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The impact of access to ICT, student background and school/home environment on academic success of students in Turkey: An international comparative analysis

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ABSTRACT

This paper utilizes OECD's original PISA 2012 dataset to investigate the impact of access to ICT, student background and school/home environment on academic performance of students. Using cross-section data from 4848 15-year-old students in Turkey, ordered logit models are developed and analyzed. The results indicate that (i) availability of internet connection at home or school and student's possession of his/her own room at home have positive impacts on academic success, (ii) internet connection at schools may not be used for school-related activities and therefore distracts student's attention from schoolwork, (iii) as student-per-teacher ratio or school size increases, the academic success of students declines, (iv) pre-primary education and education in student's native language contribute to academic achievement, (v) there is a positive relationship between education level of parents and student's performance at school. Using additional data from 22,273 students, the paper also presents an international analysis that compares the results from Turkey with those from Germany, France and the United Kingdom. Finally, the urgent need for collection of micro level (at student, school or parent level) data on Turkish education system is underlined.

1. Introduction

The results of the Programme for International Student Assessment (PISA), conducted in 2012 by the Organisation for Economic Co-operation and Development (OECD), led to a public outcry in Turkey as the students in Turkey got the third-lowest test scores[3] among OECD countries in all three test subjects, namely mathematics, science and reading. So, an intense public debate on the quality of education system in Turkey has begun. PISA made headlines on the front pages of all leading Turkish newspapers for several weeks. For example, on December 3, 2013, Hurriyet (2013) titled "Turkey Failed Again in OECD's PISA 2012 Report". Consequently, "PISA" is now a catch-phrase, known by many citizens in Turkey, for the poor state of the Turkish education system. While this coverage proves the immense public interest, the quality of much of the underlying analysis is less clear. Often, public assessments tend to simply repeat long-held believes, rather than being based on data produced by the PISA 2012 study.

Today, it is commonsense that better school performance provides students greater opportunities to succeed in their subsequent life. Individuals who succeed in school have strong advantages in occupational placement and earnings attainment (Ganzeboom, Treiman, & Ultee, 1991; Kerckhoff, 1995). In this context, there is considerable debate regarding *how academic performance at school can be*

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[3] The test scores of students in Turkey were higher than Chile and Mexico only.

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enhanced. Do student background, school and home environment produce improvements in student performance? Are not access to information and communication technologies (ICT) critical to promoting student success?

The theory and the previous literature covered in Section 2 suggest that student background, school and home environment and access to ICT are among important sets of determinants of educational performance. In the paper, PISA 2012 dataset is used to test the robustness of the findings of previous studies in Turkish context by constructing and estimating an education production function for Turkey. The paper focuses on the relationship between academic success **and** student background, school/home environment and access to ICT. It also compares the results from Turkey with those from Germany, France and the United Kingdom in order not only to put the results from Turkey into an international context but also to attract more interest from the international research community.

The contribution of this paper to the current literature is threefold. As in the case of most countries, the primary objective of education policy in the Republic of Turkey is to increase the amount of student learning that results from the 13.5% of central government budget (63.5 billion TL) allocated to education (GDBFC, 2013). However, at the moment, reliable information and research about to what extent this spending is translated into improved student learning is extremely limited and, therefore, the benefits obtained from this enormous outlay of public resources remain elusive. Therefore, first of all, this paper attempts to shed a light on this question. So, it is an important contribution to the remarkably narrow literature that focuses on the factors related to academic performance of students in Turkey. Second, this is among the very first studies that exploit OECD's fresh PISA 2012 dataset. Finally, this paper is one of the few studies to use ordered logit regression methods to estimate the impacts of student background, school and home environment and access to ICT on student performance.

The paper tries to answer the following research questions: (i) what is the relationship between student background and academic success in Turkey? (ii) how do school characteristics affect the educational success of students in Turkey? (iii) what are the effects of home/family environment on student achievement in Turkey? (iv) is students' internet use at home and school in Turkey related to their performance at school?

The remainder of the paper is structured as follows. The second section presents a literature review of empirical studies investigating the factors related to academic performance of students, and develops the hypotheses to be tested in the study in order to answer research questions above. In the third section, methodology and data are explained. The following section presents empirical analysis. Section 5 discusses the results and their policy implications. The next section provides an international analysis that compares the results from Turkey with those from Germany, France and United Kingdom. The final section concludes.

2. Literature review and research hypotheses

The objective of educational institutions is to increase the level of academic success which itself is an indicator of the actualization of educational goals. A vast literature has focused on examining the linkages between educational inputs (i.e., per pupil expenditures, pupil-teacher ratio and so on) and educational outputs (e.g. student achievement or future labor market wages). These individual studies often differ in their findings, depending on the assumptions of the model and the choice of inputs. A summary of previous econometric studies is systematically presented in Appendix 1, clearly indicating hypotheses tested or research questions, dependent variables, explanatory variables, main results, data and methodology. The studies presenting an anecdotal discussion without any applied analysis are outside the scope of the literature review in this section.

As done in this study, the factors considered in the literature as having an impact on the academic performance of students may be divided into four, namely student characteristics, home/family background, school resources and access to ICT. Ammermueller (2007), Bahar (2010), Castillo-Merino and Serradell-López (2014), Darolia (2014), Erten and Burden (2014), Freitas and Leonard (2011), Goulart and Bedi (2008), Mostafa (2010), Perl (1973) and Rangvid (2007) focus on the impact of student characteristics on academic performance while the effect of home/family background on school success is investigated by Carneiro (2008), Chiu (2010), Chiu and Khoo (2005), Cyrenne and Chan (2012), Gevrek and Gevrek (2010), Houtenville and Conway (2008), Lindahl (2011), Marks (2008), Mertoğlu and Aydın (2012), Mostafa (2010), Pong (1997), Rangvid (2007) and Toby and Dufur (2001).

The impact of school resources on student achievement constitutes another topic extensively studied in the literature. The examples include Ammermueller (2007), Calcagno, Bailey, Jenkins, Kienzl, and Leinbach (2008), Chiu (2010), Chiu and Khoo (2005), Collier and Millimet (2009), Cyrenne and Chan (2012), Erten and Burden (2014), Fuchs and Wößmann (2007), Graddy and Stevens (2005), Hanushek (1997), Ludwig and Bassi (1999), Mostafa (2010), Perl (1973), Pong (1997), Rangvid (2007) and Toby and Dufur (2001). However, these studies by no means constitute an exhaustive list of the literature. Hanushek (1997) reviews about 400 studies of student achievement and concludes that there is not a strong or consistent relationship between student performance and school resources, at least after variations in family inputs are taken into account. His results underline that simple resource policies alone hold little hope for improving student outcomes. The impact of access to ICT on education output is probably the least explored aspect of student performance. The paper by Wittwer and Senkbeil (2008) is a prominent study in this area.

The literature above implies that academic success of students, measured usually by grade point average (GPA) or various test scores, is correlated with individual characteristics and their backgrounds (Betts & Morell, 1999; Irandoust & Karlsson, 2002). In this paper, the validity of this finding in Turkish context is tested within the framework of PISA 2012 dataset. So, the following hypothesis is derived as a direct parallel with the empirical findings reported in the literature.

Hypothesis 1: *Students' academic performance at school is affected by their personal characteristics and background.*

Since the landmark 1966 Coleman Report in USA, which found evidence that poor black children did perform better in integrated middle-class schools, researchers from a number of disciplines have sought empirical evidence of which school inputs influence student achievement. This literature initiated a debate around whether financial resources influence student achievement. In an influential series of papers, Hanushek (1986, 1989, 1996a, 1996b, 1997, 1998) reviewed the many studies of the impact of school resources (particularly class size or pupil-teacher ratio) on student achievement in U.S. schools and concluded that there is no strong or consistent relationship between school inputs and student performance. However, Hedges and Greenwald (1996) and Krueger (1999) find positive correlation between

school resources and academic success (Houtenville & Conway, 2008). To find out the impact of school characteristics on student performance in Turkish context, the hypothesis below is formulated.

Hypothesis 2: *School characteristics have a statistically significant impact on educational success of students in Turkey.*

The Coleman Report also underlined family background as a vital component of educational production. As data sources become richer, the education production function has been improved by including a set of family variables such as parental education, job status and income. However, the literature on the relative importance of mother's and father's socioeconomic characteristics has been inconclusive. For the United States, Kalmijn (1994) concluded that mother's education was as important as father's education. In their three country study, Korupp, Ganzeboom, and Van Der Lippe (2002) did not conclude that one parent's characteristics were more important than the other. On the other hand, for Australia, Crook (1995) found stronger effects for mother's education than for father's education but stronger effects of father's occupational status (Marks, 2008). One of the purposes of this paper is to explore the influence of home/family environment on student performance. The hypothesis below is therefore relevant to the study.

Hypothesis 3: *Home/family background has an impact on student achievement in Turkey.*

Decades of research have scrutinized the advantages and disadvantages of computer-based technology for students' academic success (e.g. Roschelle, Pea, Hoadley, Gordon, and Means (2000)). Recently, research has begun to particularly focus on the impact of students' computer and/or internet use at home and school on their performance at school. The main question asked in the literature is whether those students who do not have a computer/internet at home/school or only rarely use a computer/internet might be disadvantaged at school. For instance, Attewell and Battle (1999) investigated the relationship between the availability of a computer at home and students' performance in reading; and found that the access to a home computer was associated with higher performance scores even after accounting for students' socio-economic status and ethnic classification. Likewise, Papanastasiou, Zembylas, and Vrasidas (2003) found that students achieved higher scores in scientific literacy the more often they used a computer at home. Also, the paper by Nævdal (2007) links the frequency of using a computer at home with students' achievement in reading. In general, the findings in the previous literature suggest that having a computer/internet at home/school and using it frequently are obviously associated with better performance at school. However, in order to examine the effectiveness of students' computer/internet use, it is essential to consider its influence on their academic achievement in relation to other determinants of school performance. Otherwise, the relevance of students' computer use at home for their academic achievement might be overestimated (Wittwer & Senkbeil, 2008). These considerations lead us to include the following hypothesis among the hypotheses.

