First Place	
Authors	Natalie Bold (nataliebold@yahoo.com) Department of Economics, Seattle University 345 Sheridan Ave #111, Palo Alto CA ,94306 Phone: (530)400-5840
Title	Making the Grade: A Cross-National Analysis of Teacher Training on Student Achievement Across 52 Nations
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Instructor Sponsor	Brian Kelly (kellybr@seattleu.edu) Department of Economics, Seattle University
Abstract	This paper explores the relationship between teacher training and student outcomes for students in over 298,000 students in over 50 countries assessed by PISA in 2006 and 2009. This paper will provide evidence that high-quality teacher training is related to student achievement and learning and suggests that improving teacher training might contribute to local and national growth and development. The 2006 regression model explains 32.9% (R^2 = 0.329) of student achievement for students across 52 countries. The 2009 model explains 30.8% (R^2 = 0.308) of student achievement across 58 countries. The index for national minimum teacher training requirements by country was positively and significantly correlated with student performance at the .01 level ($p < .01$) for both years. The effect of teacher training on student achievement as measured by the coefficients shows that teacher training affected PISA scores by 3.8-9.0 points. Teacher training showed a larger impact on achievement than the parents' level of education, immigration status, issues of staff shortages and class size. Given the variance in student achievement and teacher training requirements across many countries, additional analyses are necessary to better understand the impact of teacher training and the components of a quality preparatory program. The inclusion of both teacher and student data in the same model, across multiple countries is important to understand the role of teacher training requirements. This large sample provides the evidence to show that students need support from many sources and that teacher and school resources greatly contribute to student success.

Making the Grade: A Cross-National Analysis of Teacher Training on Student Achievement Across 52 Nations

Natalie Bold

This paper explores the relationship between teacher training and student outcomes for students in over 298,000 students in over 50 countries assessed by PISA in 2006 and 2009. This paper will provide evidence that high-quality teacher training is related to student achievement and learning and suggests that improving teacher training might contribute to local and national growth and development. The 2006 regression model explains 32.9% (R^2 = 0.329) of student achievement for students across 52 countries. The 2009 model explains 30.8% (R^2 = 0.308) of student achievement across 58 countries. The index for national minimum teacher training requirements by country was positively and significantly correlated with student performance at the .01 level ($p < .01$) for both years. The effect of teacher training on student achievement as measured by the coefficients, shows that teacher training affected PISA scores by 3.8-9.0 points. Teacher training showed a larger impact on achievement than the parents' level of education, immigration status, issues of staff shortages and class size. Given the variance in student achievement and teacher training requirements across many countries, additional analyses are necessary to better understand the impact of teacher training and the components of a quality preparatory program. The inclusion of both teacher and student data in the same model, across multiple countries is important to understand the role of teacher training requirements. This large sample provides the evidence to show that students need support from many sources and that teacher and school resources greatly contribute to student success.

Introduction

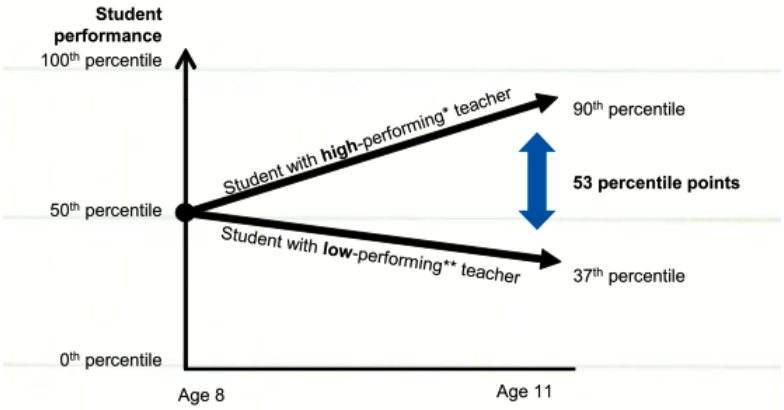
"[Schools] are only as effective as those responsible for making them work"[1]. An increasing number of teachers and school systems are being held accountable for how students learn and what they achieve. However, in many countries, teachers are not being sufficiently and consistently prepared to support or improve student learning. The variation is huge in the teacher preparatory programs both across and within each of these countries.[2] There is growing consensus, shown by the many studies around the world, that teachers are a major factor in predicting student achievement and academic success.[3] And yet, to date there has been a lack of cross-national focus on the preparatory programs of educators and available data is sparse. This paper hopes to bring new attention to the importance of quality teacher training by linking data from the OECD's Program for International Student Assessment (PISA) and UNESCO's International Bureau of Education (IBE). This paper will present a broad comparison of national education systems, allowing for a more comprehensive picture of the importance of teacher preparation. The findings draw from a sample of over 290,000 students in over 50 countries to show that more national teacher training requirements are associated with higher student achievement, as measured by the 2006 and 2009 PISA.

Importance of teachers on students

[1] Rowe 2007
[2] Schmidt et al. 2011, UNESCO Institute for statistics 2011
[3] Hattie 2008

Hundreds of studies around the world have shown that teachers are a major factor in predicting and determining student achievement and academic success.[4] One study out of New Zealand, observed 3000 students and 491 teachers over four years' time, concluded that "'teachers' class performance had the most impact on students' learning.'"[5] Another study identified the "…effectiveness of teaching as the most powerful system level available to change learning outcomes."[6] Sanders et al. (1996) surveyed nearly 3 million students in grades 2-8 in Tennessee between 1990 and 1996. They compared average achieving students in different math classes for three years. Using a value-added method, they found that after controlling for other factors, teacher quality contributed to a variance of more than 50 percentile points in final student performance.[7] Figure 1 shows the graph produced by this study. What is significant is the large difference in student performance attributed to teacher quality, which is partially measured by training. This provides visual understanding of the compounding effects of teachers on students' academic performance.

Figure 1: The Effect of Teachers on Student Achievement (Value-Added)[8]



The impact of teacher training on student achievement

When teachers are untrained or receive poor quality or insufficient training, they are not equipped to handle a classroom, let alone maximize learning. Preparation for training comes in three forms: pedagogical, subject specialization, and actual classroom experience. It is important for teachers to understand how best to explain and expose knowledge to students in order to stimulate learning. Teachers must not only be knowledgeable, but also sensitive to cognitive and social development, poverty, disabilities, and second language learners. Their job requires not simply understanding these issues but being able to identify them in a classroom. These peripheral conditions are often overlooked when considering the harmful effects of untrained and poorly trained teachers.[9]

[4] Hattie 2008, Darling-Hammond (2010)
[5] Bishop et al. (2003) p. 7
[6] Fancy (2004) p. 332
[7] Sanders et al. (1996)
[8] McKinsey (2007) p.11
[9] Rowe (2007)

High-quality training for teachers affects individual students today, but will impact the future of nations for generations. McKinsey reviewed 25 countries and identified characteristics that are believed to be precursors to building a successful education system. Two of the three recommendations involve quality teacher training. It stated that, "…education outcomes will only improve by improving instruction."[10] Akiba et al. (2007) examined students' performance in math on the 2003 Trends in International Mathematics and Science Study (TIMSS) in 46 countries. The study looked at the effect of student achievement as compared to teacher quality, based on their qualifications: whether the teacher was fully certified; had at least 3 years of teaching experience; and their college major (mathematics, mathematics education, or otherwise). The study found that nations with higher teacher quality produced higher achieving math students.[11]

Case Study: TEDS-M

In 2008, a study assessed over 23,000 teachers and their formal professional training from 498 institutions across 17 countries.[12] It found that the courses in the teacher training programs affected teachers' "professional competencies" as measured by this assessment. Using the survey of the different teacher training programs, the study also proposed an outline for the minimum course requirements for teacher training programs as a way to create an international set of standards

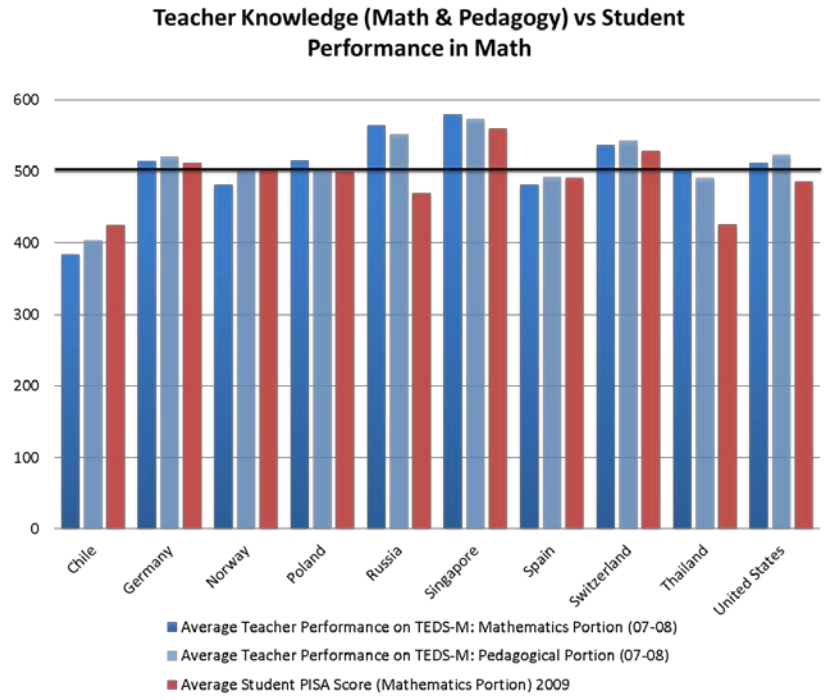
Based on these proposed minimum requirements, teacher training institutions in the US met between 6-67% of the standards; the performance of teachers on the assessment varied considerably.[13] With the large variance in teacher training standards in the US, the mean score for math teachers on the exam was expectedly average. Student performance in the US on an international standardized test[14] the following year in math was also average. Teachers affect student achievement significantly and the part of the variance in student achievement is a result of the variance in teacher preparation. Table 1 shows the average number of courses required for teacher training programs as reported by participants of the TEDS-M.

