LAS DESIGUALDADES DE LOS RESULTADOS DE LAS PRUEBAS PISA DEBIDO AL DESEMPEÑO DEL PROFESOR: LAS DIFERENCIAS ENTRE LOS PAÍSES[1]

INEQUALITIES OF THE RESULTS OF THE PISA TESTS DUE TO TEACHERS FACTORS: DIFFERENCES BETWEEN COUNTRIES

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Resumen

La reflexión que presentamos son las consecuencias con respecto a la desigualdad de los resultados de las pruebas PISA: diferencias entre países debido al desempeño del profesor 'Nuestro trabajo está siendo desarrollado bajo nuestra tesis de doctorado en Ciencias de la Educación. Vamos a tratar de analizar de qué forma los factores relacionados con el desempeño de los profesores puedan interferir en los resultados de los estudiantes actuales. Nos referimos a cómo ciertas características tales como las expectativas de los profesores hacia los alumnos, las relaciones alumno-profesor, el ausentismo docente, el rigor de los profesores, la relación alumno-profesor, entre otros, pueden ser directa o indirectamente correlacionada con los resultados de las pruebas PISA. De acuerdo con estas correlaciones se seleccionarán algunas de las variables estadísticamente significativas con el fin de estabilizar el número de factores relacionados con las características del profesor, menores en número en comparación con el conjunto original de variables, lo que puede explicar en parte el logro del estudiante. M Posteriormente, y en base a las variables seleccionadas, vamos a tratar de identificar y caracterizar los grupos homogéneos de países en función del grado de similitud entre los factores considerados. Para lograr este resultado, vamos a utilizar las técnicas de segmentación y clasificación de los datos, es decir, el análisis de conglomerados que permitirán encontrar grupos de países con posibles similitudes entre sí y diferentes de los demás, teniendo en cuenta los factores inicialmente avalados reflexionamos sobre qué mecanismos los profesores desempeñaran para descifrar su similitud o diferenciación.

Palabras clave: Desempeño docente, la participación docente, racio profesor-alumno, los resultados de PISA, correlaciones, análisis de regresión, las agrupaciones.

Abstract

The reflection we propose aims to present results regarding the inequalities of the PISA test results: differences between countries due to teacher's performances'. Our work is being developed under a doctoral thesis in Education Science. We will seek to

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examine how factors related to teacher's performance may affect the actual student results. We refer to how certain features such as the teacher expectations towards students, student-teacher relationships, teacher absenteeism, strictness of the teachers, student-teacher ratio, among others, may direct or indirectly be correlated with the PISA test results. According to these correlations, we will select some of the statistically significant variables in order to stabilize a number of factors relating to teacher characteristics, fewer in number compared to the original set of variables, which can partially explain student's achievement.
Subsequently, and based on selected variables, we will identify and characterize homogeneous groups of countries, depending on the degree of similarity of the factors considered. To achieve this result, we will use techniques of segmentation and classification of data, namely, the cluster analysis. This will allow us to find sets of countries as similar as possible to each other and different from the rest, considering the variables initially validated in order to reflect on what Teachers mechanisms enhance their similarity or differentiation.

Keywords: Teacher performance, Teacher participation, Student-teacher ratio, PISA results, correlations, regression analysis, clusters.

1. INTRODUCTION

For many years, researchers have debated which school-related variables really affect student performance. Much literature on these issues have been written since policymakers become more involved in school reforms, basing them on the presumed relationships between various education-related factors and learning outcomes. However, opinions do not have been consensual. There are researchers who argue that school related factors shortly interfere with the results obtained by students "schools bring little influence to bear upon a child's achievement that is independent of his background and general social context" (Coleman et al., 1966, p. 325). Other researchers suggest that factors like class size (Glass, Cahen, Smith & Filby, 1982; Mosteller, 1999), teacher qualifications (Ferguson, 1993), school size (Haller, Monk & Tien, 1993) and other school variables can make all the difference.

Our study aims to understand the factors related to teachers performance that influence student results, namely their performance in PISA (Programme for International Student Assessment) tests. We use as explanatory variables, the variables contained in the databases relating to schools provided by the OECD (Organization for Economic Cooperation and Development) itself. Thus we intend to test how the performance of teachers (translated in student teacher ratio, teacher participation, teacher shortage, teacher behavior, proportion of certified or qualified teachers, teacher low expectations, teacher absenteeism or teacher strictness) is of significance for the students results and what of these features more influence student's PISA results.

We intend to test only the relevance of explanatory variables included in the PISA questionnaire applied to schools (answered by schools directors') on the teacher performance. We are, nevertheless aware of the fact that there are many other variables related to teachers that might influence students' performance but it is not our intention to study them here.

PISA studies were released by OECD in 1997. The results of these studies allow countries to monitor, on a regular basis, their education systems in terms of student performance in the context of a conceptual framework internationally accepted. PISA seeks to measure the ability of 15 year olds to use the knowledge they have in order to face the challenges of real life, rather than simply assessing the field that hold the content of their specific school curriculum. The study is organized in cycles of three years. The first data collection took place in 2000 (first cycle of PISA) and its main area of assessment was literacy in reading context. The PISA 2003 gave a greater focus on mathematics literacy and had as secondary domains literacies of reading and science and problem solving. In PISA studies which took place in 2006 (third round), there was a preponderance of scientific literacy. In PISA 2009 the main focus was again literacy in reading context. These tests held again in 2012 (focus in mathematics literacy) but those results will only be published in December 2013. Our study will only use the data for the year 2009 which is the last year with available data. In the future, we intend to apply this study to the new data.

We will investigate the 63 countries for which we have statistical data and test the impact that these teachers' characteristics have in PISA test results. We will also investigate if the results are the same considering reading, mathematics or science tests.

Then we will try to classify countries into homogeneous groups, the most similar between them and distinct from the others, using for such a cluster analysis.

Finally, this study would not make sense without thinking his usefulness. We are going to briefly question how it may be used in public policies, particularly in the field of educational policies.

2. METHODOLOGY

We start by doing an exploratory analysis of all independent variables, which allow us to identify the statistically significant variables to be considered in the regression analysis. We individually analyze the relationship between the tests results and each of the independent variables. Only variables that show significant correlation coefficients (positive or negative) will be taking into account in regression analysis.

A regression analysis will be performed on the data of country PISA results and all the independent variables previously chosen. Regression analysis is a statistical measure that attempts to determine the strength of the relationship between one dependent variable (Pisa results) and a series of other changing variables (independent variables).

Cluster analysis will be the last step of our statistical exploration. It is a statistical technique that groups objects (countries) in a same group (cluster) where countries are more similar (depending on the variables included in the analysis) to each other than to those in other groups (clusters).

As we have quantitative data for a sufficiently wide range of countries we employ statistical analysis of country-level data to test our hypothesis and so our study is therefore based on cross-national comparative analysis. A cross-national comparative approach seems to us the best, and indeed often the only, way to investigate the societal relationships. There is too little variation between systems (of welfare or education, for instance) within countries, for it to be possible to conduct comparative analysis within one country (Green, Preston & Janmaat, 2006).

There may be objections, especially from a methodologically individualist perspective, to this type of cross-national analysis. These may relate particularly to the so-called “ecological fallacy” (Pearce, 2000) were conclusions about the relationships between variables at the individual level are inferred from analysis of the relationships observed at the national level using national or aggregate data.