Table 1
Descriptive statistics of the variables.

Variables	Obs.	Mean	Std. dev.	Min	Max
Dependent variables					
- Test score category in Reading	4848	1.750	0.835	1	5
- Test score category in Science	4848	1.726	0.895	1	5
- Test score category in Mathematics	4848	1.909	0.992	1	5
Explanatory variables					
Student background					
- Pre-primary school attendance	4821	1.380	0.636	1	3
- Grade that student is in	4848	9.721	0.606	7	12
- Gender (dummy: 1 = female, 0 = male)	4848	0.489	0.500	0	1
School characteristics					
- Number of students per teacher	4708	17.917	8.359	2.6	47.9
- Number of students per computers with internet	4329	52.599	88.773	3.8	785.0
- School size (number of students in school)	4783	841.693	602.745	2	2829
- School type (dummy: 1 = private, 0 = public)	4841	0.012	0.110	0	1
- School location	4848	3.675	1.040	1	5
Home/family environment					
- Possession of own room (dummy: 1 = yes, 0 = no)	4735	0.688	0.463	0	1
- Mother's current job status	4498	1.260	0.652	1	3
- Language spoken at home (dummy: 1 = not Turkish, 0 = Turkish)	4793	0.064	0.244	0	1
- Father's current job status	4545	2.306	0.889	1	3
- Mother's education	4626	2.593	1.282	1	6
- Father's education	4661	3.198	1.370	1	6
Access to ICT					
- Browsing the internet for schoolwork outside of school	4689	2.570	1.156	1	5
- Browsing the internet for schoolwork at school	4670	1.969	1.172	1	5
- Internet connection at school (dummy: 1 = yes, 0 = no)	4763	0.410	0.492	0	1
- Internet connection at home (dummy: 1 = yes, 0 = no)	4739	0.545	0.498	0	1

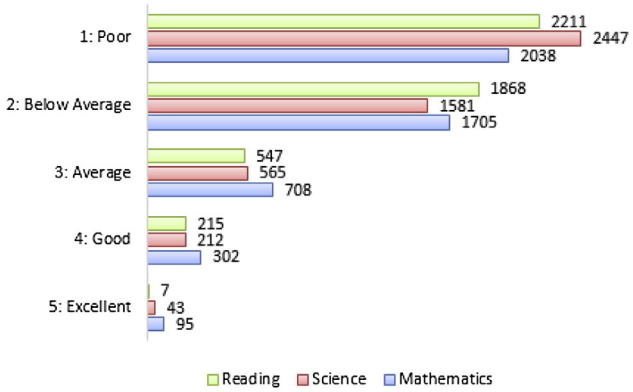


Fig. 1. Number of students in each score category by subject.

Hypothesis 4: *Students' internet use at home and school in Turkey is correlated with their performance at school.*

3. Data and methodology

The Programme for International Student Assessment (PISA) is a triennial international survey which aims to evaluate education systems worldwide by testing the skills and knowledge of 15-year-old students. Since the year 2000, every three years, 15-year-old students from randomly selected schools worldwide have taken the tests; and the results from PISA surveys have provided the basic data for many professional and academic studies, such as Gil-Flores, Torres-Gordillo, and Perera-Rodriguez (2012), Lee and Wu (2013), Luu and Freeman (2011), Tomte and Hatlevik (2011), Wittwer and Senkbeil (2008) and Zhong (2011).

PISA 2012 is the program's 5th survey. It assessed the competencies of 15-year-olds in reading, mathematics and science in 65 countries and economies. Around 510,000 students between the ages of 15 years 3 months and 16 years 2 months participated in the assessment, representing about 28 million 15-year-olds globally. The students took a paper-based test that lasted 2 h. The tests were a mixture of open-ended and multiple-choice questions that were organized in groups based on a passage setting out a real-life situation. A total of about 390 min of test items were covered. Students took different combinations of different tests. Students and school principals also answered questionnaires to provide information about the students' backgrounds, schools and learning experiences and about the broader school system and learning environment. The data used in this paper come from PISA 2012 dataset, the further details of which is available from OECD (2013). Table 1 shows descriptive statistics of the variables.

As shown in Table 1, 21 variables are used in the study. Out of 21 variables, 3 of them are used as dependent variables and the remaining 18 as explanatory variables representing student background (3 variables), school characteristics (5 variables), home/family environment (6 variables) and access to ICT (4 variables). The total number of maximum observations for each variable is 4848 but, because of missing observations, some variables have less than 4848 observations.

The test scores of students in Turkey for mathematics, science and reading are not directly available from PISA 2012 dataset, which reports three possible results for each question asked in the test as “full credit”, “partial credit” and “no credit or missing”. In order to calculate a test score for each student and for each subject, 1 point for “full credit”, 0.5 point for “partial credit” and 0 point for “no credit or missing” is assigned. Having calculated total scores with this method, five test score categories are created for each subject as follows; 5: excellent (scores above 28), 4: good (scores between 21 and 28), 3: average (scores between 14 and 21), 2: below average (scores between 7 and 14) and 1: poor (scores below 7). Fig. 1 presents the number of student in each score category by subject.

In the analysis, the student background is represented by three variables, namely pre-primary school attendance, grade that student is in and gender of the student. The variable “pre-primary school attendance” takes the value of 3 if the student attended pre-primary education for more than a year, 2 if one year or less and 0 if not attended at all. Moreover, in the paper, the school characteristics are embodied in five variables; that is, number of students per teacher, number of students per computers with internet, school size (number of students in school), school type (public or private) and school location. The variable “school location” takes the value of 1 if the school is located at a village, hamlet or rural area (fewer than 3000 people); 2 if a small town (3000 to about 15,000 people); 3 if a town (15,000 to about 100,000 people); 4 if a city (100,000 to about 1,000,000 people) and 5 if a large city (with over 1,000,000 people). Since using logarithms of variables enables us to interpret coefficients easily and is an effective way of shrinking the distance between values; number of students per teacher, number of students per computers with internet and school size (number of students in school) variables are transformed into logarithmic form and these transformed variables are used in the models.

In the analysis, whether the student has his/her own room at home, mother's and father's job status and education level and the language spoken at home constitute a set variables used as a proxy for home and family environment of the student. Job status variables take the value of 1 if mother or father does not work; 2 if they work part-time and 3 if they work full-time. The variables representing mother's and father's education level take the value of 1 if they did not complete primary education; 2 if they completed primary education (ISCED[4] Level 1); 3 if they completed lower secondary education (ISCED Level 2); 4 if they completed upper secondary education programs not designed to lead

[4] International Standard Classification of Education.

to the first stage of tertiary education (ISCED Level 3B, 3C); 5 if they completed upper secondary education programs designed to provide direct access to the first stage of tertiary education (ISCED level 3A) and 6 if they hold a bachelor's or equivalent degree.

Finally, availability of internet connection at home and at school and the frequency of browsing the internet for schoolwork both outside of school and at school are variables that signify the student's access to ICT facilities. The variables "browsing the internet for schoolwork" take the value of 1 if the student browses the internet for schoolwork never or hardly ever; 2 if once or twice a month; 3 if once or twice a week; 4 if almost every day and 5 if every day.

Having discussed the dataset utilized in the paper, let me focus on the methodology used to analyze it. In this study, the educational system is viewed as a production process. The outputs of that process are test scores, which are assumed to measure the student's level of academic achievement. The inputs include measures of the student's background, school characteristics, home/family environment and the student's access to ICT facilities.

Actually, in the literature, there are two types of education production function (EPF), namely time or value-added EPFs and linear additive EPFs. The first one relates the variations in inputs over a period of time to variations in outputs over the same period. They can be written as follows:

$$y_{it} - y_{it^*} = f\left(P_i^{t-t^*}, S_i^{t-t^*}, F_i^{t-t^*}, I_i^{t-t^*}\right) + (\varepsilon_{it} - \varepsilon_{it^*}) \tag{1}$$

where y is test score of student i at two different time periods t and t^*. P, S, F and I are vectors of student background, school characteristics, home/family environment and access to ICT, respectively, taken at the same periods. However, PISA 2012 dataset does not allow for the estimation of time or value EPF since data are collected only over a single period of time. What is needed is to relate variations in inputs to variations in outputs. Multilevel regressions allow for this type of estimation. A linear additive EPF can be written as follows:

$$y_i = f(P_i, S_i, F_i, I_i) + \varepsilon_{ij} \tag{2}$$

where y_i is test score of student i, P_i, S_i, F_i and I_i are student, school, home/family and access to ICT characteristics of student i, respectively. This formulation eliminates the need for historical information and has the advantage of being adapted to international databases, such as PISA 2012.

The two formulations above are quite different in their conceptual frameworks. The first one analyses the change in student performances over time, while the second analyses the variations in students' performances during one period (Mostafa, 2010). Since this paper analyses the differences among students' performances, the second formulation is more suitable for the purposes of this paper. So, a linear additive functional relationship is postulated between the inputs and each measure of output and multiple regression analysis is used to estimate the parameters of these functions.

The dependent variables in the models are categorical and ordered, called "ordinal variables". The models in this paper cannot be consistently estimated using ordinary least squares; they are usually estimated using maximum likelihood. Ordered logit models are used to estimate relationships between an ordinal dependent variable and a set of independent variables.

