE</i>		<i>B</i>	<i>SE</i>	<i>B</i>	<i>SB</i>	<i>SE</i>	<i>B</i>	<i>SE</i>	
Australia	533.16*	8.39		-12.49*	2.12	-20.68	7 -8.14*	2.62	43.61*	1.62	0.14
Belgium	523.46*	4.61		-23.59*	3.21	11.53	4 -12.82*	3.16	43.49*	1.69	0.20
Hong Kong- China	532.66*	7.92		-14.62*	4.67	56.19*	7 -14.69*	4.39	23.33*	1.90	0.10
Croatia	452.01*	12.00		-14.06*	3.87	25.21	1 0.79	3.87	30.07*	2.50	0.11
Hungary	445.91*	25.93		-10.88*	3.71	63.26	2 -5.74	3.52	48.63*	2.41	0.28
Ireland	472.29*	8.50		-7.87	2.91	27.96*	8 -12.84*	4.43	34.51*	1.86	0.15
Iceland	472.10*	10.77		-4.26	2.88	24.87	1 -9.60	4.69	27.71*	1.91	0.09
Italy	484.41*	2.97		-19.37*	2.31	23.44*	2 -5.07	2.66	23.69*	1.14	0.10
Latvia	492.37*	7.42		-2.97	3.02	-0.79	7 -1.01	3.14	31.73*	2.61	0.13
Macao- China	536.55*	2.96		-12.95*	2.13	10.45*	2 -2.27	3.64	14.92*	1.30	0.03
Mexico	416.11*	6.64		-14.53*	1.34	47.35*	6 -13.76*	1.89	21.24*	0.95	0.17
New Zealand	503.33*	5.18		-10.94*	2.87	27.39*	4 -5.28	3.73	51.12*	1.85	0.21
Poland	487.32*	20.79		-6.12	2.44	28.46	2 -15.28*	4.25	37.65*	1.89	0.16
Portugal	490.81*	9.93		-10.41*	2.35	18.78	9 -4.42	4.19	33.67*	1.78	0.21
Singapo re	584.57*	2.64		-9.23*	2.54	18.02*	3 -15.20*	4.79	42.89*	2.04	0.15
Serbia	440.13*	12.19		-13.03*	3.74	12.52	1 -1.49	3.59	29.42*	1.88	0.11
Slovak Republi	483.31*	13.60		-0.93	3.69	25.53	1 -10.09	4.62	44.23*	2.71	0.17

Latvia										*		
										-		
										3		
										3.		
										4		
				3.0					2.5	4		
499.94*	7.49	-2.54	5	-2.03	7.31	-0.84	32.31*	5	*	3.22	0.16	
Macao										-		
-China										3		
										4.		
										2		
				2.1					1.3	8		
547.52*	3.20	-12.87*	4	11.40*	3.09	-2.14	16.62*	0	*	2.68	0.06	
Mexico										-		
o										2		
										9.		
										6		
				1.3					0.9	0		
429.25*	6.68	-14.94*	2	42.28*	6.68	-13.32*	21.82*	3	*	1.48	0.20	
New Zealand										-		
d										2		
										8.		
										9		
				2.8					1.9	0		
511.23*	5.38	-10.58*	7	23.48*	4.94	-5.02	52.45*	0	*	3.82	0.23	
Poland										-		
										4		
										7.		
										8		
				2.4					1.8	6		
489.79*	20.5	-8.12*	2	29.21	20.63	-14.08*	37.74*	9	*	5.43	0.17	
Portug	507.55*	9.78	-10.14*	2.3	9.09	9.18	-4.78	32.52*	1.7	-	3.86	0.25

0

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8
*

Note. ESCS = Economic, social, and cultural status.
* $p < 0.05$.