Much of the existing work on education focuses on individuals in specific countries, using individual-level data. Methodologically, our work makes a little break with all the individual-level investigations, considering us only the average of all the individual values (namely schools values), obtained by country. We do not intend thereby conducting a study at the individual or school level but rather to compare data and results between the different participating countries.

3. RESULTS AND DISCUSSION

i) Variables and Correlations

As we have already said, results for the explanatory variables used in this study were extracted from the database of the questionnaire applied to schools (answered by school directors), particularly questions Q9, Q11, Q17 and Q24, all about teachers performance, existence or shortage. (Table I in Appendix: transcriptions of used part of Questions Q9, Q11, Q17 and Q24).

Data considered for each country resulted of simple arithmetic average obtained data from all participated schools of each country.We considered only mean, for each variable and for each country as the representative statistical measure to use in this situation. We know, however, that the diversity and heterogeneity existing within each country is not captured by this central tendency measure but this is the only way we have to compare countries results.

Besides the results of Reading, Science and Mathematics tests, we built a new variable that we called “PISA”, which is the three previous results arithmetic average. Table II in appendix shows the direction and intensity of correlations between our dependent variables (tests scores mean, by country) and all the independent variables to be considered.

In order to properly choose significant variables to use in next steps, we started by a correlation study between PISA tests results and all the explanatory variables.This type of analysis wants to check the direction of the response of dependent variable when explanatory variable changes (we refer to positive or negative correlation, if they vary in the same or in opposite way respectively) and can also quantify the intensity of this relationship.

The strongest correlation is between PISA tests results and Teacher participation. It is a positive correlation which means that an increase in Teacher participation corresponds to an increase in PISA tests results. There is also another positive and significant relationship, between the proportion of certified teachers and Pisa tests results. This correlation is somewhat weaker than between Pisa tests results and teacher participation. All other significant correlations have negative linear correlation coefficients and are between PISA tests results and student teacher ratio, teacher low expectations and teacher absenteeism. The last one (correlation between teacher absenteeism and PISA results) is not significant for reading tests. Negative correlation coefficients mean that an increase in the explanatory variable translates into a decrease in PISA tests results, in other words, are variables that behave reverse. They are not very strong correlations (present Pearson linear correlation coefficients with absolute values between 0,226 and 0,369) but are indeed statistically significant correlations (Table 1: Significant correlations coefficients).

All other variables (Teacher shortage, teacher behavior, proportion of qualified teachers, shortage of science teachers, shortage of mathematics teachers, shortage of test language teachers, student teacher relations and teachers too strict) do not present a significant relationship with PISA tests results and for this reason will not be taken into account in regression analysis (Table II in Appendix).

Correlations

		Reading	Maths	Science	PISA
Student Teacher ratio	Pearson Correlation	-,281*	-,342**	-,306*	-,315*
	Sig. (2-tailed)	,026	,006	,015	,012
	N	63	63	63	63
Teacher participation	Pearson Correlation	,477**	,499**	,500**	,498**
	Sig. (2-tailed)	,000	,000	,000	,000
	N	63	63	63	63
Proportion of certified teachers	Pearson Correlation	,292*	,369**	,357**	,345**
	Sig. (2-tailed)	,020	,003	, 004	,006
	N	63	63	63	63
Teachers low expectations	Pearson Correlation	-,304*	-,309*	-,319*	-,314*
	Sig. (2-tailed)	,015	,014	,011	,012
	N	63	63	63	63
Teacher absenteeism	Pearson Correlation	-,243	-,277*	-,266*	-,266*
	Sig. (2-tailed)	,055	,028	,035	,035
	N	63	63	63	63

Table 1: Significant correlations coefficients

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

a) Student teacher ratio

Class size and student-teacher ratios and also teachers' salaries are much-discussed aspects of economics of education by having a considerable impact on the level of current expenditure on education. Correlation between expenditure on education and education achievement is also widely discussed.

Smaller classes are often perceived as allowing teachers to focus more on the needs of individual students and reducing the amount of class time needed to deal with disruptions. Opinions herein are not, however, unanimous. There are those who argue that smaller classes may specially benefit specific groups of students, such as those from disadvantaged backgrounds (Krueger, 2002), defending the evidence of the effects of differences in class size on student performance is weak.

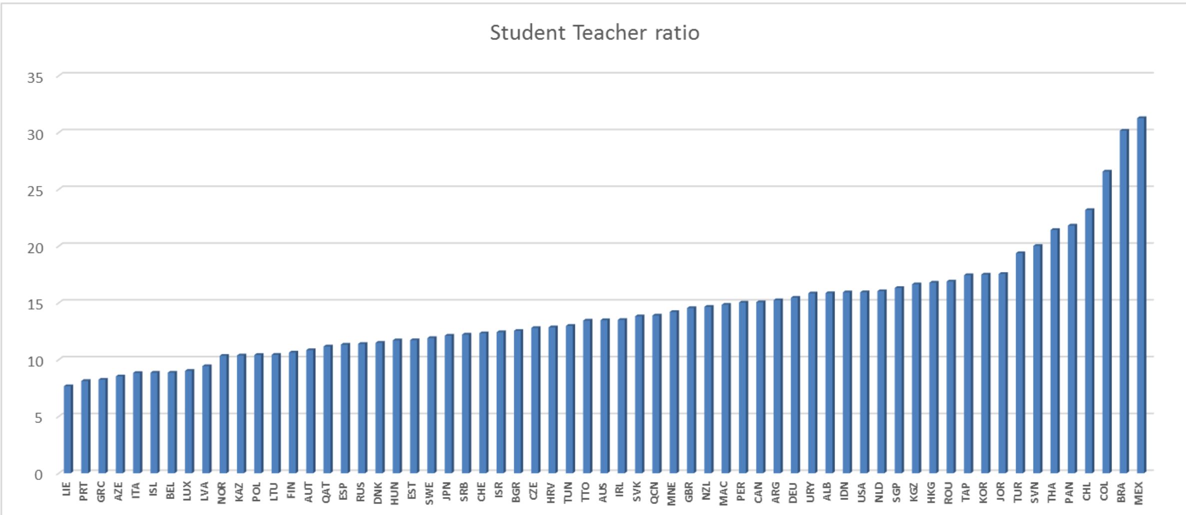
Hanushek wrote that money doesn't make a difference. He has conducted a series of influential literature reviews that support the conclusion that increased spending in general, and smaller class size in particular, do not "systematically" lead to improved student achievement.

Table 2: Descriptive statistics for *Student teacher ratio*

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
StudentTeacher_ratio_MEAN	63	7,664	31,272	14,30659	4,863909
Valid N (listwise)	63				

Figure 1: Student Teacher ratio



Source: PISA schools dataset 2009. OECD (adapted)

The average student teacher ratio in our 63 countries it is about 14 (mean: 14,31). This ratio ranges from fewer than 8 (7,664) in Liechtenstein to more than 31 (31,272) in Mexico (see Table 2 and Figure 1). This ratio is fewer than 10 in Liechtenstein, Portugal, Greece, Azerbaijan, Italy, Iceland, Belgium, Luxembourg and Latvia and it is more than 25 in Colombia, Brazil and Mexico.