Table 1: Average Number of Courses Taken in Teacher Training Programs by Subject[15]

	Math	Mathematics Pedagogy	General Pedagogy
Primary Level			
Taiwan, Singapore, Switzerland	9.0	7.0	6.0
United States	7.1	7.3	6.9
Lower Secondary			
Taiwan, Russia, Singapore, Poland	17.1	9.9	6.6
United States	9.5	7.7	6.7

[10] Sahlberg (2010) p. 132
[11] Akiba et al. (2007)
[12] Schmidt et al. (2011)
[13] Schmidt et al. (2011)
[14] Program for International Student Assessment (PISA) produced by the OECD
[15] Schmidt et al. (2011) p. 144

Figure 2: Math Teachers in Training vs. Student Performance in Math[16]



Scores for both teacher and student assessments were calibrated such that 500 represents an average score, therefore the results of these assessments can be compared.

Data

The data used in this study was collected by the Organization for Economic Cooperation and Development (OECD) as part of the Program for the International Student Assessment (PISA). PISA was first administered in 2000, and has since been produced every three years for all countries that are interested and able to finance the administration of the assessment. It has been widely accepted by many countries and consistently tests over 250,000 fifteen year olds in at least 30 countries, each year it has been produced. PISA focuses on testing students' literacy in three broad subjects: mathematics, language, and science. Its purpose is to inform and influence policy towards the improvement of education systems worldwide. There is tremendous preparation that goes into crafting the PISA so that it may be a test that is relevant to all students. In many countries, compulsory education ends at or near when students are fifteen years old. In this way PISA has created a test that is able to assess what students are retaining from their total time spent at school. Not only is this assessment the first of its kind in terms of testing for these three subjects, but also its greater purpose is unique in that it strives to gauge how well we are preparing the next generation.

PISA only looks at 15-year olds, regardless of grade, and all participants must be full-time students. PISA tests are always given in the official national or regional language to avoid bias. Additionally PISA has optional questionnaires for both students, principals, and since 2009, parents, regarding socioeconomic background, school and home climate, students' attitudes towards school, as well as the organizational makeup of the school and classroom. Careful

[16] Babcock et al. (2010)

consideration is taken when selecting participating schools as well as students in order to produce a random sample and ensure representative results. Schools are selected using a stratified sampling method to represent minority and majority populations proportionately. In each country, there must be an overall response rate of at least 95 percent. At least 150 schools are chosen for the national sample and 35 students are selected from each school. Precision with regard to sample selection helps to mitigate the inherent issues associated with conducting a study of this magnitude and increases the validity of the database.[17]

The sample data used in this study was taken from the PISA 2006 and 2009 cycles. The sample from 2006 includes data from 298,142 students in 52 countries.[18] The sample from 2009 includes data from 373,529 students in 58 countries.[19] Only schools that responded as being public were included in the sample data since private schools may have different requirements for instructors.

Variables

Student Performance

The dependent variable in the regression model is student achievement. Student achievement for both test years was calculated as follows. First, the PISA database provides five plausible values for each student in each of the three subjects: math, language, and science. Five different readers grade each student's exam. The plausible value scores are meant to be takes as an average. With these three averaged subject scores, the scores were averaged again into an average overall score.[20]

Teacher Training

While there are many studies regarding the importance of teachers on student achievement and the importance of teacher training, there are far fewer that link teachers' training as a determinant of student achievement, and even fewer when taking a broad international perspective. In order to show this connection and include a teacher training variable, I took information that was self-reported and was not standardized from the International Bureau of Education, housed within UNESCO.[21] I went through each country's profile and created a rubric to estimate the national minimum requirements for teacher certification (Table 2). Because of the obvious lack of reliable data, this index is indeed an estimate, however it is thus far, more comprehensive than any comparison I have been able to find, both in aspect of teacher training and in number of countries included. This index is the centerpiece of my regression analyses (Figure 6).

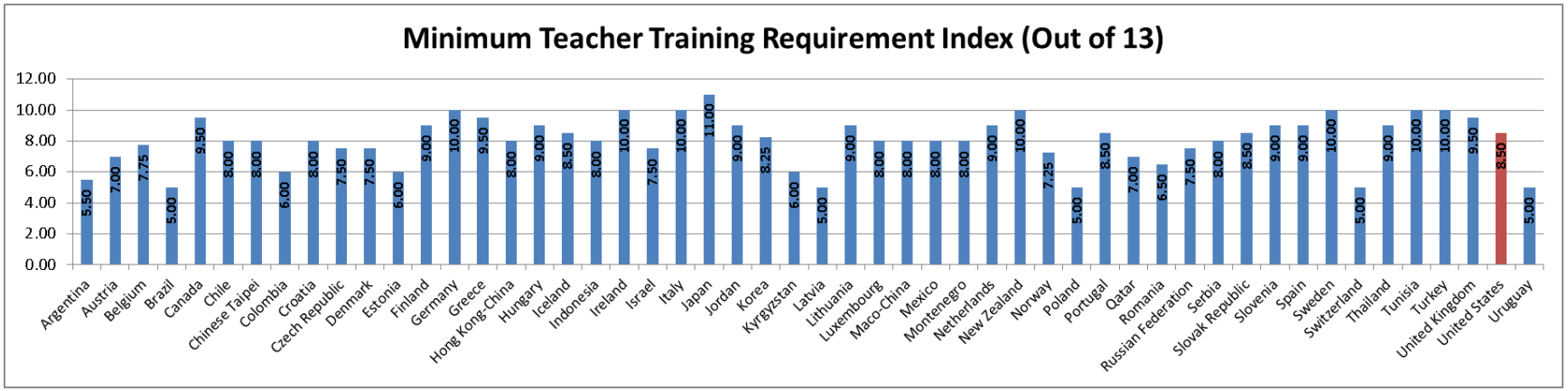
[17] Adams, R., & Wu, M. (2002)
[18] OECD 2006
[19] OECD 2009
[20] Adams, R., & Wu, M. (2002)
[21] World data on education. (2006/07).

Table 2[22]

Index for Minimum Teacher Training Requirements	
	Possible Points
Primary Teacher Education Level	4
Teaching Certificate Program	1
Secondary Teacher Education Level	4
Teaching Certificate Program	1
Professional Exam	1
Pre-Service Training	1
In-Service Training	1
Maximum Index Score	13

	Education Levels
1	Secondary School
1.5	Secondary School with a Pedagogical Emphasis
2	Teacher Training College
3	Bachelors
3.5	Bachelors with Specialization in Subject Taught
4	Masters
4	Bachelors & Teacher Training College
1	Yes (Required)
0	No (Not Required)

Figure 6[23]



[22] World Data on Education (2006/07)

[23] World Data on Education (2006/07)

Student Characteristics

When attempting to explain student performance in school, it is imperative to include information on the students themselves. Age is already controlled for, as the students are only eligible if they are 15 years old. All three models include the language spoken at home. The response choices for this question only differentiated between whether or not students spoke at home the same language as of the test: 1 for the language of the test, 2 if another language. The model also includes information on immigration status. While it might seem likely that language spoken at home and a student's immigration status would be highly correlated, this was not the case. Students were asked to respond, 1 for native, 2 for second-generation, and 3 for first-generation. In order to account for academic home resources, a question was included for students regarding the approximate number of books are in their home. Socioeconomic status is generally cited as a major predictor of students' academic performance. In order to account for this I included information on the highest occupational and educational levels of parents. The questions asked about what was the highest level job of either parent in general terms (white collar-skilled/unskilled, blue collar-skilled/unskilled), as well as the highest level of education of either parent, on the international ISCED scale. The data gleaned from these questions are important and avoided problems with having to account for family-unit structure, as the responses could be about either parent or guardian. Family wealth level more generally gets to the heart of the debate surrounding socioeconomic status and student performance. A wealth index was included, based on students' responses to their family's physical possessions such as a dishwasher, Internet, cars, and computers. Responses have been standardized; "positive values indicate more wealth-related possessions and negative values indicate fewer wealth-related possessions."[24]

School Characteristics

Principals were asked whether or not there were issues of staff and resource shortage to understand if the funds allocated to education are going where it's needed. The staff shortages variable is based on the responses of principals of whether their school experiences teacher and/or staff shortages, both with regard to specific subjects, as well as qualified and certified teachers, and other staff and personnel. The variable to account for resource shortages is in regards to physical resources such as instructional material, lab equipment, and Internet connectivity. Responses were given by principals on a four point scale: 1 for no shortages, 4 for severe shortages. These numbers were averaged to produce one variable representing staff and resource shortages. Finally, student-teacher ratios were included in the model as it is also representative of the capacity of the school in terms of physical resources.