Table 6
Multiple Regression Analyses Predicting Scientific Literacy

	Model 1											
	Constant	Gender	Language at home	Family structure	ESCS	R^2						
	<i>B</i>	<i>SE</i>		<i>B</i>	<i>SE</i>	<i>B</i>	<i>SB</i>	<i>SE</i>	<i>B</i>	<i>SE</i>		
Australia	521.70*	9.35		-2.51	2.28	0.40	8	-7.80*	2.75	46.18*	1.84	0.13
Belgium	511.21*	4.38		-10.49*	3.17	10.69	4	-11.77*	2.91	41.73*	1.67	0.18
Hong Kong- China	516.32*	8.55		-3.22	3.86	57.62*	8	-13.64*	3.85	18.50*	1.91	0.08
Croatia	476.16*	13.67		5.59	4.06	17.60	1	1.39	3.46	29.19*	2.25	0.11
Hungary	460.24*	32.17		0.91	3.16	54.17	3	-5.53	3.40	42.93*	2.32	0.25
Ireland	469.51*	10.84		0.89	3.99	47.90*	1	-6.51	5.30	37.49*	2.02	0.13
Iceland	447.89*	12.27		-2.46	2.82	36.50	1	-6.49	4.64	26.92*	1.88	0.08
Italy	477.00*	3.07		-3.93	2.44	30.99*	2	-2.09	2.90	25.89*	1.10	0.11
Latvia	486.67*	7.21		4.75	2.95	13.03	7	-0.27	3.60	28.38*	2.52	0.11
Macao- China	483.88*	2.80		1.08	1.70	44.99*	2	-0.68	3.13	14.74*	1.20	0.05
Mexico	406.06*	6.09		-7.10*	1.51	50.32*	6	-10.38*	1.90	21.53*	0.86	0.17
New Zealand	497.97*	5.22		0.92	3.13	43.01*	4	-4.21	4.61	51.09*	2.36	0.19
Poland	460.31*	19.64		2.92	2.56	64.06*	1	-16.76*	3.96	35.71*	1.78	0.15
Portugal	476.00*	8.37		4.14	2.58	29.25*	8	1.65	3.76	29.96*	1.57	0.19
Singapo re	558.27*	2.39		-2.85	2.43	24.85*	3	-16.06*	5.38	43.89*	1.97	0.18
Serbia	440.37*	13.01		-0.20	3.35	5.25	1	-0.66	3.53	25.74*	1.53	0.09
Slovak Republi	461.06*	11.13		1.70	4.23	38.39*	1	-1.51	4.43	40.48*	2.45	0.15

										4	
										1	
Hungary										4	
	468.89						3.3	43.05		.	
	*	31.53	3.21	50.90	32.03	-5.50	6	*	2 -28.67*	1	
Ireland										3	0.26
										7	
	474.28						5.2	38.27		.	
	*	11.07	3.98	46.77*	10.78	-6.47	6	*	2 -41.14*	1	
Iceland										6	0.15
										5	
	468.45						4.4	26.59		.	
	*	12.30	2.94	22.47	12.19	-4.45	6	*	1 -72.12*	5	
Italy										4	0.13
										2	
	482.91						2.8	26.03		.	
	*	3.01	2.38	30.34*	2.59	-0.98	6	*	1 -50.27*	3	
Latvia										9	0.14
										3	
	492.07						3.6	28.79		.	
	*	7.33	3.00	12.15	7.47	-0.15	7	*	2 -23.85*	2	
Macao-China										7	0.13
										2	
	492.54							16.08		.	
	*	2.83	1.71	45.74*	2.77	-0.58	3.11	*	1 -27.07*	7	
Mexico										5	0.07
										1	
	418.55						1.8	22.07		.	
	*	6.04	1.51	45.50*	6.06	-9.96*	9	*	0 -28.12*	3	
New Zealand										0	0.20
	507.58	5.35	3.14	38.26*	4.84	-3.89	4.5	52.71	2 -35.12*	4	0.21
	*						8	*		.	