Figure I in appendix shows us that Mexico, Brazil, Colombia, Panama, Chile, Thailand, Kyrgyzstan, Peru, Indonesia, Albania, Jordan and Romania are the countries with a student teacher ratio above mean (above 14,31) and at the same time with PISA average results below the 63 countries mean (below 467,35). Through this diagram it is also possible realize which countries have high PISA tests results regarding their student teacher ratio.

b) Teacher participation

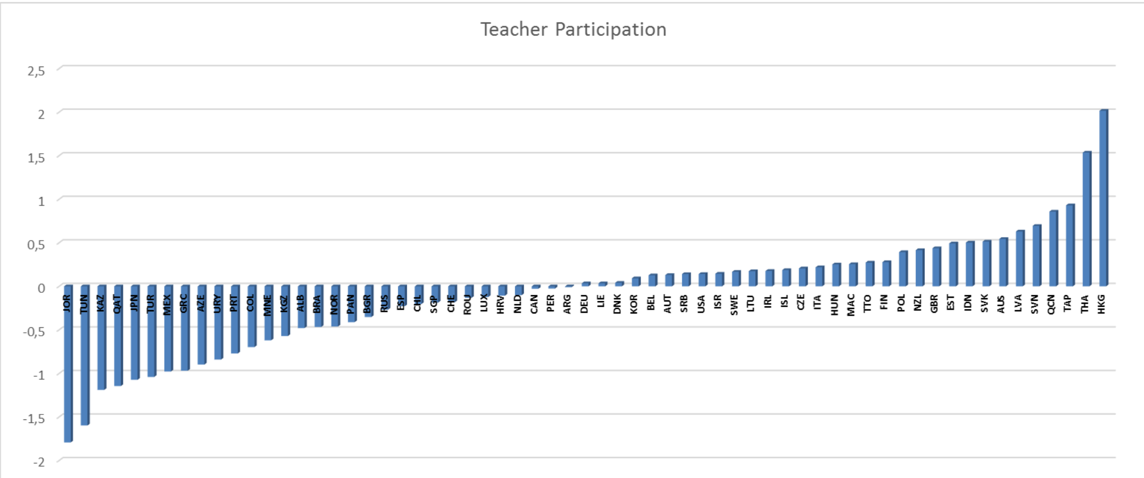
The question on teacher participation was computed based on the analysis of the number of ticks on the following twelve items referred to teachers and their responsibility for: teacher hire, firing teachers, starting salaries, salary increases, formulate budget, budget allocation, student discipline, student assessment, student admission, textbook use, course content and courses offered (see Table I in appendix. Question 24). A "tick" on an item was treated as positive score on that item and the absence of a "tick" meant a negative score on that item.

Table 3: Descriptive statistics for *Teacher participation*

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Teacher_participation_MEAN	63	-1,792	2,016	-,07794	,670408
Valid N (listwise)	63				

Figure 2: Teacher participation



Source: PISA schools dataset 2009. OECD (adapted)

Teacher participation ranges from -1,792 (Jordan) to 2,017 (China- Hong Kong). The highest values, very far from all other, belong to China Hong Kong and Thailand. Jordan, Tunisia, Kazakhstan, Qatar, Japan, Turkey, Mexico and Greece have the lowest values for teacher participation. Average value for this Teacher participation is -0,7794 which almost corresponds to Portugal value.

It is also important analyzing the relationship between teacher participation and PISA results. The scatter diagram (Figure II in appendix) shows a positive relationship between teacher participation and Pisa results (which is confirmed by his Pearson linear correlation coefficient for all the three tests).

We accentuate China-Hong Kong, with the highest mean of Teacher participation followed by Thailand, China-Taipai, China-Shangai, Slovenia, Latvia, Australia, Slovak Republic, Indonesia, Estonia, with values nearly above 0,5. On the opposite side Jordan, Tunisia, Azerbaijan, Mexico and Qatar have the lowest teacher participation and also Pisa results below all countries mean. While Portugal, Greece, Japan and Norway have teacher participation below average but manage to get PISA results above all countries average.

All other countries have teacher participation above average. Nevertheless, Thailand, Trinidad and Tobago, Peru, Argentina, Serbia, Israel and Lithuania fail to provide PISA results above the mean values (above 467,37).

c) Proportion of certified teachers

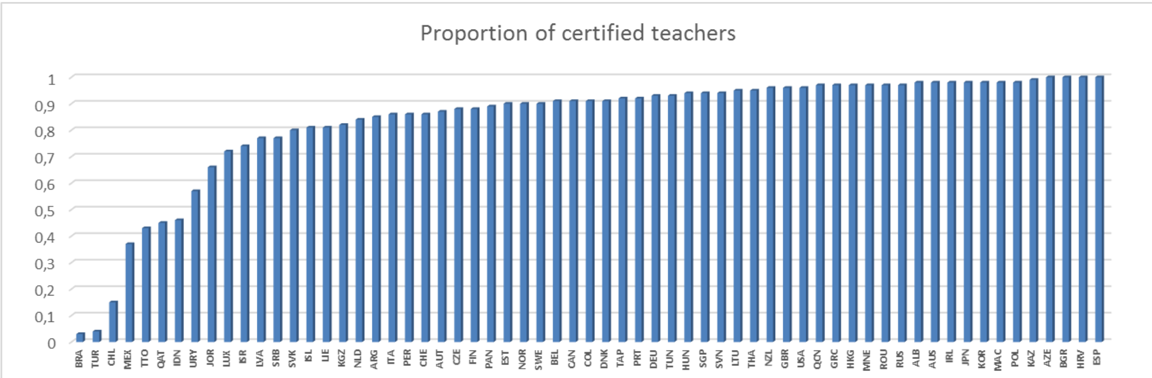
Academic ability, years of education, years of teaching experience, measures of teaching knowledge, teaching behaviors in the classroom, certification status, obtained qualifications, proportion of certified and qualified teachers among other factors are presumed variables indicative of teacher's competence. It is important analyzing the role that teacher quality plays in student achievement and for this reason we are going to verify the importance of the proportion of certified teachers.

Table 4: Descriptive statistics for *Proportion of certified teachers*

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Proportion_of_certified_teachers_MEAN	63	,03	1,00	,8337	,22454
Valid N (listwise)	63				

Figure 3: Proportion of certified teachers



Source: PISA schools dataset 2009. OECD (adapted)

Brazil and Turkey have a very low proportion of certified teachers. On the other hand, Azerbaijan, Bulgaria, Croatia and Spain have all teachers certified. Only Brazil, Turkey, Chile, Mexico, Trinidad and Tobago, Qatar, Indonesia, Uruguay, Jordan, Luxembourg, Israel, Latvia, Serbia, Slovak Republic, Iceland, Liechtenstein and Kyrgyzstan have a proportion of certified teachers shorter than 0,84 which is the average value for all countries.

Relating PISA results and the proportion of certified teachers we can say that Turkey, Brazil and Chile have the lowest proportion of certified teachers, followed by Mexico, Trinidad and Tobago, Indonesia, Qatar, Uruguay, Jordan, Serbia and Thailand, Kyrgyzstan and Israel. All these countries have PISA results under average (under 467,35) (Figure III in Appendix).

Slovak Republic, Luxembourg, Czech Republic, Liechtenstein and Iceland also have a proportion of certified teachers below average but they can achieve PISA mean results above all countries mean. All other countries have a proportion of certified teacher between the average value (0,834) and 1, which is the maximum value.