Additional Variables

In the 2009 PISA, there were several pertinent variables included in the questionnaires for both students and principals; some of these were included in the third model. Although age is accounted for, grade was not a characteristic that was possible to include in the first two models. Past performance has been argued to be a significant contributor to future academic success. Therefore, students were asked to identify whether or not they were at modal grade. Positive numbers were assigned to students who were ahead of their modal grade, 0 for at modal grade and negative numbers for students behind their modal grade. Teacher participation has been shown to improve teacher morale, the quality of lessons, and the level of engagement of students

[24] Adams et al. (2002) p. 224

in class. This variable is an index based on several questions regarding the level of autonomy and involvement teachers have on a class, school, and district level. Larger numbers indicate higher levels of teacher participation; smaller numbers indicate lower levels of teacher participation. School climate is an averaged response variable based on questions to the principal regarding teacher and student morale, absenteeism, school violence, and classroom disruptions. Responses are on a four point scale, 1 for climate is excellent, 4 for climate is poor. Student attitudes towards school was included in order to account for individuals' level of self-confidence and behavior in school. The variable is an average of responses regarding students' feelings of how their teachers treat them and if they feel supported. 4 for an excellent attitude, 1 for poor attitude. It has also been shown that support for teachers by the administration in the form of professional development and continued education is very influential in determining whether teachers are effective, and therefore if students are receiving a quality experience. This is an average response variable based on principals' response to these questions. 4 for lots of teacher support, 1 for no teacher support. Teachers' classroom management skills vastly affect what is covered in class. An effective teacher is able to keep the class on topic, engaged, and avoids disruptions. This variable is based on students' feelings of problems with class disruptions. 4 for every lesson is interrupted, 1 for lessons are never disrupted.

Descriptive Statistics

Table 2 shows the descriptive statistics of the dependent and independent variables, as well as student performance in the three test subjects. Student performance on the PISA overall and within each subject area varies dramatically. Overall PISA performance in 2006 varies by 795 points and 771 points in 2009 across the participating countries. The estimated overall PISA score for all students is approximately 463 for both years. This overall average low as the OECD calibrated an average to be 500 points. This means the international student average is below what the OECD would consider average by approximately 37 points for both test years. Teacher training requirements, the variable of interest varies a lot across countries. The minimum score was a 2.5, the maximum was an 11, out of a total 13. The average value for teacher training was approximately 8 for both test years. It is interesting to see that the United States receives a score of 8.5.

For both years, the average student speaks the same language at home and in school. Additionally, on average students identify as native citizens, as opposed to first- or second-generation citizens. On average for both years, the highest level of education attained by either parent was ISCED 3A or 4. This means that most parents of tested students have an upper secondary or post-secondary, non-tertiary level of education. For the United States, this translates to high school graduation and/or vocational training. Of sampled students for both years, on average parents' occupational level would be considered white collar-low skilled. This is likely due to which countries were willing and able to participate in the PISA. Most countries surveyed did not suffer from extreme poverty, because of the costs associated with administering the test and therefore this variable suffers from self-selection bias. This is echoed in the variable representing familial wealth. It was compiled on a standardized scale where 0 is considered average. For both years, the mean value for this variable is -0.53 in 2006 and -0.47 in 2009. This indicates a typical student lives in enough comfort to have basic needs met, but perhaps is slightly below "average wealth." This question is attempting to understand families' disposable income. The variable suffers from subjective interpretations of what each wealth level means

within the context of the particular country and culture. Nevertheless, it is still a numeric indicator of familial, wealth, which is an indicator of student performance. While the average wealth level was near 0 for both years, in 2006, the lowest wealth level reported is a -5; -7 is the lowest in 2009. These numbers suggest that some students' basic needs are not being met and that their families are likely living in poverty.

Issues of teacher and staff shortages are included as another variable in the model. On average, for both years, principals noted that there are some shortages; however most report that there are more issues of physical resource shortages than teacher and staff shortages. While the average score for the index on students' attitudes towards school is 2.86, meaning students attitude is good, but not excellent; the average for the school climate variable indicates that climate is quite good. Results show that teachers are highly supported, although this may suffer from the problems of self-reported data bias because the principals are answering these questions, not the teachers themselves.

Table 3

Descriptive Statistics for All Countries									
		2006				2009			
		Minimum	Maximum	Mean	Std. Deviation	Minimum	Maximum	Mean	Std. Deviation
Student Performance	Estimated overall PISA score	54.00	849.14	463.33	99.46	42.00	813.80	462.60	97.32
	Estimated PISA math score	7.56	895.23	463.28	102.98	20.80	864.20	461.16	101.04
	Estimated PISA reading score	1.00	1079.00	456.85	106.13	13.40	847.20	460.53	100.03
	Estimated PISA science score	18.63	912.84	469.51	102.51	7.00	839.60	466.11	100.68
Student Family Background	Highest occupational level of parents	1.00	4.00	1.92	1.06	1.00	4.00	1.91	1.05
	Highest educational level of parents	0.00	6.00	4.08	1.68	0.00	6.00	4.14	1.66
	Home Language	1.00	3.00	1.15	0.44	1.00	2.00	1.11	0.31
	Immigration status	1.00	3.00	1.11	0.42	1.00	3.00	1.12	0.42
	Number of books in students' homes	1.00	6.00	3.05	1.43	1.00	6.00	2.96	1.44
	Wealth level of family	-5.00	3.00	-0.53	1.22	-7.00	4.00	-0.47	1.23
Teacher and School	Teacher training requirements	5.00	11.00	8.15	1.57	2.50	11.00	8.02	1.76
	Teacher-student ratio	0.00	100.00	15.51	8.21	0.00	723.00	15.98	15.24
	Teacher shortage	1.00	3.40	1.54	0.61	1.00	4.00	1.65	0.74
	Staff & teacher shortage	1.00	4.00	1.83	0.70	1.00	4.00	1.78	0.68
	Resource shortage	1.00	4.00	2.31	0.79	1.00	4.00	2.18	0.76
	Grade compared to modal					-3.00	3.00	-0.14	0.64
	Student attitude					1.00	4.00	2.86	0.58
	School climate					1.00	4.00	2.11	0.53
	Classroom management					1.00	4.00	2.15	0.87
	Teacher participation					-2.00	4.00	-0.09	1.13
	Teacher support					1.00	4.00	3.45	0.56
	N	293910				234450			

As the correlations matrices will show, there were no major issues with any of the variables in any of the models, in either test year that caused for concern for multicollinearity.