										7	
										4	
Poland										4	
	462.98									.	
	*	19.34	2.52	64.87*	19.20	15.47*	3.9	35.81		8	
Portugal							7	*	1 -51.61*	4	0.17
										3	
	488.17									.	
	*	8.90	2.53	22.21	8.62	1.38	3.7	29.13		3	
Singapore							3	*	1 -37.86*	0	0.22
										2	
	562.44									.	
	*	2.74	2.41	24.61*	3.10	-15.99	5.3	44.48		7	
Serbia							8	*	1 -9.36*	4	0.18
										3	
	446.29									.	
	*	13.26	3.33	3.43	13.15	-0.15	3.4	26.49		4	
Slovak Republic							5	*	1 -22.88*	4	0.11
										5	
	465.57									.	
	*	11.01	4.15	36.28*	10.59	-0.19	4.3	41.33		1	
Slovenia							6	*	2 -23.87*	2	0.16
										4	
	484.50									.	
	*	5.63	2.78	34.92*	5.84	4.71	4.5	32.24		0	
Trinidad and Tobago							9	*	1 -63.87*	1	0.18
										4	
	418.33									.	
	*	12.11	3.43	41.47*	12.19	28.84*	4.2	37.50		5	
							1	*	2 -30.40*	9	0.16

Note. ESCS = Economic, social, and cultural status.

* $p < 0.05$.

Table 7
Percentage of Students at Each Proficiency Level on the Reading Literacy Scale

	Proficiency levels															
	Below Level 1b	Level 1b	Level 1a	Level 2	Level 3	Level 4	Level 5	Level 6								
	%	SE	%	SE	%	SE	%	SE	SE	%	SE	%	SE	%	SE	
Australia					0.5		0.8	22.3	1.3						1.3	
	1.21	0.36	3.28	1	9.89	0	8	1	1.44	23.44	1.56	8.30	0.96	7	0.45	
Belgium				1.0	14.1	1.4	27.4	1.7							0.4	
	0.88	0.43	4.36	0	4	7	2	2	1.79	18.04	1.35	4.24	0.65	0	0.28	
Hong Kong-China				0.4		0.8	16.7	1.3							0.7	
	0.34	0.19	1.52	2	6.38	5	1	5	1.47	32.87	1.43	8.71	0.98	9	0.37	
Croatia				1.0	22.4	1.8	29.2	2.4							0.0	
	1.50	0.65	7.55	1	2	9	1	6	2.69	9.79	1.46	1.94	0.76	2	0.07	
Hungary				1.8	15.6	2.2	25.3	2.7							0.1	
	1.24	0.69	8.06	3	8	3	1	5	2.31	17.27	1.73	4.01	1.02	7	0.17	
Ireland				1.7	16.6	2.9	25.6	3.2								
	2.57	1.17	6.17	0	8	3	5	4	3.25	17.99	2.93	4.22	1.23	0.11	0.32	
Iceland				2.0	22.6	2.8	30.6	3.0							0.0	
	2.15	1.10	9.70	7	1	5	4	3	2.53	8.52	1.93	1.06	0.63	6	0.20	
Italy				1.0	22.6	1.2	28.7	1.5							0.1	
	3.49	0.76	8.91	8	4	0	3	2	1.14	9.76	0.68	1.61	0.48	4	0.13	
Latvia				1.1	19.4	2.3	30.8	2.6								
	0.27	0.34	5.29	7	6	8	7	0	2.21	12.49	1.54	1.97	0.70	0.11	0.23	
Macao-China				0.4	14.7	1.1	35.6	1.2							0.0	
	0.39	0.18	3.09	6	2	2	0	4	1.47	12.14	0.82	1.72	0.38	1	0.04	
Mexico				15.4	0.8	27.3	0.9	29.9	1.0						0.0	
	4.79	0.60	5	4	8	6	1	2	0.89	3.79	0.37	0.20	0.07	0	0.01	