The positive correlation between the proportion of certified teachers and PISA results is mainly due to countries like Turkey, Brazil, Chile, Mexico, Trinidad and Tobago, Uruguay, Indonesia, Qatar and Jordan. If we drop these countries it is very difficult to graphically check any kind of correlation.

d) Teacher low expectations

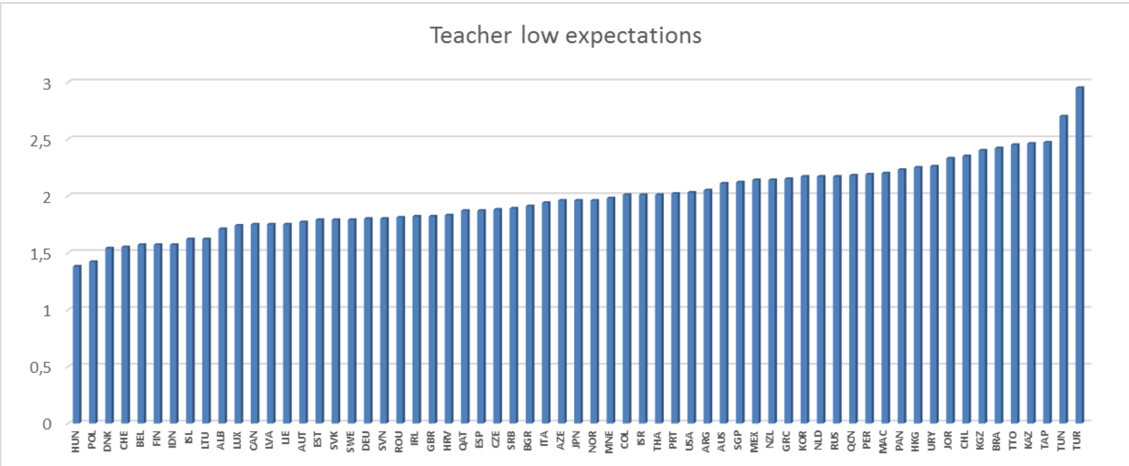
Researchers have been studying how teachers' beliefs about students affect their behavior toward students. This can conduct us to the "self-fulfilling prophecy" term, which means that once an expectation develops, even if it is wrong, people behave as if the belief were true (Stipek, 2002). By behaving this way, they can actually cause their expectations to be fulfilled. Self-fulfilling prophecies occur only if the original expectation was erroneous and a change was brought about in the student's behavior as a consequence of the expectation.

Table 5: Descriptive statistics for *Teachers low expectations*

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Teachers_low_expectations	63	1,38	2,95	1,9829	,30683
Valid N (listwise)	63				

Figure 4: Teacher low expectations



Source: PISA schools dataset 2009. OECD (adapted)

Hungary has the lowest value for teacher expectation (1,38), followed by Poland, Denmark, Switzerland, Belgium, Finland, Indonesia, Iceland or Lithuania. Countries like Turkey, Tunisia, China-Taipai, Kazakhstan, Trinidad and Tobago, Brazil Kyrgyzstan, Chile, Jordan, Uruguay, China Hong Kong, Panama, Macau-China also have high values (above 2,2).

Graphically (Figure IV in Appendix) it is difficult to see any relationship between low teacher expectations and PISA tests results. Countries such Indonesia, Albania, Azerbaijan, Qatar, Bulgaria, Romania and Serbia teachers have low expectations towards students and low test scores. On the other hand Hungary, Poland, Switzerland, Finland, Denmark, Latvia, Sweden, Lithuania, Ireland, Iceland, Belgium, Slovenia, Estonia, Canada and Italy have low teacher expectations but are able to achieve PISA results above average value.

Chile, Uruguay, Thailand, Trinidad and Tobago, Brazil, Mexico, Jordan, Peru, Panama, Kazakhstan, Tunisia and Kyrgyzstan have low values for teacher expectations and PISA results under 467,35, which is the all countries average value.

e) Teachers absenteeism

There are several (direct or indirect) mechanisms through which teacher absences may reduce student achievement. Teacher regular absence may directly reduce instructional intensity (Capitan & et al., 1980; Gagne, 1977; Varlas, 2001). A second mechanism through which teacher absences may affect student achievement is through the creation of discontinuities of instruction, the disruption of the regular routines and procedures of the classroom (Rundall, 1986).

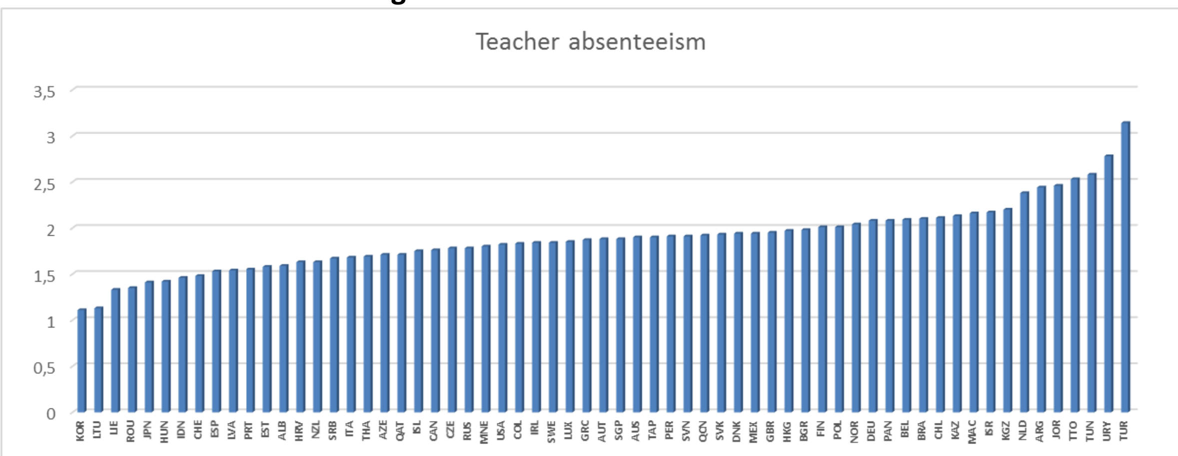
Teacher absenteeism also have another indirect effects, such as inhibit attempts by school faculties to implement consistent instructional practices across classrooms and grades. By this way teacher's absence not only impacts negatively on the students he directly works with, but also on the students taught by the teacher's colleagues.

Table 6: Descriptive statistics for *Teacher absenteeism*

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Teacher_absenteeism	63	1,11	3,14	1,8829	,36497
Valid N (listwise)	63				

Figure 5: Teacher absenteeism



Source: PISA schools dataset 2009. OECD (adapted)

It is in Korea that the perception of teacher absenteeism by school directors is the lowest (Minimum value: 1,11). Lithuania, Liechtenstein, Romania, Japan, Hungary, Indonesia and Switzerland also have teacher absenteeism lower than 1,5. On the opposite side are Turkey, Uruguay, Tunisia, Trinidad and Tobago, Jordan, Argentina and Netherland with the highest perception of teacher absenteeism. Turkey has even the worst value (3,14). Mean value for teacher absenteeism is 1,8829 (see Table 6).

ii) multivariate regression

Classical assumptions for regression analysis include: i) the sample must be representative of the population for the inference prediction. As we used all the available countries data, our sample is just the same of our statistical universe. ii) the error is assumed to be a random variable with mean of zero, conditioned on the explanatory variables iii) the predictors must be linear independent iv) the errors are uncorrelated, that is the variance-covariance matrix of the errors is diagonal and each non-zero element is the variance of the error and v) the variance of the error is constant across observations (homocedasticity)

Starting by the multiregression analysis performed with mean scores of PISA (arithmetic mean of Reading, Mathematics and Science) as dependent variable and Student-Teacher ratio, Teacher participation, proportion of certified teachers, teachers low expectations and teachers absenteeism as independent variables (which were the variables with significant correlations coefficients):

Table7: Portrays the variability of predictors explained by the relationship between variables