Table 4: Correlation Matrix 2006

	Teacher training requirements	Home Language	Number of books in students' homes	Highest occupational level of parents	Highest educational level of parents	Immigration Status	Wealth of Family	Estimated overall PISA score	Teacher Shortage	Staff Shortage	Resource Shortage	Teacher-Student Ratio
Teacher training requirements	1											
Home Language	.024	1										
Number of books in students' homes	.099	-.063	1									
Highest occupational level of parents	-.043	.072	-.335	1								
Highest educational level of parents	.015	-.067	.367	-.472	1							
Immigration Status	-.016	.415	-.056	.028	.016	1						
Wealth of Family	.208	-.044	.379	-.357	.354	.031	1					
Estimated overall PISA score	.177	-.088	.453	-.324	.279	-.055	.379	1				
Teacher Shortage	-.012	.079	-.117	.061	-.083	.010	-.194	-.179	1			
Staff Shortage	-.017	.066	-.147	.095	-.132	-.017	-.253	-.221	.890	1		
Resource Shortage	-.188	-.006	-.195	.138	-.114	-.071	-.365	-.315	.361	.476	1	
Teacher-Student Ratio	-.139	-.068	-.200	.090	-.112	-.060	-.303	-.182	.195	.242	.248	1

Table 5: Correlation Matrix 2009

	Teacher training requirements	Home language	Number of books in students' homes	Highest occupational level of parents	Highest educational level of parents	Immigration status	Wealth of family	Estimated overall PISA score	Teacher shortage	Staff shortage	Resource shortage	Teacher-Student Ratio	Student grade compared to modal	School climate	Teacher participation	Student attitude	Classroom management	Teacher support
Teacher training requirements	1																	
Home Language	.063	1																
Number of books in students' homes	.154	-.021	1															
Highest occupational level of parents	-.072	.042	-.330	1														
Highest educational level of parents	.070	-.033	.371	-.486	1													
Immigration status	.042	.321	-.040	.015	.035	1												
Wealth of family	.291	.008	.362	-.350	.356	.038	1											
Estimated overall PISA score	.264	-.046	.446	-.331	.289	-.029	.317	1										
Teacher shortage	-.050	.073	-.098	.071	-.101	-.002	-.165	-.125	1									
Staff shortage	-.034	.057	-.123	.114	-.165	-.018	-.208	-.161	.889	1								
Resource shortage	-.192	-.058	-.190	.158	-.161	-.076	-.312	-.282	.377	.495	1							
Teacher-student ratio	-.107	-.059	-.133	.073	-.095	-.055	-.189	-.106	.104	.105	.135	1						
Student grade compared to modal	.014	-.022	.128	-.143	.165	-.055	.115	.264	-.042	-.095	-.050	.003	1					
School climate	-.026	-.018	-.091	.071	-.075	.012	-.068	-.148	.336	.337	.279	.013	-.070	1				
Teacher participation	.083	.063	.120	-.069	.067	.000	.159	.177	-.050	-.083	-.124	-.096	.059	-.048	1			
Student attitude	-.048	.001	-.011	.025	-.031	.017	-.069	.020	.035	.030	.045	.034	.012	-.010	-.022	1		
Classroom management	.039	.011	-.018	.009	-.011	.010	.066	-.067	.000	.013	-.016	.006	-.060	.062	.021	-.132	1	
Teacher support	-.011	.002	-.041	.005	-.003	-.005	-.005	-.049	-.051	-.082	-.043	.069	.036	-.102	.041	.046	.014	1

Empirical Results

The regression analyses were an exploration of student achievement across many nations over six years' time and as more variables became available it was important to try to better understand the factors that contributed to student achievement. Therefore Models 1 and 2 have the same independent variables, and Model 3 is also from 2009 data, however it included additional data not previously available. All three estimated equations have an R squared of between 0.308 and 0.35. This means that the regression models explain between 30.8%-35% of the variance in student achievement. These results are satisfying because all the data was purposefully taken from the sampled individuals, therefore there are response biases on the part of students and principals, however the model is likely capturing information regarding the quality of the school, teachers, and classes in a way that aggregated information or official surveys are unable to provide. All variables included in all three models are highly statistically significant, except in the case of the variable for immigration status in Model 3. This variable is significant at the 1 percent level in 2006 and in 2009 until other variables are introduced. The correlation matrix does not indicate any strong relationship with immigration and any other variable and furthermore, while the variable's significance level is reduced, the model's R squared increases.

The variable of interest, teacher training requirements stays positive-as expected, highly significant, and fairly consistent in magnitude throughout all models. Therefore, this variable can be considered robust. The variable that had the largest impact on student achievement between the two original models is the number of books in a student's home, followed closely by resource shortages. Both of the coefficients for these variables in terms of magnitude and sign suggest that there likely is the presence of a resource "sufficiency threshold." This means that before all else, physical educational resources both at home and at school have the most significant impact on performance until provided up to a "sufficiency threshold". It is interesting to note that the occupational level of parents had a larger impact on achievement than did parental education levels and familial wealth across all three models. The magnitude of the coefficient for wealth drops by 7 points between 2006 and 2009. The coefficient on the variable for immigration status had a relatively small magnitude that decreased between the two years, unlike the coefficient for the variable on home language, which increased between 2006 and 2009. It is possible that immigrants to the participating countries are on average more likely to be of middle/high incomes and have higher education levels. Thus, immigration status may be less important than whether or not the language spoken at home is the same as the language spoken in school. This would be true in countries such as Australia, Sweden, Canada, Finland, as opposed to the United States, and the United Kingdom, where immigration status is generally associated with lower socioeconomic status. Teacher-student ratio had the smallest coefficient of all the variables across all three models. Since the coefficient stayed significant and negative, we can infer that larger class sizes have a negative impact on student performance, but since there are other variables that also account for school resources, perhaps class size is of lesser importance. The variable with the largest coefficient was only included in Model 3. Student's grade compared to modal grade had a 24-point effect on performance. This result does not seem surprising; as many researchers have shown that past performance is one of the most influential factors in determining future school performance.

The coefficients for the variables for school climate, attitude, classroom management, and teacher participation all have the expected sign; however the coefficient for teacher support does not. The coefficient for teacher support is negative and highly statistically significant. There is much evidence to support the opposite of this finding that when teachers are supported by the administration via educational opportunities and professional development, that they perform better as teachers, and their students are more successful. This is not the case in Model 3. This unexpected relationship may be due to an unobserved variable, as it seems unlikely that promoting teachers' learning would take away from student performance. Furthermore the sign of this variable is in direct contrast to the variable of interest- teacher training requirements, and are likely closely related.

Based on the sample data sets, this study is able to provide graphical representations of the correlation between teacher training and student performance. Figures 9 and 10 illustrate the positive relationship of the two variables when considering teachers and students from over 50 countries. This positive correlation is apparent for both test years. In Figures 11 and 12 they show the graphical relationship between student achievements in the three subjects as compared to the required level of training for teachers in that country. There is a positive and consistent graphical correlation between these two variables that indicate that teacher training, as estimated by minimum requirement standards is positively associated with higher student performance, regardless of country. Figure 13 shows the teacher training index by country with the inclusion of student performance as estimated by overall performance on the PISA in 2006 and 2009. The PISA scores are calibrated around an average of 500; therefore the teacher training index was rescaled to be out of 923 in order to provide comparable magnitudes in order to see the relationship between training and performance across the two test years.

Table 6

Regression Results			
	2006	2009	
	(1)	(2)	(3)
(Constant)	469.854	416.516	464.407
	(1.488)***	(1.274)***	(1.768)***
Teacher training requirements	3.805	8.819	9.002
	(0.105)***	(0.086)***	(0.0834)***
Home Language	-8.651	-13.673	-16.423
	(0.410)***	(0.497)***	(0.485)***
Number of books in students' homes	20.275	20.526	18.909
	(0.129)***	(0.113)***	(0.110)***
Highest occupational level of parents	-12.100	-13.523	-12.290
	(0.180)***	(0.161)***	(0.157)***
Highest educational level of parents	2.702	2.957	2.031
	(0.117)***	(0.106)***	(0.104)***
Immigration Status	-2.728	-2.990	.199
	(0.453)***	(0.368)***	(0.359)
Wealth of Family	10.412	3.054	2.632
	(0.165)***	(0.141)***	(0.139)***
Staff Shortage	-5.514	.055	3.259
	(0.271)***	(0.248)***	(0.249)***
Resource Shortage	-19.491	-19.709	-18.668
	(0.249)***	(0.227)***	(0.223)***
Teacher-Student Ratio	-.303	-.110	-.094
	(0.021)***	(0.009)***	(0.009)***
Student Grade Compared to Modal			24.288
			(0.234)***
Teacher Participation			7.905
			(0.125)***
School Climate			-9.312
			(0.282)***
Student Attitude			5.747
			(0.245)***
Classroom Management			-5.720
			(0.163)***
Teacher Support			-9.265
			(0.247)***
R Squared	.329	.308	0.35
Observations	238078	304762	298208
Std. Error of Regression	78.323	78.682	75.576
Standard errors are in parenthesis			
***significant at 1% ** significant at 5% * significant at 10%			

Figure 7: Variance in Student Performance by Country (2006)