In ordered logit models, an underlying score is estimated as a linear function of the independent variables and a set of cut-points. The probability of observing outcome i corresponds to the probability that the estimated linear function, plus random error, is within the range of the cut-points estimated for the outcome:

$$\Pr(outcome_j = i) = Pr\left(K_{i-1} < \beta_1 X_{1j} + \beta_2 X_{2j} + \cdots + \beta_k X_{kj} + u_j \le K_i\right) \tag{3}$$

u_j is assumed to be logistically distributed in ordered logit. In either case, the coefficients β_1, β_2, …, β_k are estimated together with the cut-points K_1, K_2, …, K_{n-1}, where n is the number of possible outcomes. More specifically, the probability of a given observation for ordered logit is given by.

$$\begin{aligned} p_{ij} &= \Pr\left(y_j = i\right) = Pr(K_{i-1} < x_j\beta + u \le K_i) \\ &= \frac{1}{1+\exp(-K_i + x_j\beta)} - \frac{1}{1+\exp(-K_{i-1} + x_j\beta)} \end{aligned} \tag{4}$$

where Category $i = 1$ is defined as the minimum value of the variable, $i = 2$ as the next ordered value, and so on, for the empirically determined n categories. K_0 is defined as $-\infty$ and K_n as $+\infty$. The log likelihood is given by

$$\ln L = \sum_{j=1}^{N} w_j \sum_{i=1}^{k} I_i(y_i) \ln p_{ij} \tag{5}$$

where w_j is an optional weight and

$$I_i\left(y_j\right) = \begin{cases} 1, & if\ y_j = i \\ 0, & otherwise \end{cases} \tag{6}$$

Because of the restrictions on the length of the paper and the fact that it is not one of the aims of this paper, further details of ordered logit models are not presented here but available from Wooldridge (2010).

An educational production function is to be estimated at student, school and home/family levels, in which the output, as measured by the pupils' performance in PISA 2012 tests, is determined by the resource inputs of the student, school and home/family. Actually, if student background, school characteristics, home/family environment or access to ICT variables had been used alone as explanatory variables; since the student performance would also depend on other variables which cannot be controlled but may be associated with the variation in inputs, a potential endogeneity problem may be present in the analysis. To address this potential endogeneity problem (which is one of the most demanding challenges in this kind of study), student background, school characteristics, home/family environment or access to ICT

variables together are included into the models so that the results are conditioned on a comprehensive set of variables, which are available in PISA 2012 dataset.

4. Empirical analysis

As mentioned before, throughout the analysis, test scores of 15-year-old students in Turkey are explained as a function of four sets of variables representing (i) student background, (ii) school characteristics, (iii) home/family environment and (iv) access to ICT. The analysis starts with estimation of three ordered logit models – one for each subject. Table 2 presents estimation results; including predictor and response variables, coefficients that are significant at 1%, 5% or 10% level, standard errors (shown in parentheses after coefficients), cut-points, log likelihood, number of observations, LR chi2(18), Prob > chi2, Pseudo R^2. Let me focus on each of these indicators one by one.

Coefficients shown in Table 2 are the ordered log-odds (logit) regression coefficients that are significant at 1%, 5% or 10% level. Standard interpretation of the ordered logit coefficient is that for a one unit increase in the predictor, the response variable level is expected to change by its respective regression coefficient in the ordered log-odds scale while the other variables in the model are held constant. For instance, in Model 1, the coefficient for the variables representing pre-primary school attendance is 0.191, which is significant at 1% level. Actually, this is the ordered log-odds estimate for a one unit increase in "pre-primary school attendance" variable on the expected mathematics test score

Table 2
Ordered logit estimation results.

Explanatory variables	Dependent variables		
	Test score category in mathematics (Model 1)	Test score category in science (Model 2)	Test score category in reading (Model 3)
Student background			
- Pre-primary school attendance	0.191*** (0.055)	0.093* (0.055)	NS
- Grade that student is in	0.553*** (0.062)	0.369*** (0.061)	0.424*** (0.062)
- Gender (dummy: 1 = female, 0 = male)	−0.353*** (0.065)	NS	0.184*** (0.066)
School characteristics			
- Log of number of students per teacher	−0.25*** (0.083)	−0.181** (0.084)	NS
- Log of number of students per computers with internet	0.249*** (0.043)	0.091** (0.044)	NS
- Log of school size (number of students in school)	−0.312*** (0.066)	−0.181*** (0.067)	−0.159** (0.067)
- School type (dummy: 1 = private, 0 = public)	−0.516* (0.289)	NS	NS
- School location	NS	NS	NS
Home/family environment			
- Possession of own room (dummy: 1 = yes, 0 = no)	0.194** (0.076)	NS	NS
- Language spoken at home (dummy: 1 = not Turkish, 0 = Turkish)	−0.308* (0.177)	−0.486*** (0.18)	−0.32* (0.178)
- Mother's current job status	NS	NS	NS
- Father's current job status	0.076** (0.038)	NS	NS
- Mother's education	0.067** (0.032)	0.069** (0.033)	NS
- Father's education	0.172*** (0.029)	0.048* (0.029)	NS
Access to ICT			
- Browsing the internet for schoolwork outside of school	NS	NS	NS
- Browsing the internet for schoolwork at school	−0.054* (0.03)	−0.055* (0.031)	−0.083*** (0.031)
- Internet connection at school (dummy: 1 = yes, 0 = no)	NS	0.151** (0.069)	NS
- Internet connection at home (dummy: 1 = yes, 0 = no)	0.252*** (0.073)	NS	NS
Cut 1:	4.254 (0.692)	2.577 (0.691)	2.983 (0.69)
Cut 2:	5.957 (0.696)	4.168 (0.693)	4.894 (0.693)
Cut 3:	7.231 (0.698)	5.511 (0.696)	6.177 (0.696)
Cut 4:	8.735 (0.705)	7.24 (0.711)	9.897 (0.824)
Log likelihood:	−4340.041	−4028.2949	−3924.96
Number of observations:	3477	3477	3477
LR chi2(18):	489.37	159.62	136.63
Prob > chi2:	0.0000	0.0000	0.0000
Pseudo R^2:	0.0534	0.0194	0.0171

Coefficient that is significant at ***1% level, **5% level, *10% level.
NS: not significant
Standard errors are shown in parentheses () with coefficients.

category level given the other variables are held constant in the model. That is, if a student's "pre-primary school attendance" condition were to increase by one point, his ordered log-odds of being in a higher mathematics test score category would increase by 0.191 while the other variables in the model are held constant.

Cut-points are estimated points on the latent variable used to differentiate test score categories when values of the predictor variables are evaluated at zero. For instance, the first cut-point in Model 2 is 2.577. This is the estimated first cut-point on the latent variable used to differentiate "poor" test score category in science from other categories (excellent, good, average and below average) when values of the predictor variables are evaluated at zero. Student test scores that had a value of 2.577 or less on the underlying latent variable that gave rise to the science test score category variable would be classified as "poor" when values of the predictor variables are evaluated at zero.

Log likelihood is the log likelihood of the fitted model. It is used in the Likelihood Ratio Chi-Square test of whether all predictors' regression coefficients in the model are simultaneously zero and in tests of nested models. **Number of observations** is the number of observations used in the ordered logistic regression. It is less than the number of cases in the dataset because there are missing values for some variables in the equation. By default, Stata does a listwise deletion of incomplete cases. **LR chi2(18)** is the Likelihood Ratio (LR) Chi-Square test that at least one of the predictors' regression coefficient is not equal to zero in the model. The number in the parenthesis indicates the degrees of freedom of the Chi-Square distribution used to test the LR Chi-Square statistic and is defined by the number of predictors in the model. **Prob > chi2** is the probability of getting an LR test statistic as extreme as, or more so, than the observed under the null hypothesis that all of the regression coefficients in the model are equal to zero. In other words, this is the probability of obtaining this chi-square statistic if there is in fact no effect of the predictor variables. This *p*-value is compared to a specified alpha level, the willingness to accept a Type I error, which is typically set at 0.05 or 0.01. The small *p*-value from the LR test, <0.00001, would lead us to conclude that at least one of the regression coefficients in the model is not equal to zero. Finally, Pseudo R^2 is McFadden's pseudo *R*-squared. Logistic regression does not have an equivalent to the *R*-squared that is found in OLS regression (the proportion of variance for the response variable explained by the predictors), and therefore this statistic should be interpreted with great caution.

Table 3
The marginal effects evaluated at the mean for the "excellent" test score category.

Explanatory variables	Dependent variables		
	Test score category in mathematics (Model 1)	Test score category in science (Model 2)	Test score category in reading (Model 3)
Student background			
- Pre-primary school attendance	0.0038*** (0.0011)	NS	NS
- Grade that student is in	0.0109*** (0.0016)	0.0038*** (0.0009)	0.0006** (0.0003)
- Gender (dummy: 1 = female, 0 = male)	−0.007*** (0.0015)	NS	0.0002* (0.0001)
School characteristics			
- Log of number of students per teacher	−0.0049*** (0.0017)	−0.0019** (0.0009)	NS
- Log of number of students per computers with internet	0.0049*** (0.001)	0.0009** (0.0005)	NS
- Log of school size (number of students in school)	−0.0061*** (0.0014)	−0.0019** (0.0008)	NS
- School type (dummy: 1 = private, 0 = public)	−0.0081** (0.0036)	NS	NS
- School location	NS	NS	NS
Home/family environment			
- Possession of own room (dummy: 1 = yes, 0 = no)	0.0037** (0.0014)	NS	NS
- Language spoken at home (dummy: 1 = not Turkish, 0 = Turkish)	−0.0053* (0.0027)	−0.0041*** (0.0014)	NS
- Mother's current job status	NS	NS	NS
- Father's current job status	0.0015** (0.0008)	NS	NS
- Mother's education	0.0013** (0.0007)	0.0007** (0.0004)	NS
- Father's education	0.0034*** (0.0007)	NS	NS
Access to ICT			
- Browsing the internet for schoolwork outside of school	NS	NS	NS
- Browsing the internet for schoolwork at school	−0.0011* (0.0006)	−0.0006* (0.0003)	−0.0001* (0.0001)
- Internet connection at school (dummy: 1 = yes, 0 = no)	NS	0.0016** (0.0008)	NS
- Internet connection at home (dummy: 1 = yes, 0 = no)	0.0049*** (0.0015)	NS	NS

Coefficient that is significant at ***1% level, **5% level, *10% level.
NS: not significant.
Standard errors are shown in parentheses () with coefficients.