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,587[a]	,345	,287	47,65087

a. Predictors: (Constant), Teacher_absenteeism, StudentTeacher_ratio_MEAN, Teacher_participation_MEAN, Proportion_of_certified_teachers_MEAN, Teachers_low_expectations

b. Dependent Variable: PISA

Table 8: Shows the significance of the model with five parameters

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	68108,094	5	13621,619	5,999	,000[b]
	Residual	129424,499	57	2270,605		
	Total	197532,593	62			

a. Dependent Variable: PISA

b. Predictors: (Constant), Teacher_absenteeism, StudentTeacher_ratio_MEAN, Teacher_participation_MEAN, Proportion_of_certified_teachers_MEAN, Teachers_low_expectations

Table 9: Shows the significance of the individual parameters in the model

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	499,602	63,584		7,857	,000
	StudentTeacher_ratio_MEAN	-2,692	1,516	-,232	-1,775	,081
	Teacher_participation_MEAN	37,800	9,818	,449	3,850	,000
	Proportion_of_certified_teachers_MEAN	26,617	33,350	,106	,798	,428
	Teachers_low_expectations	-1,906	27,414	-,010	-,070	,945
	Teacher_absenteeism	-4,889	21,959	-,032	-,223	,825

a. Dependent Variable: PISA

Looking at the analysis of variance (Table 8), the P-value is equal to 0,000 which means we have enough evidence to say at least one of the model's predictors is useful. If we look at the T-test of the predictors (Table 9), we see that there is only one significant predictor (Teacher participation). All the other have P-values bigger than our significance level, which is 0,05. For this reason, we opted to make another regression analysis without the independent variables, proportion of certified teachers, teachers low expectations and teacher absenteeism. The new model is presented in tables 11,12 and 13.

Table 10: Descriptive Statistics for explanatory variables

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
StudentTeacher_ratio_MEAN	63	7,664	31,272	14,30659	4,863909
Teacher_participation_MEAN	63	-1,792	2,016	-,07794	,670408
Valid N (listwise)	63				

Table 11: Adjusted R Square

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,578[a]	,334	,311	46,83882

a. Predictors: (Constant), Teacher_participation_MEAN, StudentTeacher_ratio_MEAN

b. Dependent Variable: PISA

Table 12: Shows the significance of the model with two parameters

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	65900,075	2	32950,038	15,019	,000[b]
	Residual	131632,518	60	2193,875		
	Total	197532,593	62			

a. Dependent Variable: PISA

b. Predictors: (Constant), Teacher_participation_MEAN, StudentTeacher_ratio_MEAN

Table 13: Shows the significance of the individual parameters in the model

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	519,170	18,466		28,116	,000		
	StudentTeacher_ratio_MEAN	-3,400	1,224	-,293	-2,777	,007	,998	1,002
	Teacher_participation_MEAN	40,808	8,882	,485	4,594	,000	,998	1,002

a. Dependent Variable: PISA

As the VIFs (Variation Inflation Factor, that measures the correlation of the variable with every other of the model) of the two independent variables are smaller than 5, there is no problem of multicollinearity (Table 13). Multicollinearity is a common problem in regressions where the independent variables have exact or approximately exact linear relationships.

As the Std. Residual Std is within the range of three standard deviations, then there are no outlier candidate value nor influential value. The maximum Cook's distance is much less than 1, which reinforces the above statement, that there are not influential values (Table III in Appendix).

P-P Plot diagram shows that the normality assumption is not violated and also if we look at the chart of the standardized residuals versus standardized predicted values , we observe that other assumptions are met, because the residuals are randomly distributed (Figures VI and VII in Appendix).We conclude that all this conditions, for all our attempts are satisfied.

From this model we see by the Adjusted R-Square (we use the Adjusted R^2 because it is a multiple regression. Adjusted R^2 ponders R^2 according to the number of independents variables in the model and the number of observations) that 31.1% of the total variation is explained by the relationship between the independent variables (Teacher Student teacher ratio and participation) and the dependent variable (PISA tests results) (Table 11) when taken into account the number of independent variables in the model, which means that this model explains 31,1% of the variability in the scores.

The overall F-test for significance of the model, as significant (0,000) is less than alpha (0.05) (Table 12), we conclude that at least one of the coefficients of the explanatory variables is non-zero, then there is a linear relationship between the PISA tests results and at least one of the explanatory variables.

Its is also possible to see that variables Student Teacher ratio and Teacher participation are both statistically significant (Table 13), so we fitted a model using just these variables. The results is:

Pisa = 519,170 – 3,4 x Student Teacher ratio + 40,808 x Teacher participation
(-2,777) (4,594)

519,170 is the intercept, which means that a country with zero value for both independent variables, is expected to have a Pisa result of 519,170.

One value more in Student Teacher ratio means less 3,4 points in Pisa Mean results (negative relationship) and one value more in teacher participation means more 40,808 points in Pisa Mean results (positive relationship).

As both sig (0.000) are less than alpha, we conclude that these parameters are statistically significant, or are nonzero.

Repeating this kind of exercise for Reading, Mathematics and Science, results are shown in the following tables (Tables IVa,b,c; Va,b,c and VIa,b,c in Appendix):

***Reading** = 506,671 – 2,793 x Student Teacher ratio + 36,288 x Teacher participation*
(-2,397) (4,293)
(Adjusted R Square = 0,272)

***Mathematics** = 528,649 – 4,074 x Student Teacher ratio + 44,743 x Teacher participation*
(-3,076) (4,656)
(Adjusted R Square = 0,33)

***Science** = 522,191 – 3,333 x Student Teacher ratio + 41,391 x Teacher participation*
(-2,689) (4,603)
(Adjusted R Square = 0,308)

After several attempts of multivariate, is interesting to note that for all tests-reading, mathematics or science-(considered individually as dependent variables), the statistically significant independent variables turn out to be always the same: student teacher ratio and teacher participation. In other words, with our data we can only use Student Teacher ratio and Teacher participation, as teacher's performance variables, to explain students PISA results. The Adjusted R Square ranges from 0,272 (Reading) to 0,33 mathematics which means that it is in mathematics that the relationship between independent variables (Student teacher ratio and Teacher participation) and dependent variables (PISA mathematic results) more is able to explain the total variation (and less in Reading tests). Both other coefficients are also in absolute value higher in mathematics and lower in Reading. This means that one point more in Student Teacher ratio, decreases Reading results in 2,793 points and mathematics results in 4,074 (Science has an intermediate value: 3,333). For the case of Teacher participation one more value in this variable, means 44,743 more values in mathematics results, and 36,288 more values in Reading tests (41,391 more values in Science tests).

iii) Análise de clusters

Last step of our study consists of a cluster analysis. We do this to be able to group countries into homogeneous groups on the basis of three considered characteristics: global PISA tests results, student teacher ratio and teacher participation. Clusters found grouped countries that are more similar to each other and different from the others with regard to the three characteristics above mentioned.