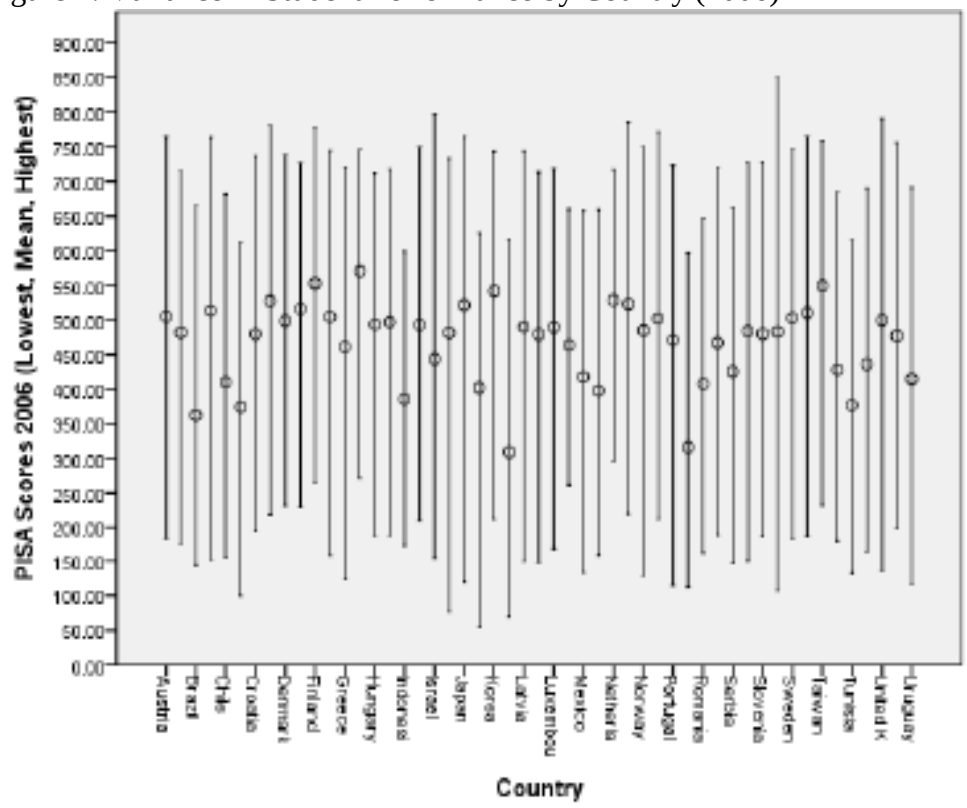


Figure 8: Variance in Student Performance (2009)

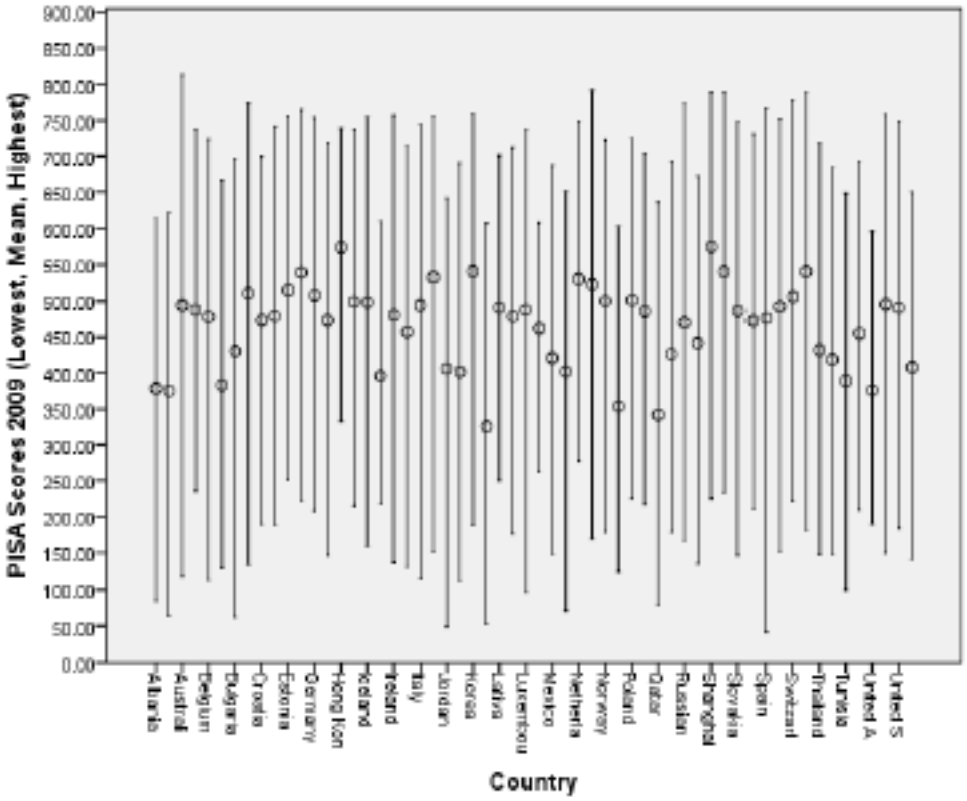


Figure 9: Teacher Training vs. Student Performance (2006)

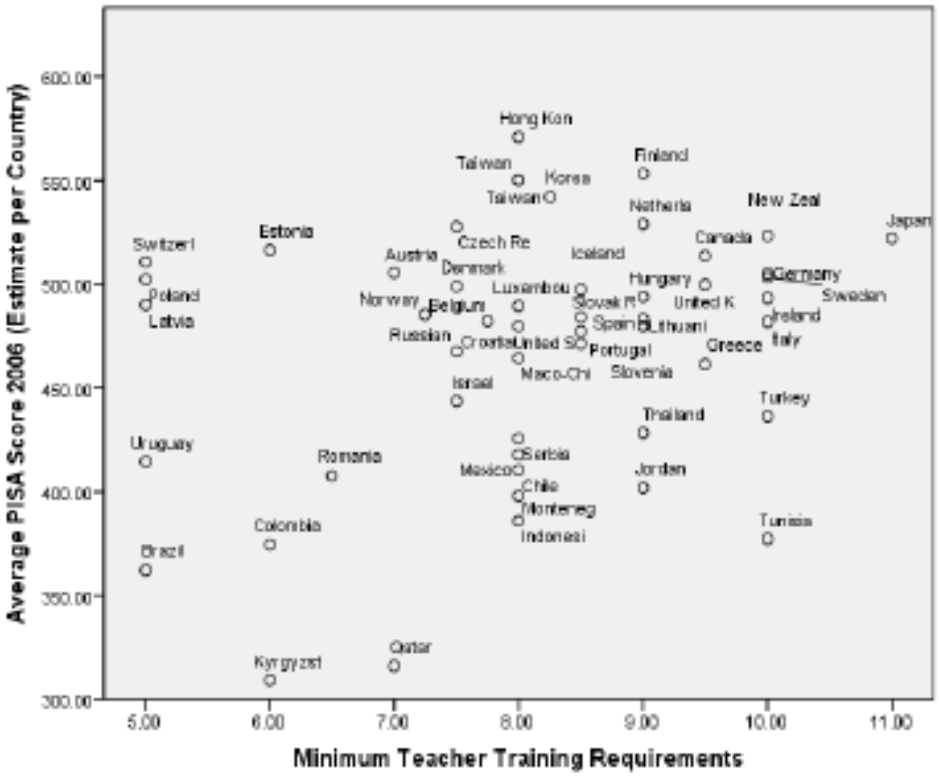


Figure 10: Teacher Training vs. Student Performance (2009)