Table 4
The marginal effects evaluated at the mean for the "poor" test score category.

Explanatory variables	Dependent variables		
	Test score category in mathematics (Model 1)	Test score category in science (Model 2)	Test score category in reading (Model 3)
Student background			
- Pre-primary school attendance	−0.0439*** (0.0126)	−0.0232* (0.0138)	NS
- Grade that student is in	−0.1267*** (0.0143)	−0.0919*** (0.0153)	−0.1035*** (0.015)
- Gender (dummy: 1 = female, 0 = male)	0.0808*** (0.0149)	NS	−0.045*** (0.016)
School characteristics			
- Log of number of students per teacher	0.0574*** (0.0189)	0.0452** (0.0208)	NS
- Log of number of students per computers with internet	−0.057*** (0.0099)	−0.0228** (0.0109)	NS
- Log of school size (number of students in school)	0.0715*** (0.0152)	0.0451*** (0.0168)	0.0387** (0.0164)
- School type (dummy: 1 = private, 0 = public)	0.1247* (0.072)	NS	NS
- School location	NS	NS	NS
Home/family environment			
- Possession of own room (dummy: 1 = yes, 0 = no)	−0.045** (0.0178)	NS	NS
- Language spoken at home (dummy: 1 = not Turkish, 0 = Turkish)	0.0731* (0.0431)	0.1206*** (0.0436)	0.0793* (0.0444)
- Mother's current job status	NS	NS	NS
- Father's current job status	−0.0175** (0.0087)	NS	NS
- Mother's education	−0.0154** (0.0074)	−0.0171** (0.0081)	NS
- Father's education	−0.0394*** (0.0066)	−0.012* (0.0073)	NS
Access to ICT			
- Browsing the internet for schoolwork outside of school	NS	NS	NS
- Browsing the internet for schoolwork at school	0.0124* (0.0068)	0.0137* (0.0077)	0.0203*** (0.0075)
- Internet connection at school (dummy: 1 = yes, 0 = no)	NS	−0.0377** (0.0173)	NS
- Internet connection at home (dummy: 1 = yes, 0 = no)	−0.058*** (0.0168)	NS	NS

Coefficient that is significant at ***1% level, **5% level, *10% level.
NS: not significant.
Standard errors are shown in parentheses () with coefficients.

For linear models (e.g. OLS), model interpretation is relatively easily since the effects are linear. For non-linear models (e.g. ordered logit), the interpretation of the results can be tricky. For ordered logit models, the interpretation of individual coefficients does not have the simple linear relationship. The coefficient in an ordered logit regression can only be interpreted as the ordered logit coefficient. If the model is to be interpreted in terms of predicted probability, the effect of a change in a variable depends on the values of all variables in the model, or to put it differently, it depends on where the effect is evaluated. Stata ("mfx" command) can numerically calculate the marginal effects and their standard errors. By default, Stata calculates the marginal effects at the means of the independent variables. Tables 3 and 4 present the marginal effects evaluated at the mean for two extreme test score categories, namely "excellent" and "poor" respectively.

5. Discussion of the results

The empirical results presented above are consistent with the hypotheses. So, one fails to reject the hypotheses. Reviewing the findings in more detail and in relation to the research hypotheses, it is found that students' academic performance at school is affected by their personal characteristics and background (Hypothesis 1). The results also reveal that school characteristics have a statistically significant impact on educational success of students in Turkey (Hypothesis 2). Moreover, the findings imply that home/family background has an impact on student achievement (Hypothesis 3). Finally, based on the results from the analysis, it may be concluded that students' internet use at home and school is correlated with their performance at school. The interpretation of the results in detail and their policy implications are provided in three sub-sections below. In the first subsection, the results from the estimation of three ordered logit models (see Table 2) are discussed in detail. In the next sub-section, the paper focuses on the factors that have an impact on whether a student gets "excellent" (see Table 3) or "poor" (see Table 4) test scores in Turkey. In the final sub-section, the policy implications of the results are discussed.

5.1. Results from ordered logit models in detail

A closer look at the results reveals that students' academic performance is affected by their personal characteristics and background. Pre-primary education clearly contributes to student's being in a higher test score category in mathematics and science. As expected, grade that student is in is positively correlated with test score category in all three subjects, meaning that 15-year-old students in higher grades get higher test scores in all subjects. Furthermore, gender is seen as an important determinant of academic performance but its impact differs based on the subject. In mathematics, male students seem to be more successful while females perform better in reading. The fact that female and male students have dissimilar academic interests and expectations may have been influential in this finding.

The results also imply that school characteristics have a statistically significant impact on educational success of students in Turkey. Unsurprisingly, a negative relationship is detected between number of students per teacher and test score categories in mathematics and science. That is, as the number of students per teacher increases in a school, the academic success of students declines in mathematics and science in that school. Parallel to this finding, a negative association is detected between academic performance and school size. To be precise, the students in overcrowded schools perform worse than those in lightly populated ones. Surprisingly, number of students per computers with internet connection at school and test score categories in mathematics and science seem to be positively correlated. This unexpected result may be an indication that internet connection at schools is not used for school-related activities and therefore distracts student's attention from schoolwork, let alone improving it. Furthermore, the results from the analysis indicate that school type (private or public) and school location are not among predictors of academic success with the only exception that students in private schools perform worse than those in public ones in mathematics.

The findings identify home environment and family background as important factors in student achievement in Turkey. Possession of his/her own room contributes to student's success in mathematics. Besides, the results show that language spoken at home, representing most probably student's native language, and academic success in all subject groups are strongly correlated, underlining the fact that the education in student's native language deeply supports his/her academic achievement. Moreover, a positive relation is detected by the findings between education level of both mother and father and student's performance at school. However, a positive or negative relationship cannot be identified between the employment status of parents and the test score category that student is in, the only exception of which is the positive correlation between father's job status and student's performance in mathematics.

Finally, the results suggest that students' internet use at home and school in Turkey is correlated with their performance at school. The findings indicate that internet connection at home has a positive impact on student's success in mathematics while access to internet at school improves student's test score in science. A statistically significant relationship between browsing the internet for schoolwork outside of school and academic success cannot be detected. However, unpredictably, the results indicate a negative relationship between browsing the internet for schoolwork at school and test score performance of students, meaning that test scores of students decline in all three subject categories as they browse the internet more frequently for schoolwork at school. This result makes us question again whether the internet is really used for academic purposes at schools in Turkey.

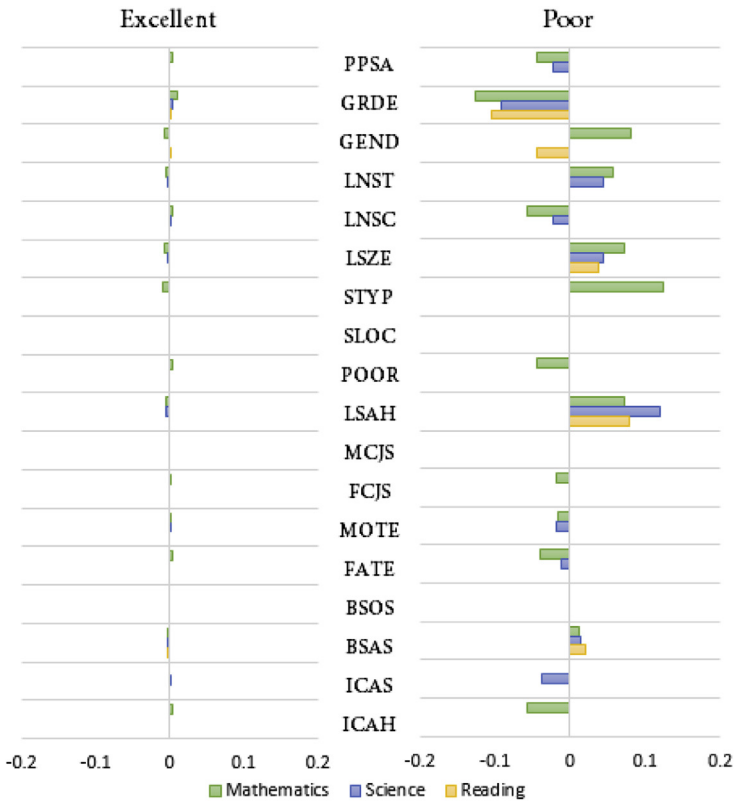
5.2. Determinants of excellent and poor test scores

As mentioned before, the interpretation of the results from ordered logit models can be difficult as individual coefficients do not have simple linear relationship. Although the signs of the coefficients give us an idea about the direction of the relationship between dependent variables and explanatory variables, the estimated coefficients in Table 2 do not say anything about the magnitude of the impact of explanatory variables on dependent variables. To interpret the models in a more meaningful way and be able to comment on magnitude of the impacts, the marginal effects evaluated at the mean for two extreme test score categories, namely “excellent” and “poor”, are presented in Tables 3 and 4. Fig. 2 provides a visual plot of the data presented in Tables 3 and 4. Any positive value for a specific variable in Fig. 2 indicates that this variable contributes to student's being in this specific category while a negative one signifies that this variable pushes student away from the category towards other categories. For instance, in Fig. 2, gender (being female) dummy variable has a value of −0.007 for mathematics “excellent” test score category. Since this is a negative value, it indicates that gender (being female) pushes a student away from being in “excellent” test score category. Similarly, language spoken at home (not speaking Turkish at home) dummy variable has a value of 0.1206 for science “poor” test score category. Since this is a positive value, it may be concluded that language spoken at home (not speaking Turkish at home) pushes a student towards being in “poor” test score category. The magnitude of the impacts is shown by the length of the bars in Fig. 2.