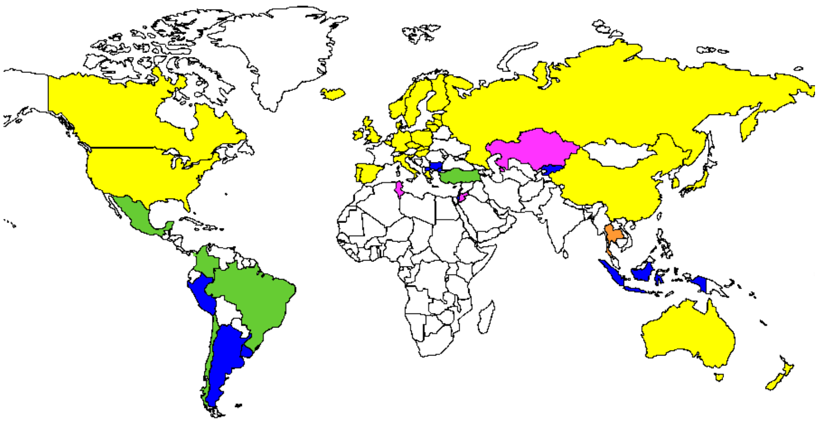
Cluster analysis allowed us to group all 63 countries into six clusters, composed of the following countries, each one:

Table 14: clusters

Cluster 1	Albania, Argentina, Bulgaria, Indonesia, Israel, Kyrgyzhistan, Montenegro, Peru, Romania, Serbia, Trinidad and Tobago and Uruguay
Cluster 2	Azerbaijan, Jordan, Kazakhstan, Qatar, Tunisia
Cluster 3	Australia, Austria, Belgium, Canada, China-Shangai, China-Taipai, Croacia, Czech Republic, Denmark, Estonia, Finland, Germany, Greece,

	Hungary, Iceland, Ireland, Italy, Japan, Korea, Latvia, Liechtenstein, Lithuania, Luxembourg, Macau-China, Netherland, New Zealand, Norway, Poland, Portugal, Russian Federation, Singapore, Slovac Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom and United States.
Cluster 4	Brazil, Chile, Colombia, Mexico, Panama and Turkey
Cluster 5	China- Hong Kong
Cluster 6	Thailand

Figure 7: geographic illustration of clusters



Legend: cluster 1- blue; Cluster 2- pink; Cluster 3- yellow; Cluster 4- green; Cluster 6- orange

We have two clusters each consisting of a country (cluster 5: China Hong Kong and cluster 6: Thailand). We have one cluster constituted by five countries (cluster 2: Azerbaijan, Jordan, Kazakhstan, Qatar and Tunisia), one cluster with six countries (cluster 4: Brazil, Chile, Colombia, Mexico, Panama and Turkey), a cluster slightly larger (cluster 1 contains twelve countries) and one huge cluster (cluster 3 containing 38 countries) (Table 14).

Figure 8: PISA tests results, by cluster

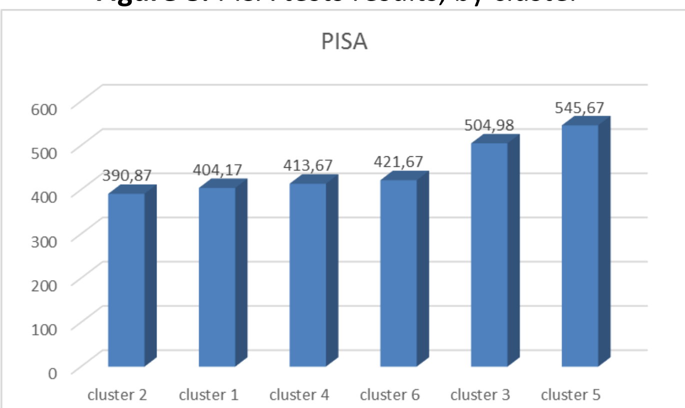


Figure 9: Teacher participation results, by cluster

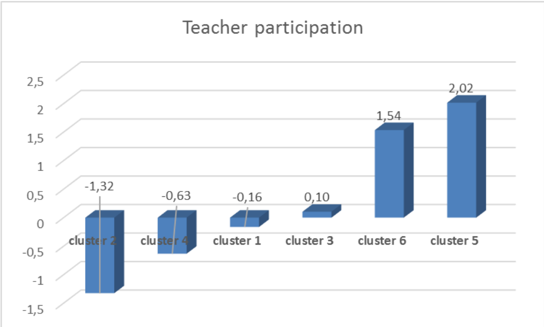
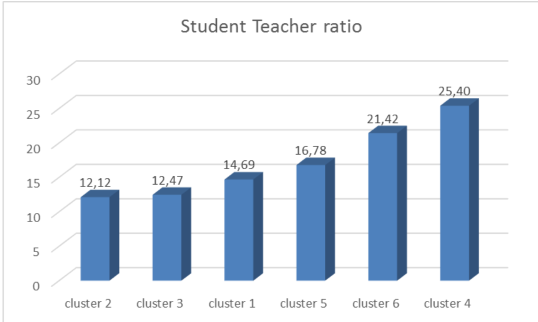


Figure 10: Student teacher ratio, by cluster



Analyzing PISA results (Figure 8) Student teacher ratio and Teacher Participation values (Figures 9 and 10) for each cluster, we see that is Cluster 5 (composed only by China Hong Kong) the one with the best average result of the PISA tests. This cluster is also the one that presents the best average result for teacher participation. In terms of Student-teacher ratio the value obtained by this cluster is between clusters 1, 2 and 3 (with lower values) and clusters 4 and 6 with higher values for this variable.

The huge cluster 3 is the second best PISA results cluster. His teacher participation is positive (slightly positive, 0,10) above clusters 2, 4 and 1 far below the clusters 6 and 5, this last with the highest value for this variable (2,02). Cluster 3 has, however, the second lowest value for Student teacher ratio (12,47). Only cluster 2 has a lower (the lowest one) student teacher ratio (12,12).

On the opposite side, cluster 2, has the worst performance on PISA tests results, the lowest teacher participation but contrary to expectations, also the lowest student teacher ratio. Cluster 1 presents the second worse PISA tests results. Has a low (even positive) teacher participation and a student teacher ratio situated more or less in the cluster number.

4. CONCLUSION

This study focused only on the teacher factors presented on PISA questionnaires that might influence student's performance and for this reason all other variables were not taken into account. The aim is understanding the impact that factors like student teacher ratio, teacher shortage (mathematics teacher, science teacher and test language teacher), teacher behavior, proportion of certified teachers, proportion of qualified teachers, teacher low expectations, student teacher relations, teacher absenteeism or teacher strictness) might have on student achievement.

Of all the explanatory variables we tested, we choose only those whose showed statistically significative correlations with which we did a multiregression analysis. We conclude that only Student teacher ratio and Teacher participation presented statistical significant coefficients. This was valid for the four dependent variables individually tested (PISA mean results, Reading results, Mathematics results and Science results). All the regressions had similar results.

Then we did a cluster analysis in order to classify all countries in homogenous groups. We found six clusters, two of them composed by only one country each and one of them with 38 countries (more than half of the countries considered).

Limitations of this study are mainly related to the exclusion of certain explanatory variables considered by international literature relevant in this area. These variables were not included because the same were not present in the PISA questionnaires and in other research sources, their data are not available for all countries. We ended up preferring not to lose observations (in this case countries) and therefore not included other additional variables. Also we used only data for 2009 PISA results, which immediately restrain comparisons and evolutions of values and countries. We suggest, for future investigation that a further similar analysis should also be performed using 2012 PISA data. This new analysis will compare evolutions of countries and realize if their division in these clusters, according to these variables, remains or not the same.

We cannot finish without reinforcing the idea of the usefulness of this type of studies. Comparing performances of different countries eventually lead us to the concept of induced regulation. As the name says this is not a compulsory regulation.