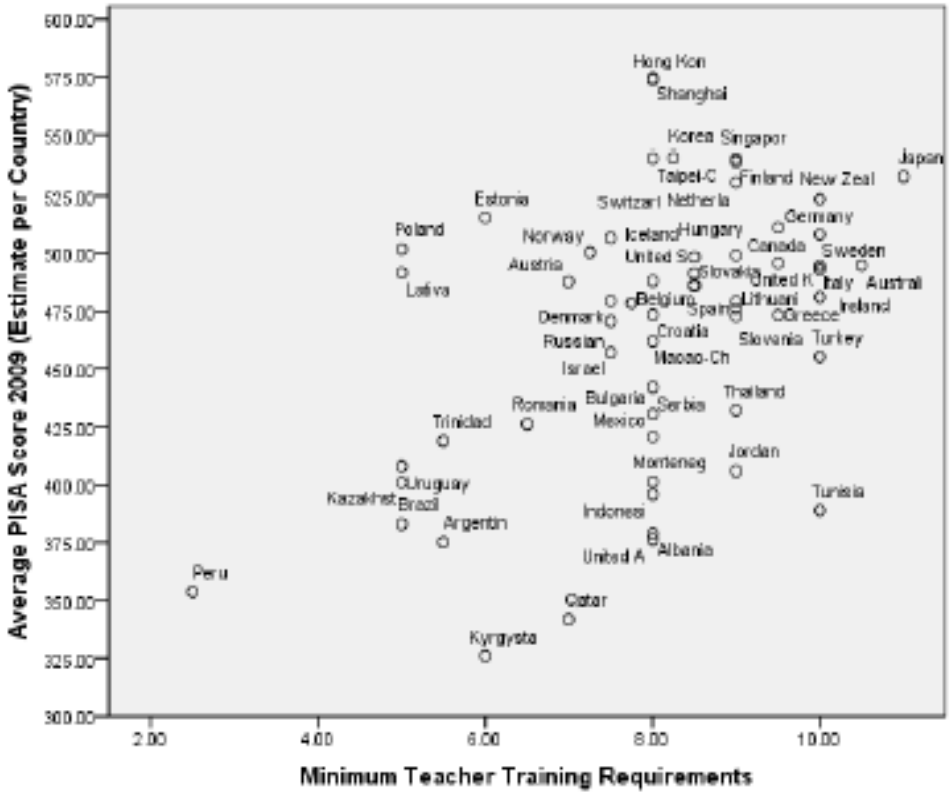


Figure 11

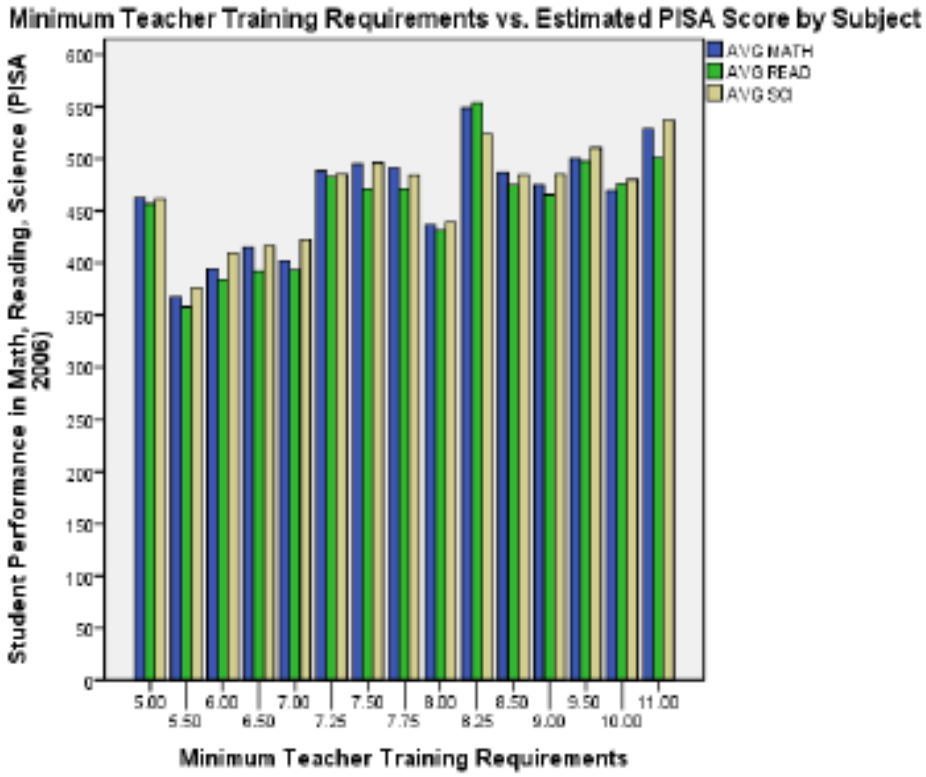


Figure 12

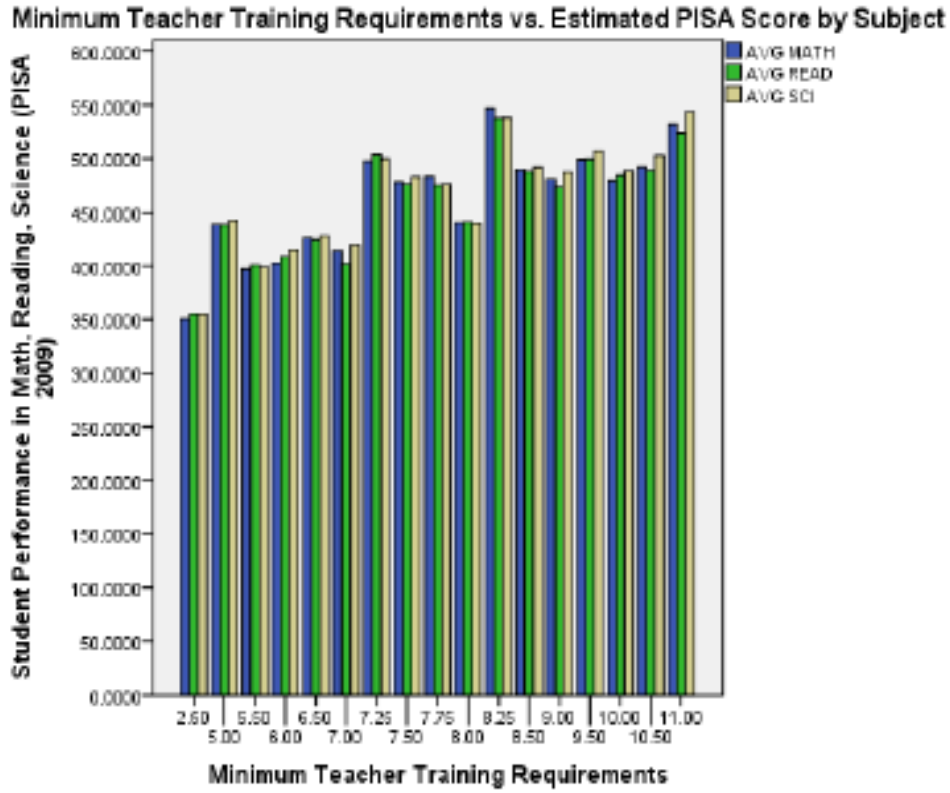
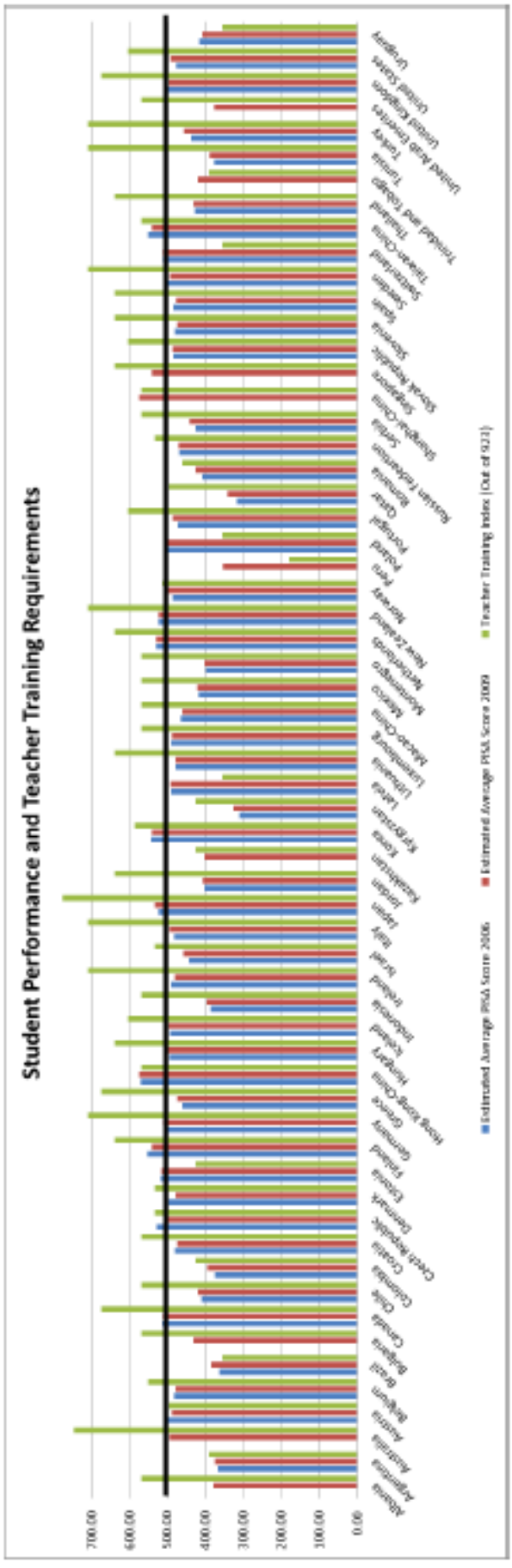


Figure 13


Student Performance and Teacher Training Requirements
Estimated Average PISA Score 2006
Estimated Average PISA Score 2009
Teacher Training Index (Out of 923)
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Albania
Argentina
Australia
Austria
Belgium
Brazil
Bulgaria
Canada
Chile
Colombia
Croatia
Czech Republic
Denmark
Estonia
Finland
Germany
Greece
Hong Kong-China
Hungary
Iceland
Indonesia
Ireland
Israel
Italy
Japan
Jordan
Kazakhstan
Korea
Kyrgyzstan
Latvia
Liechtenstein
Lithuania
Macao-China
Mexico
Montenegro
Netherlands
New Zealand
Norway
Peru
Poland
Portugal
Qatar
Romania
Russian Federation
Serbia
Shanghai-China
Singapore
Slovak Republic
Slovenia
Spain
Sweden
Switzerland
Taiwan-China
Thailand
Trinidad and Tobago
Tunisia
Turkey
United Arab Emirates
United Kingdom
United States
Uruguay

Conclusion

Based on the regression results, this model suggests that national minimum teacher training requirements affect student performance in school; this relationship is positive and statistically significant at the .01 level. This suggests that more teacher training requirements is better than fewer requirements. The model includes other explanatory variables to account for student performance, which include home background information and school resources. With the exception of the coefficient for immigration status in Model 3, the coefficients for all variables were highly statistically significant for both test years and also when including the additional variables in Model 3.