New Zealand	1.17	0.65	3.72	0.8	12.4	1.3	2.1	1.1							
Poland	1.96	1.25	9.78	4	4	6	23.11	4	1.96	21.82	2.04	9.92	1.53	6	0.41
Portugal	0.94	0.34	7.83	2.4	22.4	3.3	34.6	4.6	3.08	9.00	2.30	0.81	0.66	0	0.00
Singapore	0.30	0.14	2.33	1.2	20.7	2.2	36.0	2.1	2.51	9.22	1.20	1.03	0.48	0	0.00
Serbia	1.98	0.81	8.21	1	5	9	7	7	1.26	25.99	1.41	11.85	0.77	7	0.18
Slovak Republic	1.08	0.51	8.97	0.3		0.6	20.0	0.9	1.65	5.89	0.99	0.41	0.28	1	0.02
Slovenia	1.68	0.38	6	1.6	14.8	1.9	27.8	2.9	3.14	15.56	2.02	3.56	1.14	3	0.27
Trinidad and Tobago	8.93	1.18	8	10.6	1.5	26.9	1.9	31.6	2.34	6.53	1.53	0.47	0.43	0	0.00
			13.4	1.3	23.7	1.8	26.6	2.4	1.59	7.38	1.02	1.23	0.42	0	0.00
			1	1	1	8	1	2						2	0.05

Note. Below Level 1b (less than 262.04 score points); Level 1b (from 262.04 to less than 334.75 score points); Level 1a (from 334.75 to less than 407.47 score points); Level 2 (from 407.47 to less than 480.18 score points); Level 3 (from 480.18 to less than 552.89 score points); Level 4 (from 552.89 to less than 625.61 score points); Level 5 (from 625.61 to less than 698.32 score points); and Level 6 (above 698.32 score points).

Table 8

Percentage of Students at Each Proficiency Level on the Mathematical Literacy Scale

	Proficiency levels														
	Below Level 1	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6								
		%	SE	%	SE	SE	%	SE	%	SE	%	SE	%	SE	
Australia	5.40	0.63	12.2	1.1	1.17	26.6	1.4	20.4	1.4	9.80	0.	3.56	0.90		
			4	8		7	9	4	2		8				

Belgium											1		
											0.		
			13.3	1.6		27.0	2.1	17.8	1.5		9		
	8.03	1.49	7	9	1.82	0	5	0	8	7.94	9	1.85	0.57
Hong Kong-China											1.		
				0.8		23.8	2.0	26.9	1.8		5		
	2.55	0.52	6.46	4	1.28	9	1	2	5	18.65	4	7.51	1.11
Croatia											0.		
			28.4	1.8		14.8	2.6		1.3		5		
	22.78	1.88	2	2	2.20	5	2	6.83	8	1.21	0	0.02	0.08
Hungary											1.		
			18.1	1.9		23.4	2.1	14.8	1.8		1		
	12.77	2.10	9	4	2.18	3	2	1	2	6.34	8	1.40	0.78
Ireland											0.		
			18.5	2.6		25.7	3.0	16.2	2.8		9		
	12.14	2.38	7	1	2.63	6	0	7	5	2.08	8	0.38	0.36
Iceland											1.		
			23.3	2.7		22.5	2.8		2.2		1		
	13.32	2.41	9	7	3.16	4	4	11.10	4	2.43	0	0.16	0.26
Italy											0.		
			24.3	1.1		18.2	0.9		0.8		6		
	18.23	1.43	2	3	1.58	8	8	8.77	7	2.53	4	0.47	0.18
Latvia											0.		
			22.7	2.4		23.2	2.2	10.2	1.2		6		
	8.81	1.77	6	1	2.32	5	6	6	6	2.47	6	0.41	0.35
Macao-China											0.		
				0.9		29.9	1.6	20.1	1.3		8		
	3.86	0.45	11.21	7	1.19	7	8	8	8	8.56	4	2.04	0.43
Mexico											0.		
			29.8	1.1		12.8	0.7		0.4		1		
	28.83	1.21	4	2	1.06	0	2	2.96	3	0.29	0	0.01	0.02
New Zealand											1.		
	6.64	1.20	11.01	1.4	1.78	26.7	2.1	21.0	1.9	10.56	1.	2.79	0.80