The role of international organizations, such as the OECD fulfills one of the purposes of the open method of coordination which is the systematic comparison of educational performance through the production of studies, statistical indicators and comparable assessments. Each state can ignore these guidelines. However, its disclosure affects the action of their governments, especially when media coverage of these reports enhances the pressure of institutions, social groups and individuals on the national need of designing or reviewing policies appropriate to the identified problems. It is therefore a social pressure that is induced by the knowledge resulting from an exercise of analysis and international comparison, enhancing reactive and competitive attitude and promoting mimicry and eventual convergence of public policies (Justino & Batista, n.d., p.17).

APPENDIX

Table I: Transcriptions of used part of Questions Q9, Q11, Q17 and Q24

*"**Q9** How many of the following teachers are on the staff of your school"* (full time and part time): -------

*"**Q11** Is your school's capacity to provide instruction hindered by any of the following issues?"* (possible answers were:1- Not at all; 2-Very little; 3-To some extent and 4-A lot) a) A lack of qualified science teachers b) A lack of qualified mathematics teachers c) A lack of qualified <test language> teachers

*"**Q17** In your school, to what extent is the learning of students hindered by the following phenomenon?"* (possible answers were:1- Not at all; 2-Very little; 3-To some extent and 4-A lot) a)Teachers' low expectation of students c) Poor student-teacher relations f) Teacher absenteeism k) Teachers being too strict with students

"**Q24** Regarding your school, who has a considerable responsibility for the following tasks? (Please tick as many boxes as appropriate in each row: 1- Principals; 2- Teachers; 3-School governing board; 4- Regional or local education authority; 5- National education authority) "
a) Selecting teachers for hire
b) Firing teachers
c) Establishing teachers' starting salaries
d) Determining teachers' salaries increases
e) Formulating the school budget
f) Deciding on budget allocations within the school
g) Establishing student disciplinary policies
h) Establishing student assessment policies
i) Approving students for admission to the school
j) Choosing which textbooks are used
k) Determining course content
l) Deciding which courses are offered

Table II: correlation matrix

Correlations

		Reading	Maths	Science	PISA
Student Teacher ratio	Pearson Correlation	-,281*	-,342**	-,306*	-,315*
	Sig. (2-tailed)	,026	,006	,015	,012
	N	63	63	63	63
Teacher participation	Pearson Correlation	,477**	,499**	,500**	,498**
	Sig. (2-tailed)	,000	,000	,000	,000
	N	63	63	63	63
Teacher shortage	Pearson Correlation	-,187	-,173	-,205	-,190
	Sig. (2-tailed)	,143	,175	,107	,136
	N	63	63	63	63
Teacher behaviour	Pearson Correlation	,092	,110	,112	,106
	Sig. (2-tailed)	,471	,391	,383	,407
	N	63	63	63	63
Proportion of certified teachers	Pearson Correlation	,292*	,369**	,357**	,345**
	Sig. (2-tailed)	,020	,003	, 004	,006
	N	63	63	63	63

Proportion of qualified teachers	Pearson Correlation	,024	-,001	,033	,018
	Sig. (2-tailed)	,853	,991	,798	,889
	N	63	63	63	63
Shortage of Science Teachers	Pearson Correlation	-,217	-,199	-,227	-,216
	Sig. (2-tailed)	,088	,118	,074	,089
	N	63	63	63	63
Shortage of Maths Teachers	Pearson Correlation	-,187	-,191	-,207	-,197
	Sig. (2-tailed)	,143	,135	,103	,122
	N	63	63	63	63
Shortage of test language Teachers	Pearson Correlation	-,125	-,117	-,154	-,133
	Sig. (2-tailed)	,329	,361	,227	,298
	N	63	63	63	63
Teachers low expectations	Pearson Correlation	-,304*	-,309*	-,319*	-,314*
	Sig. (2-tailed)	,015	,014	,011	,012
	N	63	63	63	63
Student teacher relations	Pearson Correlation	,014	,067	,029	,039
	Sig. (2-tailed)	,914	,601	,823	,764
	N	63	63	63	63
Teacher absenteeism	Pearson Correlation	-,243	-,277*	-,266*	-,266*
	Sig. (2-tailed)	,055	,028	,035	,035
	N	63	63	63	63
Teachers too strict	Pearson Correlation	-,034	-,021	-,019	-,025
	Sig. (2-tailed)	,793	,870	,882	,848
	N	63	63	63	63

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Figure I: Student Teacher ratio and PISA results