There are several limitations to this model. Most importantly, in order to more precisely and accurately represent the minimum teacher training requirements for each nation, it would have been ideal to have a standardized and verified database, which also included percent of qualified and certified teachers in different schools or at least for each country. It is also important to recognize that the teacher training index was created in 2006-07, however it is unverified as to what year the information was provided by each country's department of education. This can be overlooked to some degree, as education policy does not often change requirements drastically from year to year. It must also be noted that in regards to Taiwan, Macao, and Hong Kong, when calculating the regression model and other descriptive statistics, the teacher training index score used was from China's overall score due to lack of specificity in the IBE report. Additionally several countries (Lichtenstein, Azerbaijan) were excluded due to the lack of information on national teacher training requirements.

The data reflects only schools that answered that they are publically operated. Neglecting to answer this question or answering that the school receives private funding eliminated the school from the sample. Some countries that participated in PISA are not included because none of the schools complete the supplementary questionnaire with this question. While this is unfortunate, in order to avoid including private schools, it was important to omit non-response schools.

PISA seeks to assess the degree of literacy students have within the subjects of science, math and language, by testing students on how well they apply their skills to new situations and questions. PISA allows researchers to examine which nations are best preparing students for the real world, rather than limiting the discussion to comparing curriculums. What comes out in this study is that there are many factors that contribute to student achievement across many countries, but there are likely many other factors that were not included that are also important. This study provides a uniquely comprehensive and relatively detailed look at national education systems as well as allows for a discussion of education systems as an international whole. What is particularly special about the PISA is that the information collected is coming directly from the actors involved in education: the students and the principals. This provides unique insight into the workings of schools and national education systems and likely captures qualitative data that is more accurate than observational surveys. This study contributes useful information to policy makers and parents to start a dialogue of how to understand student achievement and improve performance in a meaningful way. This study shows that students need support from many sources and that teacher and school resources greatly contribute to student success. Teacher training as it affects student achievement needs to be studied more on a national level, but with

particular attention to the international level. Thus far the goals of international education policy have been about attendance and enrollment, rather than quality. While improving quality of education may be a loftier goal, it is an important next step that will help to promote and sustain long-run economic growth. This study helps support the suggestion that investing in teachers, particularly in expanding teacher education and improving the quality of their training will significantly benefit student achievement, and contribute to the advancement of overall goals of nations.

Appendix

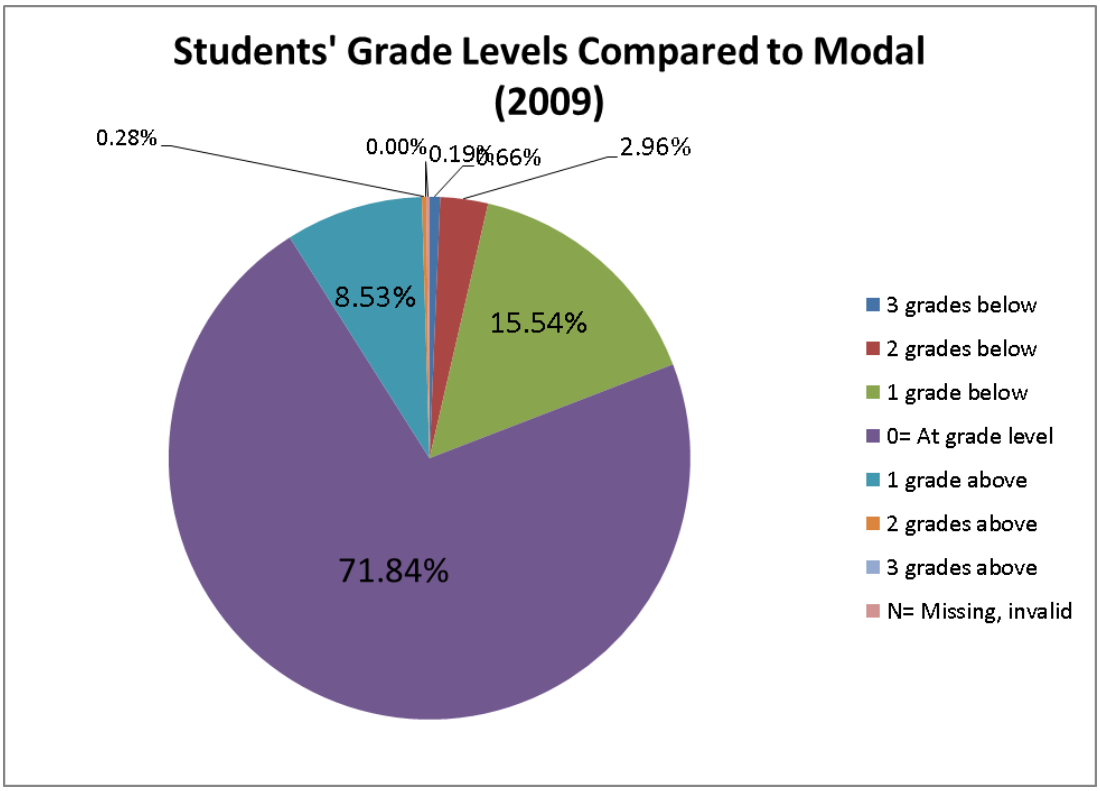
Index of Minimum Teacher Training Standards (Out of 13)							
Albania	8	Dem Rep of the Congo	9	Lesotho	6	Romania	6.5
Algeria	10	Denmark	7.5	Liberia	6.5	Russian Federation	7.5
Andorra	10	Djibouti	7	Libya	6.5	Rwanda	5.5
Angola	4	Dominica	2	Lithuania	9	Saint Kitts & Nevis	2.5
Argentina	5.5	Ecuador	7	Luxembourg	8	Saint Lucia	2
Armenia	4.5	Egypt	8	Madagascar	5	Saudi Arabia	7
Australia	10.5	Eritrea	7.5	Malawi	5	Senegal	5
Austria	7	Estonia	6	Malaysia	10.5	Serbia	8
Bahrain	8.5	Ethiopia	6	Maldives	6	Singapore	9
Bangladesh	7.5	Finland	9	Mali	5	Slovak Republic	8.5
Barbados	3	France	5	Malta	10.25	Slovenia	9
Belarus	7	Gambia	5	Mauritius	7	South Africa	8.75
Belgium (Flemish)	9.5	Georgia	9.5	Mauritania	8	Spain	9
Belgium(French)	6	Germany	10	Mexico	8	Sri Lanka	10.5
Belize	4	Ghana	6	Moldova	7	Sudan	8
Benin	5	Greece	9.5	Mongolia	9	Swaziland	6
Bhutan	10.5	Grenada	6	Montenegro	8	Sweden	10
Bolivia	6	Guinea	5	Morocco	5	Switzerland	5
Botswana	8	Honduras	5	Mozambique	5	Syria	8.5
Brazil	5	Hungary	9	Myanmar	7.5	Thailand	9
Brunei Darussalam	8.5	Iceland	8.5	Namibia	5	Togo	9
Bulgaria	8	India	8	Nepal	10	Trinidad and Tobago	5.5
Burkina Faso	7	Indonesia	8	Netherlands	9	Tunisia	10
Burundi	6.5	Iraq	7	New Zealand	10	Turkey	10
Cambodia	7	Ireland	10	Nicaragua	4.5	Turkmenistan	9
Cameroon	8	Islamic Republic of Iran	7.5	Niger	6	Ukraine	6
Canada	9.5	Israel	7.5	Nigeria	7.25	United Arab Emirates	8
Cape Verde	6	Italy	10	Norway	7.25	United Kingdom	9.5
Central African Republic	5	Jamaica	4	Oman	8.5	United Republic Tanzania	7
Chad	5.5	Japan	11	Pakistan	6.5	United States	8.5
Chile	8	Jordan	9	Papua New Guinea	7.5	Uruguay	5
China	8	Kazakhstan	5	Paraguay	6	Vanuatu	4
Columbia	6	Kenya	7.25	Peru	2.5	Venezuela	4.75
Cook Islands	5	Kuwait	5	Philippines	9.5	Vietnam	7.5
Costa Rica	6.5	Kyrgyzstan	6	Poland	5	Yemen	5
Croatia	8	Lao	5	Portugal	8.5	Zambia	6
Cyprus	9.5	Latvia	5	Qatar	7	Zimbabwe	6
Czech Republic	7.5	Lebanon	7	Republic of Korea	8.25		