A closer look at “excellent” test score category in Fig. 2 reveals that most of the variables in the analysis have an impact on whether a student is in excellent test score category in mathematics and science. The variables usually do not tell us much about factors affecting whether a student is in excellent test score category in reading. This is probably due to the fact that there are only 7 students (out of 4848 students) in excellent test score category for reading, which is most likely not enough to get statistically significant results.

Based on the results, the factors that make a 15-year old student in Turkey more likely to get excellent test scores in **mathematics** may be listed in order of significance as follows: (i) being in a higher grade, (ii) attending a lightly populated public school where student per teacher ratio is low, (iii) being male, (iv) speaking Turkish as his/her native language, (v) having his/her own room and internet connection at home, (vi) having attended pre-primary education in the past, and (vii) having more educated parents. Similarly, the factors related to excellent test scores in **science** may be listed in order of importance as follows: (i) speaking Turkish as his/her native language, (ii) being in a higher grade, (iii) attending a lightly populated school where student per teacher ratio is low and internet connection is available, and (vii) having a more educated mother.

Fig. 2 shows three major common dynamics that make a 15-year old student in Turkey more likely to get poor test scores in all three subject categories; which are, in order of significance: (i) being in a lower grade, (ii) speaking a language other than Turkish as his/her native language, (iii) attending an overcrowded school. Besides, having not attended pre-primary school in the past, attending a school where student per teacher ratio is high and having less educated parents make a student more likely to get poor test scores in mathematics and science while these do not have an impact on reading test scores.



***PPSA**: Pre-primary school attendance; **GRDE**: Grade that student is in; **GEND**: Gender (dummy, 1=female); **LNST**: Log of num. of students per teacher; **LNSC**: Log of num. of students per computers with internet; **LSZE**: Log of school size (number of students in school); **STYP**: School type (dummy, 1=private); **SLOC**: School location; **POOR**: Possession of own room (dummy, 1=yes); **LSAH**: Language spoken at home (dummy, 1=not Turkish); **MCJS**: Mother's current job status; **FCJS**: Father's current job status; **MOTE**: Mother's education; **FATE**: Father's education; **BSOS**: Browsing for schoolwork outside of school; **BSAS**: Browsing for schoolwork at school; **ICAS**: Internet connection at school (dummy, 1=yes); **ICAH**: Internet connection at home (dummy, 1=yes)*

Fig. 2. Factors pushing a student towards or away from "excellent" and "poor" test score categories in Turkey.

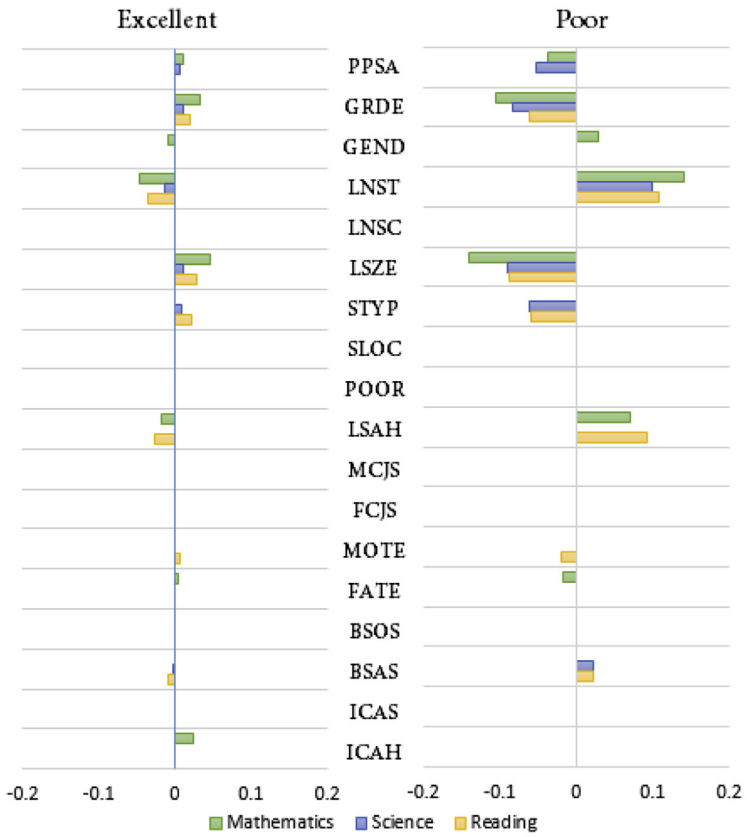
5.3. Policy repercussions

Without a doubt, a great number of guidelines can be produced for policymakers based on the analysis presented in this paper. However, due to space limitations, top eight most important policy repercussions are mentioned below.

Turkish education system can be seen as a huge production process. In 2013, approximately 33 billion USD[5] public funds (13.5% of central government budget or 63.5 billion TL) and some other private financial sources, 39,587 primary or secondary schools and 536,938 teachers are put into this production machine as inputs and it delivered primary or secondary education service to 10,589,533 students (GDBFC, 2013; TurkStat, 2013). However, surprisingly, academic research on input–output or cost–benefit analysis of this huge production process, how efficient this machine works and quality of education delivered by it is extremely limited. This situation may help some politicians or policymakers hide the inefficiencies in the current education system in Turkey; however, it definitely does not contribute to efforts to change the fact that Turkey always gets one of the lowest test scores among OECD countries in PISA studies. The main reason for non-existence of academic and professional research in this area is the lack of organized data at micro level (student, teacher, school or parent level). At present, apart from some limited data from international sources like PISA and TIMSS,[6] micro level data on Turkish education system is unavailable. There is an urgent need for collection of better data in terms of both quality (including more variables) and quantity (including more students). In order to measure and improve the efficiency of Turkish education system, **first** of all, micro level data should be regularly collected and made public by Turkish Statistical Institute and Ministry of National Education; and the funds should be provided to universities or other related public or private institutions that wish to do so.

The **second** policy repercussion of the results from this paper relates to importance of native language in the academic success of students. The findings clearly underline that language spoken at home, representing student's native language, and academic success in all subject categories are strongly correlated, meaning that the education in student's native language strongly supports his/her academic

[5] As of 1 July 2013, $1 = TL 1.9222.
[6] Trends in International Mathematics and Science Study.



***PPSA**: Pre-primary school attendance; **GRDE**: Grade that student is in; **GEND**: Gender (dummy, 1=female); **LNST**: Log of num. of students per teacher; **LNSC**: Log of num. of students per computers with internet; **LSZE**: Log of school size (number of students in school); **STYP**: School type (dummy, 1=private); **SLOC**: School location; **POOR**: Possession of own room (dummy, 1=yes); **LSAH**: Language spoken at home (dummy, 1=not German); **MCJS**: Mother's current job status; **FCJS**: Father's current job status; **MOTE**: Mother's education; **FATE**: Father's education; **BSOS**: Browsing for schoolwork outside of school; **BSAS**: Browsing for schoolwork at school; **ICAS**: Internet connection at school (dummy, 1=yes); **ICAH**: Internet connection at home (dummy, 1=yes)*

Fig. 3. Factors pushing a student towards or away from "excellent" and "poor" test score categories in Germany.

achievement. So, policymakers should take necessary measures to eliminate the hitches that result in academic failure of non-Turkish speaking students.

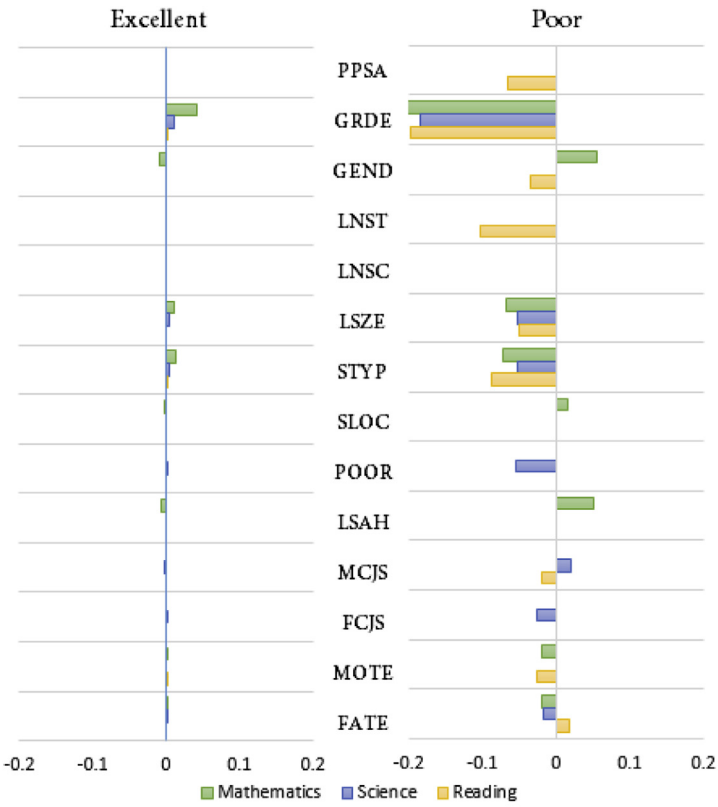
Third, it is found that as the number of students per teacher or total number of students in a school increases, the academic success of students declines. So, policymakers should develop policies to increase the number of both schools and teachers so that the students attend lightly populated schools with low student per teacher ratio. **Fourth**, in the analysis, male students seem to be more successful in mathematics while females perform better in reading. Although dissimilar academic interests and expectations may explain a part of this result, other reasons for relative failure of male students in reading and that of females in mathematics should be investigated.