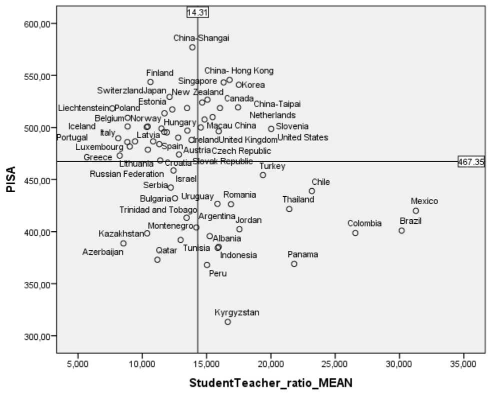


Figure II: Teacher participation and PISA results

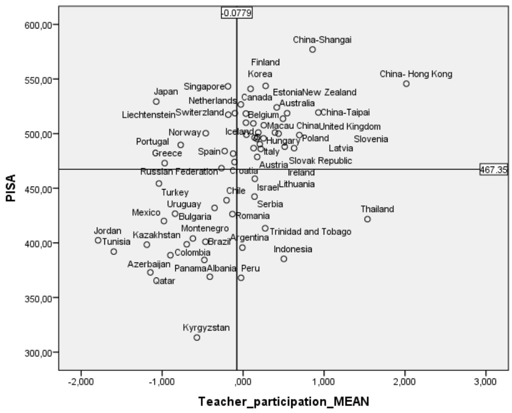


Figure III: Proportion of certified teachers and PISA results

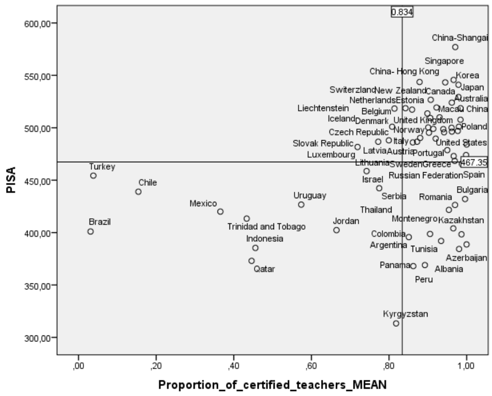


Figure IV: Teacher low expectations and PISA results

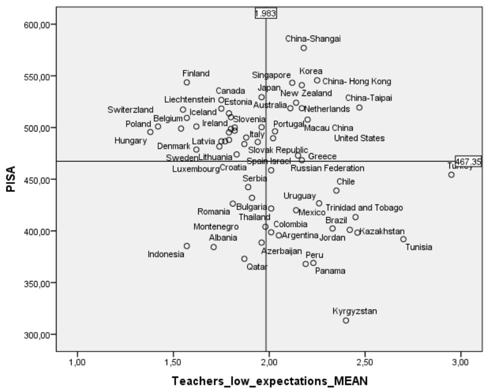


Figure V: Teacher absenteeism and PISA tests results

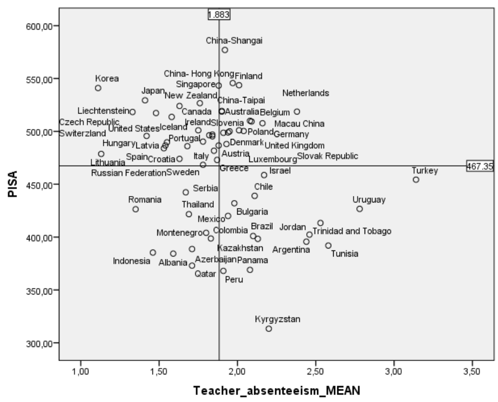


Table III: Residuals Statistics for multivariate regression

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	372,9263	544,3931	467,3492	32,60222	63
Std. Predicted Value	-2,896	2,363	,000	1,000	63
Standard Error of Predicted Value	5,988	22,696	9,487	3,834	63
Adjusted Predicted Value	358,4817	544,1126	467,3185	33,60603	63
Residual	-125,96450	95,13728	,00000	46,07716	63
Std. Residual	-2,689	2,031	,000	,984	63
Stud. Residual	-2,728	2,090	,000	1,007	63
Deleted Residual	-129,56902	100,75431	,03068	48,29687	63
Stud. Deleted Residual	-2,890	2,153	-,004	1,026	63
Mahal. Distance	,029	13,574	1,968	2,794	63
Cook's Distance	,000	,239	,016	,037	63
Centered Leverage Value	,000	,219	,032	,045	63

a. Dependent Variable: PISA

Figure VI: Residuals Analysis

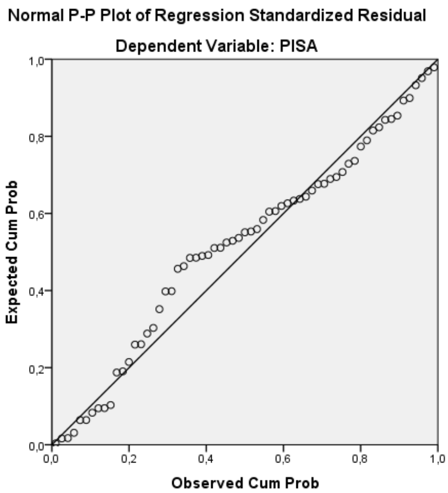


Figure VII: Residuals analysis

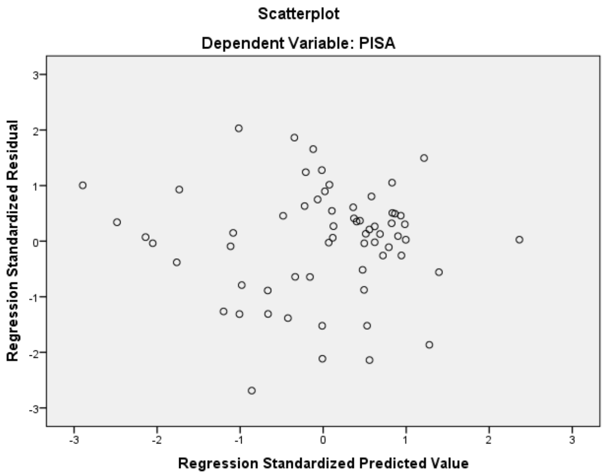


Table IVa: Adjusted R Square (Dependent variable: PISA Reading mean results)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,544[a]	,295	,272	44,575

a. Predictors: (Constant), Teacher_participation_MEAN, StudentTeacher_ratio_MEAN

b. Dependent Variable: Reading

Table IVb: Shows the significance of the model with two parameters (Variable dependent: PISA Reading mean results)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	49988,640	2	24994,320	12,580	,000[b]
	Residual	119213,582	60	1986,893		
	Total	169202,222	62			

a. Dependent Variable: Reading

b. Predictors: (Constant), Teacher_participation_MEAN, StudentTeacher_ratio_MEAN

Table IVc: Shows the significance of the individual parameters in the model (Variable dependent: PISA Reading mean results)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	506,671	17,573		28,833	,000
	StudentTeacher_ratio_MEAN	-2,793	1,165	-,260	-2,397	,020
	Teacher_participation_MEAN	36,288	8,453	,466	4,293	,000

a. Dependent Variable: Reading

Table Va: Adjusted R Square (Dependent variable: PISA Mathematics mean results)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,593[a]	,351	,330	50,671

a. Predictors: (Constant), Teacher_participation_MEAN, StudentTeacher_ratio_MEAN

b. Dependent Variable: Maths

Table Vb: Shows the significance of the model with two parameters (Variable dependent: PISA Mathematics mean results)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	83470,100	2	41735,050	16,255	,000[b]
	Residual	154052,884	60	2567,548		
	Total	237522,984	62			

a. Dependent Variable: Maths

b. Predictors: (Constant), Teacher_participation_MEAN, StudentTeacher_ratio_MEAN

Table Vc: Shows the significance of the individual parameters in the model (Variable dependent: PISA Mathematics mean results)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	528,649	19,976		26,464	,000
	StudentTeacher_ratio_MEAN	-4,074	1,324	-,320	-3,076	,003
	Teacher_participation_MEAN	44,743	9,609	,485	4,656	,000

a. Dependent Variable: Maths

Table VI a: Adjusted R Square (Dependent variable: PISA Science mean results)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,575[a]	,330	,308	47,415

a. Predictors: (Constant), Teacher_participation_MEAN, StudentTeacher_ratio_MEAN

b. Dependent Variable: Science

Table VI b: Shows the significance of the model with two parameters (Variable dependent: PISA Science mean results)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	66557,568	2	33278,784	14,802	,000[b]
	Residual	134893,289	60	2248,221		
	Total	201450,857	62			

a. Dependent Variable: Science

b. Predictors: (Constant), Teacher_participation_MEAN, StudentTeacher_ratio_MEAN

Table VI c: Shows the significance of the individual parameters in the model (Variable dependent: PISA Science mean results)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	522,191	18,693		27,935	,000
	StudentTeacher_ratio_MEAN	-3,333	1,239	-,284	-2,689	,009
	Teacher_participation_MEAN	41,391	8,991	,487	4,603	,000

a. Dependent Variable: Science

List of countries:

Country	Legend
Albania	ALB
Azerbaijan	AZE
Argentina	ARG
Australia	AUS
Austria	AUT
Belgium	BEL
Brazil	BRA
Bulgaria	BGR
Canada	CAN
Chile	CHL
China-Shangai	QCN
China-Taipai	TAP
Colombia	COL
Croatia	HRV
Czech Republic	CZE
Denmark	DNK
Estonia	EST
Finland	FIN
Germany	DEU
Greece	GRC
China- Hong Kong	HKG

Country	Legend
Hungary	HUN
Iceland	ISL
Indonesia	IDN
Ireland	IRL
Israel	ISR
Italy	ITA
Japan	JPN
Kazakhstan	KAZ
Jordan	JOR
Korea	KOR
Kyrgyzstan	KGZ
Latvia	LVA
Liechtenstein	LIE
Lithuania	LTU
Luxembourg	LUX
Macau China	MAC
Mexico	MEX
Montenegro	MNE
Netherlands	NLD
New Zealand	NZL
Norway	NOR

Country	Legend
Panama	PAN
Peru	PER
Poland	POL
Portugal	PRT
Qatar	QAT
Romania	ROU
Russian Federation	RUS
Serbia	SRB
Singapore	SGP
Slovak Republic	SVK
Slovenia	SVN
Spain	ESP
Sweden	SWE
Switerzland	CHE
Thailand	THA
Trinidad and Tobago	TTO
Tunisia	TUN
Turkey	TUR
United Kingdom	GBR
United States	USA
Uruguay	URY

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