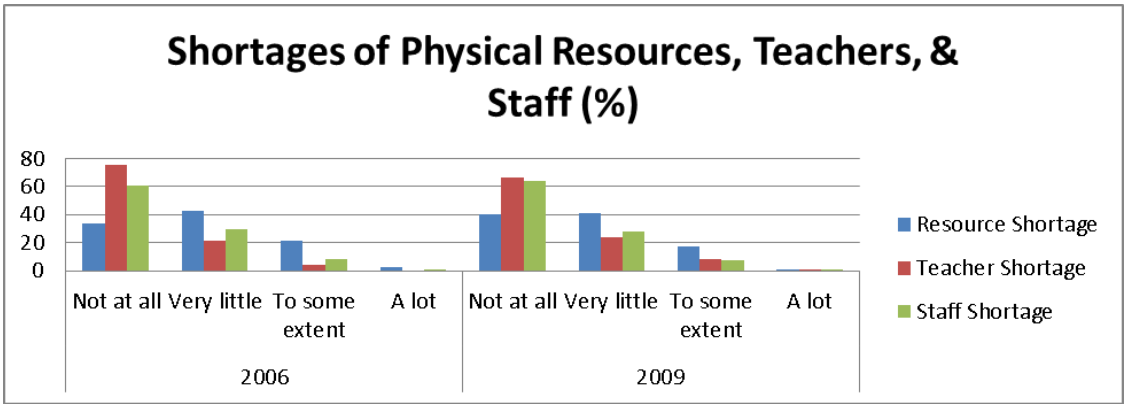
Number of Books in Students' Homes (%)		
	2006	2009
1 = 0-10 books	16.4	18.3
2= 11-25 books	19.5	20.4
3= 25-100 books	29.1	28.6
4= 101-200 books	15.5	14.5
5= 201-500 books	11	10.2
6= more than 500 books	6.3	5.9
N= missing, invalid	2	2.0

Highest Parental Occupation Classification (%)		
	2006	2009
1= White collar, high skilled	45.7	45.8
2= White collar, low skilled	22	22.5
3= Blue collar, high skilled	15.4	15.1
4= Blue collar, low skilled	11.3	11.2
N= Missing, Invalid	5.6	5.4

Highest Educational Level of Parents (ISCED)		
	2006	2009
0= None	2.7	1.9
1= ISCED 1	6.4	6.3
2= ISCED 2	11	11.5
3= ISCED 3B, C	8.1	7.9
4= ISCED 3A, ISCED 4	27.3	26.1
5= ISCED 5B	16.2	15.7
6= ISCED 5A, ISCED6	26.5	28.1
N= Missing, Invalid	1.9	2.5

Immigration Status		
	2006	2009
1= Native	90.1	89.7
2= Second-generation	3.7	4.3
3= First-generation	3.5	3.6
N= Missing, Invalid	2.7	2.4





School Climate (2009) (%)	
Very good	37.28412
Moderate	55.330108
Low	6.7504799
Very poor	0.2283625

Support for Teachers by Administration (2009) (%)	
Very poor	0.6449298
Low	8.1980248
Moderate	50.596607
Very good	40.076942

Figure 3: Primary Teacher Training Program Requirements[25]

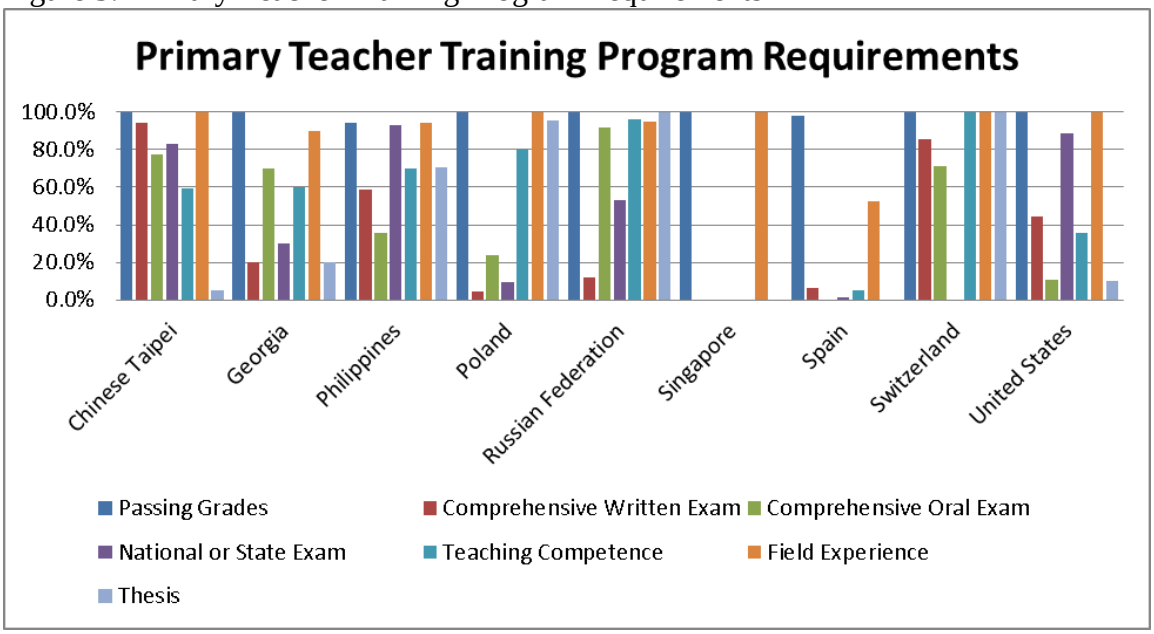
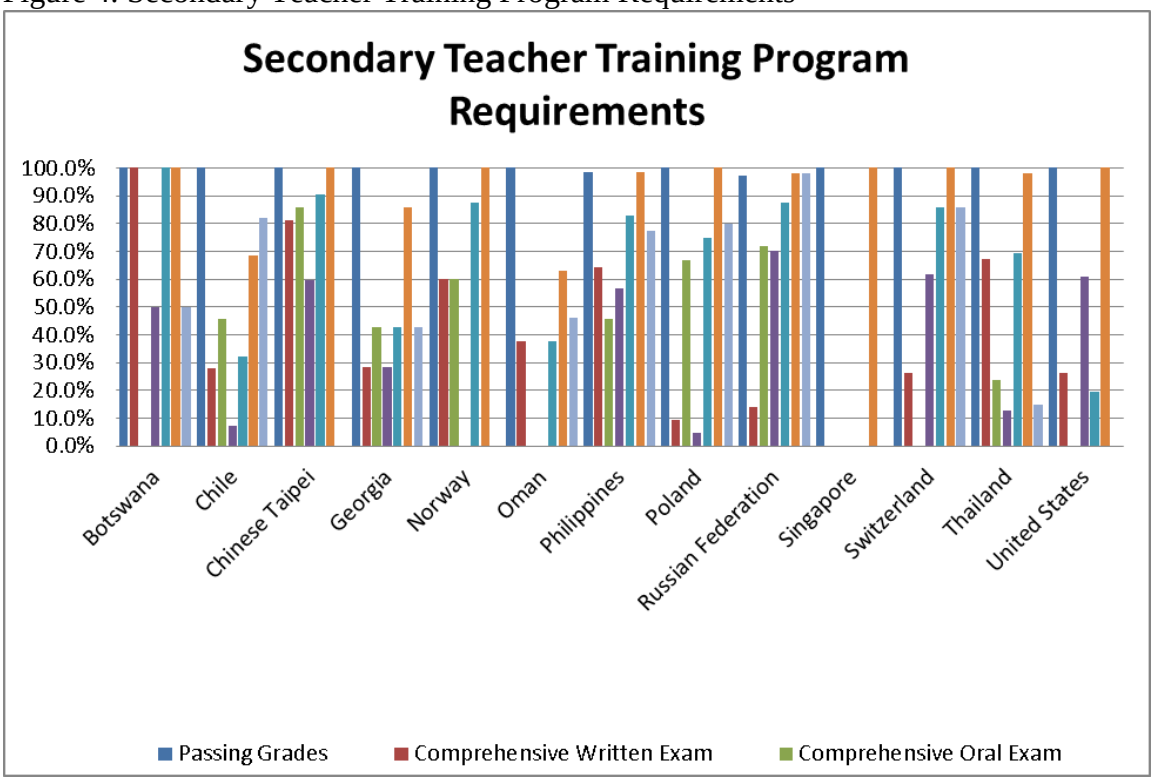


Figure 4: Secondary Teacher Training Program Requirements[26]



[25] Tatto et al. (2012) p. 219-222
[26] Tatto et al. (2012) p. 219-222

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