The results put forward that pre-primary education noticeably contributes to student achievement. Hence, the **fifth** policy implication suggests that necessary measures should be taken not only to increase the availability of pre-primary education throughout the country but also to encourage parents to send their children to pre-primary educational institutions. When Turkish educational infrastructure is ready, the inclusion of pre-primary education into compulsory education period may be considered.

The **sixth** policy suggestion relates to internet connection and possessing own room. It is found that internet connection and student's possession of his/her own room at home have positive impacts on student's success in mathematics while access to internet at school improves student's test score in science. So, policies should aim at increasing internet connection availability. Besides, since allocating a separate room for each student at home is directly related to household income; people should be encouraged to have children in line with their income.

A positive relationship between education level of parents and student's performance at school is also detected. So, the **seventh** suggestion highlights the need for education of parents using distance education and lifelong learning techniques.

The **final** policy repercussion is about the unexpected results from this paper. Surprisingly, the findings suggest a positive correlation between number of students per computers with internet connection at school and student performance and a negative one between browsing the internet for schoolwork at school and academic achievement of students. These results make it questionable that the internet is really used for academic purposes at schools in Turkey; and be an indication that internet connection at schools is not used for school-related activities and therefore distracts student's attention from schoolwork, let alone improving it. Policymakers should find out whether internet is used for academic purposes at schools and take corrective action if this is not the case.



***PPSA**: Pre-primary school attendance; **GRDE**: Grade that student is in; **GEND**: Gender (dummy, 1=female); **LNST**: Log of num. of students per teacher; **LNSC**: Log of num. of students per computers with internet; **LSZE**: Log of school size (number of students in school); **STYP**: School type (dummy, 1=private); **SLOC**: School location; **POOR**: Possession of own room (dummy, 1=yes); **LSAH**: Language spoken at home (dummy, 1=not French); **MCJS**: Mother's current job status; **FCJS**: Father's current job status; **MOTE**: Mother's education; **FATE**: Father's education*

Fig. 4. Factors pushing a student towards or away from "excellent" and "poor" test score categories in France.

6. International comparative analysis

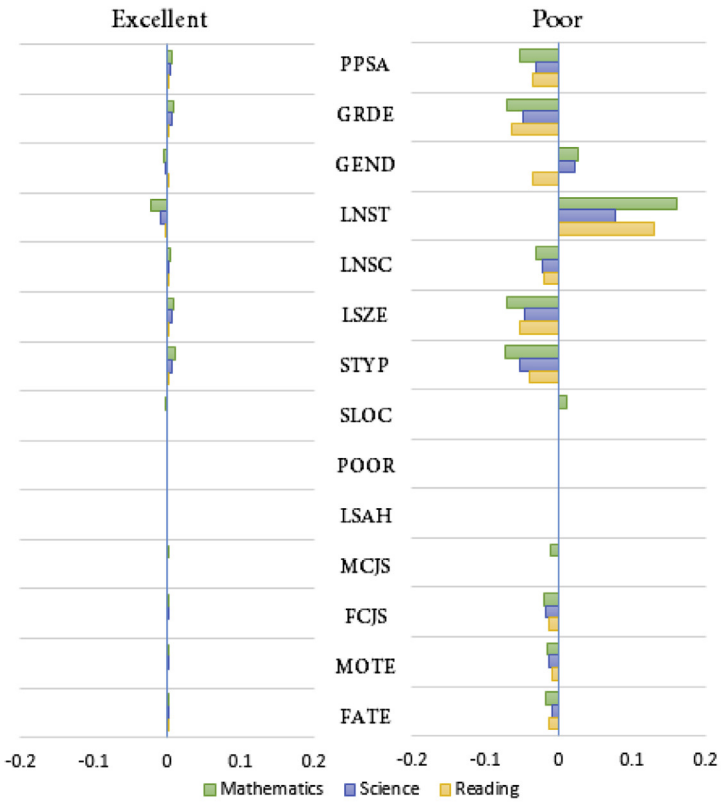
Having presented and discussed the results from Turkey, in this section, these results are compared with those from France, Germany and the United Kingdom with a view to widening the scope of the paper so that not only it attracts more interest from the international research community but also the results from Turkey are put into an international context. Turkey is a candidate country for European Union (EU) membership following the Helsinki European Council of December 1999. As of July 2014, Turkey has a population of around 81.6 million. Three most similar, in terms of population, EU member countries included in the PISA 2012 survey are selected to compare Turkish results with; namely Germany (80.9 million), France (66.3 million) and the United Kingdom (63.7 million) (CIA, 2014).

5001 Students from Germany, 4613 students from France and 12,659 students from the United Kingdom participated in the PISA 2012 survey. The same analysis applied to Turkey is repeated for Germany, France and the United Kingdom separately. As in the case of Turkey, throughout the analyses for Germany, France and the United Kingdom, test scores of 15-year-old students in these countries are explained as a function of four sets of variables representing (i) student background, (ii) school characteristics, (iii) home/family environment and (iv) access to ICT.[7] In each country, three ordered logit models, one for each subject, are estimated. Due to limitations on the length of the paper, details of the estimation results are not provided here but available from the authors upon request. Figs. 3–5 provide visual plots of the factors pushing a student towards or away from "excellent" and "poor" test score categories in Germany, France and the United Kingdom, respectively.

When the results from Turkey and Germany are compared (see Figs. 2 and 3), the direction of the effects of explanatory variables on the dependent variables is usually similar but their impact is stronger in Germany. Two main differences between Turkey and Germany relate to school size and school type (public *or* private). In Turkish case, the results imply that attending a *lightly* populated *public* school makes a student in Turkey more likely to get excellent test scores in **mathematics** and a *lightly* populated school also contributes to a student's success in **science**. On the other hand, in Germany, attending a *densely* populated *private* school makes a student more likely to get excellent test scores in **science** and **reading** and a *densely* populated school also contributes to a student's success in **mathematics**.

In the case of France, the direction of the effects of explanatory variables on the dependent variables is again mostly similar to those of Turkey (see Figs. 2 and 4). For a second time, the results from the variables relating to school size and school type (public *or* private) oppose

[7] Since ICT related variables are not available for France and the United Kingdom in the PISA 2012 dataset, these variables are removed from the models developed for France and the United Kingdom.



***PPSA**: Pre-primary school attendance; **GRDE**: Grade that student is in; **GEND**: Gender (dummy, 1=female); **LNST**: Log of num. of students per teacher; **LNSC**: Log of num. of students per computers with internet; **LSZE**: Log of school size (number of students in school); **STYP**: School type (dummy, 1=private); **SLOC**: School location; **POOR**: Possession of own room (dummy, 1=yes); **LSAH**: Language spoken at home (dummy, 1=not English); **MCJS**: Mother's current job status; **FCJS**: Father's current job status; **MOTE**: Mother's education; **FATE**: Father's education*

Fig. 5. Factors pushing a student towards or away from "excellent" and "poor" test score categories in the United Kingdom.

to those in Turkish case. In France, attending a *densely* populated *private* school makes a student more likely to get excellent test scores in all three subject categories.

For a third time, similar results are obtained from the comparison of Turkish results with those from the United Kingdom (see Figs. 2 and 5). Apart from the variables school size and school type (public *or* private), the findings from Turkey and the United Kingdom are more or less in the same direction. As in the cases of France and Germany and contrary to Turkish case, attending a *densely* populated *private* school makes a student more likely to get excellent test scores in all three subject categories in the United Kingdom.

To sum up, the comparison of the results from Turkey with Germany, France and the United Kingdom mostly verifies the findings of the paper. The main difference between Turkey on the one hand and Germany, France and the United Kingdom on the other concerns the impact of school size and school type (public *or* private) on student success. In Turkish case, students in *lightly* populated *public* schools seem to be more successful while in German, French and British cases, the students in *densely* populated *private* schools display higher levels of academic achievement.

7. Conclusion

This paper is one of the few that analyzed the output of Turkish education system and compared it with Germany, France and the United Kingdom. In the paper, the effects of student background, school and home environment and access to ICT on mathematics, science and reading test scores for 4848 15-year-old students in Turkey are investigated using OECD's original PISA 2012 dataset that has recently been released.

Although there is no reason to believe that limited nature of dataset used in this paper undermines the analyses and the results, it constitutes the most important potential limitation. There are about five million students at secondary education level in Turkey but PISA 2012 dataset contains observations from 4848 students only (less than 0.1% of total students). Besides, no education dataset can fully capture all of the factors that affect learning and PISA 2012 dataset is not an exception. So, in the analysis, a student's test score is also a function of omitted variables. These omitted variables may be student specific, such as ability and motivation, or related to home and school environment, such as financial sources available to parents and schools, the mental or emotional health of parents or teachers, teacher enthusiasm, or the quality of the parents' relationship. The direction of bias from unobserved variables could, in principle, be either positive or negative. For instance, unmeasured student ability may lead to an upward bias in estimates of test scores. Similarly, poorly measured or unmeasured aspects of family socioeconomic status or school resources may lead to a bias in the estimated effects (Ludwig & Bassi, 1999). In short, even after this study there is still a huge research gap in this important area, the filling of which requires many more studies with extended data and resources.