Table 9

Percentage of Students at Each Proficiency Level on the Scientific Literacy Scale

	Proficiency levels															
	Below Level 1	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6									
		%	SE	%	SE	%	SE	%	SE	%	SE	%	SE	%	SE	
Australia				10.1	1.1	22.3	1.4	29.8	1.2	23.8	1.4		0.9	1.8		
Belgium	3.60	0.58	0	0	9	3	0	4	0	3	8.50	8	2	0.57		
Hong Kong-China	5.22	1.15	8	9	8	4	9	0	5	9	4.12	5	5	0.25		
Croatia	1.33	0.39	4.80	9	8	4	4	1	4	3	12.19	3	2	0.43		
Hungary	5.08	0.95	6	7	6	9	5	5	9.24	1	1.58	4	4	0.08		
Ireland	7.35	2.03	7	2	0	3	5	0	0	5	3.94	7	8	0.16		
Iceland	7.92	2.11	8	6	2	8	5	4	6	7	4.72	0	6	0.44		
Italy	13.93	2.20	5	4	9	2	7	6	7.97	0	0.39	9	0	0.00		
Latvia	11.12	1.37	9	0	6	4	2	8	9.42	7	1.61	1	9	0.09		
Macao-China	2.65	0.97	7	7	7	8	9	8	2	7	1.59	9	0.11	0.14		
Mexico	1.93	0.35	2	4	3	6	4	6	5	4	2.28	0	7	0.09		
	19.04	0.98	8	8	8	6	6	4	1.75	7	0.09	5	0	0.00		

New Zealand	5.02	1.13	11.63	8	5	2	3	4	3	4	10.16	7	0	0.64		
Poland	6.13	2.03	21.8	2.9	35.6	3.5	23.7	3.2	10.5	2.3	2.02	8	5	0.20		
Portugal	5.66	1.09	3	2	0	8	6	5	1	7	2.02	8	5	0.20		
Singapore	2.20	0.35	21.0	2.0	38.9	2.2	24.5	2.5			0.7	0.0				
Serbia	10.73	1.33	8	1	3	9	6	1	8.51	1.11	1.18	4	9	0.18		
Slovak Republic	7.08	1.31	0.8	18.7	1.0	26.2	1.1	26.0	1.2		0.9	4.4				
Slovenia	6.40	1.12	2.20	0.35	7.80	2	4	3	6	5	3	7	14.52	6	5	0.60
Trinidad and Tobago	25.21	2.03	28.4	1.9	35.4	1.8	20.1	1.8		1.2	0.4	0.0				
			2	7	5	4	0	2	4.78	2	0.46	1	6	0.13		
			16.6	2.3	28.0	2.6	29.5	2.7	13.0	1.9		1.5	0.8			
			6	8	2	3	1	8	0	2	4.88	3	5	0.65		
			23.5	1.7	33.6	2.8	26.0	2.5		1.5		0.9	0.0			
			5	8	7	2	6	3	8.58	7	1.73	4	1	0.03		
			27.0	2.5	26.7	1.9	14.3	1.2		0.9		0.3	0.0			
			4	4	9	2	0	7	5.60	0	1.02	2	4	0.10		

Note. Below Level 1 (below 334.94 score points); Level 1 (from 334.94 to less than 409.54 score points); Level 2 (from 409.54 to less than 484.14 score points); Level 3 (from 484.14 to less than 558.73 points); Level 4 (from 558.73 to less than 633.33 score points); Level 5 (from 633.33 to less than 707.93 score points); and Level 6 (above 707.93 score points).