Appendix 1. Summary of previous econometric studies

Study	Hypothesis (H) or research questions (Q)	Dependent Variable(s)	Explanatory variable(s)	Result(s)	Data & methodology
Ammermueller (2007)	**Q**: What explains the large difference in the level and variance of student performance in the 2000 PISA study between Finland and Germany?	- Student performance	- Grade level dummies - Student's age in months - Student background - School resources - Institutional variables - School type variables	- German students and schools have on average more favorable characteristics except for the lowest deciles, but experience much lower returns to these characteristics in terms of test scores than Finnish students.	- PISA 2000 dataset - Educational production functions for Finland and Germany are estimated using a unique micro-level dataset with imputed data and added school type information.
Bahar (2010)	**H**: Gender, family, friend, perceived social support from someone special and sociometric status are meaningful predictors of academic success.	- Academic success score	- Gender - Perceived social support — special person - Perceived social support — family - Perceived social support — friend - Sociometric status	- Gender, perceived familial support and sociometric status have predicted 15% of academic success. - Perceived friend support and perceived social support from someone special do not predict academic success.	- Data from 274 students enrolled in five different teacher training programs - Multiple linear regression analysis technique
Calcagno et al. (2008)	**Q**: Which institutional characteristics are correlated with positive community college outcomes for students who attend one or more colleges as measured by individual student probability of completing a certificate or degree or transferring to a baccalaureate institution?	- Attainment of any degree or transfer to a 4-year institution	- General institutional characteristics - Student compositional characteristics - Financial characteristics - Fixed locational characteristics - Student characteristics	- The study finds a negative relationship between relatively large institutional size, proportion of part-time faculty and minority students on the attainment of community college students.	- Individual-level data from the US National Education Longitudinal Study of 1988 - Institutional-level data from the US Integrated Post-secondary Education Data System - The pooled probit regression
Carneiro (2008)	**H**: Most of the variance of school achievement at age 15 is explained by family characteristics.	- Test score in reading, mathematics or science	- Number of students in school - School hours per year - Number of computers/ school size - School size/number of teachers - Proportion of teachers with pedagogy degree - Paternal schooling - Average parental cultural communication in the school - Average parental social communication in the school - Average home education resources in the school	- Observed school inputs explain very little of adolescent performance. - Children from highly educated parents benefit of rich cultural environments in the home and become highly educated adults.	- PISA 2000 dataset - OLS

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Study	Hypothesis (H) or research questions (Q)	Dependent Variable(s)	Explanatory variable(s)	Result(s)	Data & methodology
			- Average socioeconomic index in the school		
Castillo-Merino and Serradell-López (2014)	**H1**: Motivation is the main variable in the explanation of online students' achievement, as it is a critical trait in the efficiency of net-based higher education. **H2**: The ability to use ICT improves online students' performance.	- Student performance	- Student's sex - Student's age - Student's schooling - Student's work experience - Student's grade average - Student's ability - Time spent studying relevant bibliography - Time spent studying (non-relevant bibliography) - Motivation perception - Feedback intensity - ICT-based methodology - ICT uses	- Motivation is the main variable affecting performance of online students, confirming the importance of this factor as a source of educational efficiency. - Motivation appears in the model as a latent variable receiving the influence of students' perception of efficiency, which is, in turn, a driver for the indirect positive and significant effect on students' performance from students' ability in ICT uses.	- Data from an experimental set-up performed within the eLene-EE project - An empirical model based on structural equations
Chiu (2010)	**H**: Inequality, family and school characteristics were linked to student achievement.	- Mathematics score	- Relative grade - Any remedial course - GDP per capita - GDP Gini - 1st generation immigrant - 2nd generation immigrant - Foreign language at home - Single parent - Blended family - Living with no parents - Grandparent - Number of siblings - Birth order - Number of books at home - Cultural possessions - Cultural communication - Girl	- In richer countries or schools with more educational resources, students had higher mathematics scores, but with diminishing marginal returns. - In countries with more equal distributions of income, students scored higher in mathematics. - Students in families with more resources had higher mathematics scores. - Equal distribution of resources improves overall student learning. - Many family and school characteristics' links with mathematics scores varied across countries.	- PISA 2000 dataset - Multilevel regression models
Chiu and Khoo (2005)	**H**: Resources, distribution inequality, and biases toward privileged students affect academic performance.	- Mathematics score - Reading score - Science score	- Country characteristics - Parent characteristics - School characteristics - Student characteristics	- Students scored higher in all subjects when they had more resources in their country, family, or school. - Students in countries with higher inequality, clustering of privileged students, or unequal distribution of certified	- PISA 2000 dataset - Multilevel regression analyses

				teachers typically had lower scores. - Students scored lower when parent job status had a larger effect on student performance (privileged student bias) in a school or country.	
Collier and Millimet (2009)	**H**: Variation in observable educational inputs affect student achievement.	- Mathematics test score - Science test score	- An extensive set of individual, class, teacher, school and country characteristics	- The relationships between institutional arrangements and test scores are not uniform. - A large influence of external exams on the curriculum has a strong positive association with math and science performance. - The association between autonomy over the school budget and student performance is complex but important. - There is a positive association between greater teacher autonomy over curricular decisions and student achievement.	- 1999 TIMSS data covering over 100,000 students from 22 countries - The semi-nonparametric estimation of quantile treatment effects (QTE)
Cyrenne and Chan (2012)	**Q1**: Are high school grades useful as a predictor of subsequent university performance? **Q2**: Is the performance of university students effected by their high school of graduation, independent of their high school grades?	- University GPA - High school GPA	- Student-level variables (age, sex, nationality, graduation time, bursary status, neighborhood income) - School-level variables (public or private, school expenditure per student, pupil—educator ratio, school type)	- There is a significant difference in performance by high school students at university, depending on their high school of graduation, controlling for high school marks and a host of other factors. - Greater financial resources, greater high school resources, and more favorable neighborhood effects, help to ensure that a student's respective high school grades translate into better performance at university. - Financial difficulties as a student may also make it	- A cross section of 5136 students who entered the University of Winnipeg over a six year period - Least Squares Dummy Variable Model - Hierarchical Linear Model

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Study	Hypothesis (H) or research questions (Q)	Dependent Variable(s)	Explanatory variable(s)	Result(s)	Data & methodology
				more difficult for students to maintain their academic performance at university.	
Darolia (2014)	**Q**: What is the effect of working on grades and credit completion for undergraduate students in the United States?	- College GPA - Credit hours	- The number of hours each student worked in a year - An indicator for being a part-time student - Student-level controls that may affect academic outcomes	- There is no evidence that students' grades are harmed by marginal work hours, but full-time students complete fewer credits per term when increasing work.	- Data from the 1997 US National Longitudinal Survey of Youth (9000 youth who were 12−16 years of age in 1996) - Fixed effects models - GMM estimation
Erten and Burden (2014)	**Q1**: To what do 6-grade students attribute their performance in a school based achievement test? **Q2**: How do level of achievement and academic self-concept interact with students' attributions? **Q3**: Is it possible to predict student achievement by means of the academic self-concept and attributions reported by language learners? If so, what are the best predictors?	- English test score	- Teacher - Ability - Interest - Long term effort - Class - Situational effort - Task difficulty - Family - Luck	- A set of ability attribution, academic self-concept, interest attribution, and teacher attribution are the best predictors of test performance. - Knowledge of student attributions and academic self-concept can provide useful information to teachers of English both at the level of prediction and intervention beyond the level of language instruction.	- Data from 267 6-grade students from six different cities in Turkey - Multiple regression analysis
Freitas and Leonard (2011)	**Q1**: What is the relationship between a student's needs and the student's ability to succeed in an associate degree of nursing program? **Q2**: What is the relationship between students' ability to meet their needs and student academic success? **Q3**: What is the relationship between student demographic characteristics and student academic success? **Q4**: What relationship is there between perceived student attributes and student academic success? **Q5**: What is the relationship between the amount of time working and student academic success?	- GPA	- Psychosocial importance - Psychosocial ability - Attributes - Physical ability - Physical importance - Age - Gender - Loans - Job - Work time - Job hours - Child care	- Female students have higher psychosocial needs than male students. - Assumptions about the impact of test-taking anxiety, family responsibilities, health status, psychological stress, and economic instability impacting performance in the classroom and clinical setting are supported by the study findings.	- Data from a questionnaire administered to 205 entry-level students in an associate degree in nursing program at regional campuses of a state university - A principal components factor analysis - ANOVA

Fuchs and Wößmann (2007)	**H**: Student characteristics, family backgrounds, home inputs, resources, teachers and institutions are significantly associated with math, science and reading achievement.	- Mathematics test score - Reading test score - Science test score	- Institutional characteristics - Resources and teachers - Student characteristics - Family background - Home incentives and inputs	- Student performance is higher with external exams and budget formulation, but also with school autonomy in textbook choice, hiring teachers and within-school budget allocations. - Autonomy is more positively associated with performance in systems that have external exit exams. - Students perform better in privately operated schools, but private funding is not decisive.	- PISA 2000 dataset - Two-stage least squares (2SLS) estimation
Gevrek and Gevrek (2010)	**Q**: What is the role of parent-owned businesses on children's college success and post-college aspirations?	- Cumulative GPA	- Course load - Gender - Age - Year in college - Turkish student selection examination (SSE) score - Major program - Scholarship status - Parental education levels and occupations - Family income	- The presence of self-employed parents and family businesses has a strong negative association with college success even after accounting for observed ability, parental background, and various individual characteristics. - The children of self-employed parents are more likely to have entrepreneurial intent and are less likely to plan to attend graduate school.	- Data from a questionnaire administered to 499 students of a private university in Turkey - A partial equilibrium model
Goulart and Bedi (2008)	**Q**: What is the consequence of working on the educational success of Portuguese children?	- Test scores of children	- Incidence of child work (does not work, economic work, domestic work, economic and domestic work) - Child characteristics - Family characteristics - Socio-economic characteristics - Educational characteristics - Demand characteristics - Child labor policies - Labor inspection	- Economic work hinders educational success, while domestic work does not appear to be harmful. - After controlling for a host of socio-economic variables, factors such as a child's interest in school and educational ambitions have a large effect on boosting educational success and reducing economic work.	- Household surveys conducted in 1998 and 2001 including 26,000 respondents in the age group 6–15 - Probit model
Graddy and Stevens (2005)	**Q**: What is the impact of school inputs on pupils' performance in private (independent) schools in the United Kingdom?	- Examination results at age 18 in school	- Examination results at age 16 in school - Resources supplied by the school	- There is a consistent negative relationship between the pupil-teacher ratio at a school and the examination results achieved by pupils	- A school-level panel dataset constructed from information provided by the Independent Schools Information Service