Table 10

Mean Scores of Students who Received Private Tutoring and who did not Receive Private Tutoring

Private tutoring (Yes)	Private tutoring (No)												
	Reading literacy	Mathematical literacy	Scientific literacy	SE	SE	Reading literacy	Mathematical literacy	Scientific literacy	SE	M	SE	M	SE
<i>M</i>				<i>SE</i>	<i>SE</i>	<i>M</i>			<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>

Australia		3.8	515.76 _a	3.50	524.66 _b	2.26	523.09 _b	2.45	537.55 _b	2.47
a	507.32 _a	3.53	1							
Belgium		3.4	486.33 _a	3.67	521.39 _b	2.21	530.88 _b	2.09	523.52 _b	2.23
m	483.86 _a	3.65	8							
Hong Kong-		3.5	544.89 _a	3.53	537.18 _b	2.39	560.09 _b	3.00	552.94 _b	2.91
China		2.99	7							
Croatia		4.0	457.85 _a	4.13	484.80 _b	2.81	471.45 _b	3.19	496.01 _b	2.88
	451.74 _a	4.35	6							
Hungary		5.6	480.57 _a	5.90	500.42 _b	3.06	496.36 _b	3.40	508.95 _b	2.88
y	473.06 _a	5.46	6							
Ireland		6.4	482.98 _a	7.45	505.75 _b	2.65	496.25 _b	2.52	517.66 _b	3.06
	472.59 _a	7.48	2							
Iceland		5.3	431.01 _a	5.37	511.81 _b	1.57	517.36 _b	1.44	506.80 _b	1.55
	442.72 _a	5.41	8							
Italy		2.7	445.92 _a	2.54	494.13 _b	1.57	490.93 _b	1.83	497.00 _b	1.79
	442.36 _a	2.70	0							
Latvia		4.0	477.26 _a	4.09	491.12 _b	3.07	490.42 _b	3.19	499.89 _b	3.17
	465.71 _a	3.91	1							
Macao-China		1.8	495.01 _a	2.40	494.08 _b	1.10	535.84 _b	1.26	519.56 _b	1.09
	472.69 _a	1.92	5							
Mexico		2.2	401.05 _a	2.13	438.52 _b	1.79	430.89 _b	1.83	427.99 _b	1.73
	409.17 _a	2.62	4							
New Zealand		3.9	513.09 _a	4.93	530.19 _b	2.18	526.75 _b	2.40	542.08 _b	2.41
	502.84 _a	4.56	1							
Poland		6.6	460.32 _a	6.12	508.33 _b	2.53	500.97 _b	2.82	514.68 _b	2.32
	438.76 _a	6.11	1							
Portugal		4.0	456.77 _a	3.71	501.98 _b	2.99	500.90 _b	2.98	503.90 _b	2.91
l	448.37 _a	4.05	4							
Singapore		2.3	542.22 _a	2.33	531.15 _b	1.58	568.98 _b	2.09	545.32 _a	1.87
	524.11 _a	2.09	7							
Serbia		4.2	431.65 _a	3.43	447.47 _b	2.52	451.45 _b	2.99	449.23 _b	2.48
	436.28 _a	3.57	4							

Slovak Republic		4	477.62 _a	5.56	481.03 _b	2.53	09 _b		495.49 _b	2.86
		5.8					502.			
	468.67 _a	5.03	5				62 _b	3.00		
Slovenia		3.6	455.22 _a	3.62	495.37 _b	1.16	514.		525.33 _b	1.47
	431.30 _a	3.67	5				96 _b	1.45		
Trinidad and Tobago		3.2	404.80 _a	3.44	435.48 _b	1.75	432.		429.30 _b	2.15
	412.82 _a	3.82	3				21 _b	1.82		

Note. Mean scores for their respective domains with different subscripts are statistically significantly different from one another at $p < 0.05$ level.