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Study	Hypothesis (H) or research questions (Q)	Dependent Variable(s)	Explanatory variable(s)	Result(s)	Data & methodology
			- Pupil characteristics other than exam results	aged 18, controlling for the pupils' performance in examinations two years earlier.	- Fixed effects panel data estimation
Hanushek (1997)	**Q**: What is the relationship between school resources and student achievement?	- Test scores	- The real resources of the classroom (teacher education, teacher experience, and teacher-pupil ratios) - Financial aggregates of resources (expenditure per student and teacher salary) - Measures of other resources in schools (specific teacher characteristics, administrative inputs, and facilities)	- There is not a strong or consistent relationship between student performance and school resources, at least after variations in family inputs are taken into account. - Simple resource policies hold little hope for improving student outcomes.	- The review of the available educational production literature consisting of about 400 studies - STAR experiment
Houtenville and Conway (2008)	**Q**: What is the role of parental involvement in student achievement?	- Child's scores on standardized reading and mathematics examinations in 1990 (tenth grade)	- Child characteristics - Parent characteristics - Household characteristics - School characteristics	- Parental effort has a strong positive effect on achievement that is large relative to the effect of school resources and is not captured by family background variables. - Parents appear to reduce their effort in response to increased school resources, suggesting potential "crowding out" of school resources.	- Data from the National Education Longitudinal Study (NELS), which is a comprehensive longitudinal national survey of 24,599 eighth grade students (from 815 public schools and 237 private schools), their parents, teachers, and school administrators - Estimation of a value-added education production function
Lindahl (2011)	**Q**: What is the impact of sibling and neighborhood correlations on school performance, educational attainment and income?	- Long-run income - Grade point average, sixth grade - Test scores, sixth grade	- Family characteristics - Neighborhood characteristics - Individual factors that are unrelated to family and neighborhood background	- Neighborhood correlations are in general very small and in particular they are much smaller than the sibling correlations. - Living in the same neighborhood does not seem to add much to the sibling similarities.	- Data from a cohort of nearly 13,000 individuals born in 1953 and their siblings, all of whom grew up in the Stockholm area - Restricted maximum likelihood (REML) estimation with the Delta method
Ludwig and Bassi (1999)	- Can the estimation approaches used in previous studies identify the causal effects of school resources on student test scores?	- Test score of student	- School inputs - Family characteristics	- The mixed results shown in previous studies may be due to omitted variables problems. - Value-added models cannot produce unbiased estimates in the NELS dataset, which is true	- Data from the US National Education Longitudinal Study of 1988 (NELS), a two-stage sampling design with 1052 schools selected in the first stage and 26 students per school selected in the second stage

				across a wide range of choices about model specification, functional form, and sample weighting decisions.	- OLS - Review the results of studies using IV method
Marks (2008)	**Q**: Is father's or mother's socioeconomic characteristics more important influences on student performance?	- Reading test score - Mathematics test score	- Father's occupational status - Mother's occupational status - Father's education - Mother's education	- The impact of mother's education is usually greater or comparable to that of father's education. - In most countries the impact of mother's socioeconomic characteristics (education plus occupation) on student performance is comparable to that for father's. - Of the four indicators of socioeconomic background, father's occupational status and mother's educational attainment tend to have stronger effects, although many countries do not conform to this pattern. - There are indications that the relative importance of mother's characteristics has increased over time.	- PISA 2000 dataset - Fixed effects model estimation
Mertoğlu and Aydın (2012)	**Q**: What is the relationship between domestic violence in the lives of 7th and 8th grade students and their academic success at school?	- The academic success of the students	- Violent behaviors of father or mother towards each other or child	- As the level of violence of mothers directed against their husbands increases, the level of their children's academic success was found to decrease. This finding suggests that the violent behaviors directed from fathers to mothers may be more socially acceptable and the children are psychologically affected negatively as a result of their mothers' violent behaviors against their fathers more than their fathers' violence against their mothers'.	- Data from two questionnaires which were answered by a total of 137 parents - The academic success of the students was evaluated based on the 2011 National Exam Results (SBS) - Arithmetic mean, standard deviation, and frequency-percentages tests - Pearson product-moment coefficient tests

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Study	Hypothesis (H) or research questions (Q)	Dependent Variable(s)	Explanatory variable(s)	Result(s)	Data & methodology
Mostafa (2010)	**Q1**: How does stratification lead to unequal educational outcomes? **Q2**: How are inequalities channeled through student characteristics, school characteristics and peer effects?	- Test scores of students	- Student characteristics - School characteristics - Peer characteristics	- Students' attitudes and motivation are very important determinants of performance. - Economic, social and cultural status of family is the most important student level variable affecting performance. - Comprehensiveness-driven school homogeneity is a source of equality since it dilutes the impact of school characteristics on performance scores. - Private schooling is found to have a negative effect on performance scores in all countries except in the UK, indicating that the apparent superiority of private schools is the result of better peer quality and funding.	- PISA 2003 dataset - Estimation of a multilevel econometric model with a restricted maximum likelihood (RML) using a Newton −Raphson algorithm
Perl (1973)	**Q**: What is the relationship between ability test scores and various dimensions of educational input?	- Ability test scores	- Student's family background - The background of other students at the high school attended - Components of expenditure per student at the high school attended	- The components of school expenditure have little, if any, impact on student performance. - The most effective means for improving the performance of students from disadvantaged backgrounds would be to send these students to schools with students from enriched backgrounds. - The performance of students from enriched backgrounds is not diminished from sharing the school environment with students from disadvantaged backgrounds.	- Data on a large sample of high school seniors - OLS
Pong (1997)	**H1**: Schools with greater concentrations of students from single-parent and stepfamilies create a	- Mathematics achievement - Reading achievement	- Student-level variables - School-level variables	- Schools that are predominated by students from single-parent families and stepfamilies negatively	- Data from US NELS:88 survey conducted by the National Opinion Research

	negative contextual effect on academic achievement, over and above the effect of an individual's membership in a single-parent family or stepfamily. **H2**: The negative effect of schools with high concentrations of students from single-parent families and stepfamilies can be explained by the low socioeconomic status of the student body in schools with high concentrations of single-parent and stepfamilies. **H3**: The negative effect of schools with high concentrations of students from single-parent families and stepfamilies can also be explained by the low level of parents' social relations in schools with high concentrations of single-parent families and stepfamilies.			affect their students' achievement, even after individual demographic characteristics and family background are controlled. - This negative effect of single parent families and stepfamilies is partly explained by the relatively low socioeconomic status of children in these schools. However, the negative effect of single-parent families and stepfamilies on school achievement can be countervailed when social relations among parents are strong.	Centre including over 26,000 eighth graders - Estimation of hierarchical linear models
Rangvid (2007)	**Q1**: How does the socioeconomic composition of the school affect the students' achievements in reading, mathematics and science? **Q2**: Is the assumption that the homogeneity of effects inherent in the estimation of average effects warranted, or do effects differ for students at different points of the conditional test score distribution?	- Reading literacy - Math literacy - Science literacy	- Mean school socioeconomic backgrounds - Variation school socioeconomic backgrounds - Student background controls - School controls - Learning environment	- The results suggest differential school composition effects across the conditional reading score distribution, with students in the lower quintiles achieving the largest test score gains. - Mathematics results suggest that high- and low-ability students benefit equally from attending schools with a better student intake, and most results for science are only marginally significant. - Mixing students of different home backgrounds could improve equity of achievement for both reading and mathematics; however, the average skill level would improve only for reading literacy.	- PISA 2003 dataset & register data for Denmark - Quintile regression - A standard education production function

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Study	Hypothesis (H) or research questions (Q)	Dependent Variable(s)	Explanatory variable(s)	Result(s)	Data & methodology
Toby and Dufur (2001)	**Q**: What are the effects of both family and school capital on student math and reading achievement?	- Math test score - Reading test score	- Family social capital variables - School social capital variables - Family human capital variables - Child human capital variables - School human capital variables - Family financial capital variables - School financial capital variables - Control variables	- School capital effects are modest in size while family capital effects are stronger; combinations of school and family capital boost or modify additive findings.	- Data from the National Longitudinal Survey of Youth (NLSY) & Merged Child-Mother Data for 1992 and 1994, consisting of samples of 2034 for math achievement and 2203 for reading recognition - OLS
Wittwer and Senkbeil (2008)	**Q**: Is students' computer use at home related to their mathematical performance at school?	- Mathematical test performance	- Availability of a computer at home - Economic and social status - Gender - Immigration background - Cognitive abilities - Reading in leisure time - Reading newspapers - Watching TV - Watching news on TV - Watching action, horror, or pornographic films on TV	- Students' access to a computer was not linked with their performance in mathematics. - It did not matter how often students used a computer at home. A positive effect on mathematical achievement was, however, observed for a small group of students who used the computer in a self-determined way that largely engaged them in problem-solving activities. - The findings indicate that for the majority of students the computer had no substantial influence on their academic achievement.	- PISA 2003 dataset - OLS - Arithmetic mean, standard deviation, and frequency-percentages tests

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