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8

THE EFFECTS OF HUMAN AND MATERIAL RESOURCES ON STUDENTS' MATH ACHIEVEMENT IN 45 COUNTRIES

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Abstract

This study aims to explore the effects of human and material resources on mathematical literacy. For this purpose, mathematical literacy test scores and questionnaire responses of 304,444 fifteen-year-olds in 45 countries participated in the 2012 cycle of Programme for International Student Assessment (PISA) Project, were analysed through two-level and three-level hierarchical linear models (HLM). Selected indices and scales representing material and human resources' effects on students' mathematical literacy were investigated. The results revealed that 23% of the total variance in the literacy scores is attributable to between-countries, 34% of the variance is attributable to between-schools and the remaining 43% to individual student characteristics. Only two school factors, the quality of school educational resources and teacher morale, were found to have effects on students' performance after accounting for the gender, the index of economic, social and cultural status, and the cumulative expenditure on education. The results of the study have potential to help policy makers determine their priorities in education and provide hints for future studies.
Key words: *human resources, material resources, PISA 2012, hierarchical linear model*.

Introduction

Allocation of educational resources is an important issue for governments in promoting education within their countries. Limited resources should be used efficiently to obtain better learning outcomes. Thus, the effectiveness of educational resources and defining priorities for policy makers are among the key research areas within the field of education.

Relationship between educational resources and student achievement is one of the preliminary investigations from past educational studies (Fuller, 1987; Hanushek, 1997; Alacacı and Erbaş, 2010; Yilmaz, 2010; Nicoletti and Rabe, 2012). However, there are contradictory results in the literature on the effect of resources on student achievement. Besides the studies that express a statistically significant relationship between educational resources and student achievement (Archibald, 2006; Greene et. al., 2007), there are some others which concluded that the resources make little or no difference (Fermanich, 2003).

According to Fermanich (2003), there are three common study types about the effects of schools and teachers on student achievement, namely, education production function studies, effective schools studies, and school (teacher) effects studies. The education production function studies analyse the effects of educational resources on student outcomes by meta-analytic methods. Generally the aim is to obtain a model about the relationship between educational

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PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 62, 2014

inputs and outcomes (Hedges et al., 1994). Since the landmark study of this kind is the Coleman report (Coleman et al., 1966); there are many examples of this approach which were reviewed several times (Hanushek, 1989; Hedges et al., 1994; Glewwe at al., 2011). Glewwe et. al. (2011) carried out a content analysis of these studies in education and economics literature published between 1990 and 2010. Their purpose was to develop a research on schools' and teachers' features, which appeared to have a positive impact on learning and time in school. Some of the few variables having significant effects they found were availability of desks, teacher knowledge of the subjects they teach, and teacher absence. The second type is effective schools' studies which analyze certain characteristics of effective schools. They occur in various contexts like the evaluation of school improvement programs or comparison of schools. These studies focus on the causal link between school factors and the effectiveness by means of scientific methods (Scheerens, 2013). The third type is school- and teacher-effects studies which use regression analysis and multilevel/hierarchical models. They analyze the association between various characteristics of schools and teachers and the student-level outcomes. The studies on the effectiveness of system level policies can also be discussed in this category.

Scheerens (2013) summarized effectiveness research that helps policy making in six areas: 1) studies investigating the equality of opportunities 2) the education production function studies 3) studies on compensatory and school improvement programs 4) unusually effective schools studies 5) studies investigating the effectiveness of teachers, classes and instructional procedures, and 6) studies investigating the effectiveness of system level policies and institutional arrangements. The last research area mostly appears in international assessment programs. They focus on the system level factors that reflect the decentralization, choice and accountability arrangements in educational systems. Of course, there are studies which are a combination of these areas and it is not possible to separate all of the studies strictly according to these strands. However, they provide an overview of various effectiveness researches in the literature.

Program for International Student Achievement (PISA)

There is a need for surveys around the world to compare different education systems and decide on the direction of changes in the reform process. One of the biggest studies is the Program for International Student Achievement – PISA, which is conducted for these purposes. It assesses the extent to which students near the end of compulsory education have acquired key knowledge and skills that are essential for full participation in modern societies. PISA is conducted every three years, with a primary focus on one area for each cycle since 2000. PISA 2012 was the fifth cycle of the program with a primary focus on mathematics.

Four types of educational resources are discussed in the PISA 2012 (OECD, 2013); spending on education, human resources, material resources and time resources. This study focuses on the effects of human and material resources on education. Human and material resources are two important components of education and they form an important part of the compulsory expenditures of governments. This study is looking for a priority for public policy by determining and comparing the effects of adequacy of educational materials and teacher variables. For this purpose, the researchers identified the factors that explain the variance in mathematics achievement due to differences in human and material resources of countries. The data collected from 45 countries, which participated in PISA 2012, were used to answer the following research questions:

1. In the context of a three-level model, controlling for spending on education, gender and ESCS, is there a positive relationship between human and material resources (at the school level) and students' math achievement?

2. What is the proportion of variance in mathematics achievement that can be explained by differences between individuals, in comparison to the proportion of variance that can be explained by differences between the schools and countries?

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 62, 2014

3. Does cumulative expenditure on education have an impact on achievement after controlling for the variables on individual and school level?

4. How do the effects of human and material resources change among countries?

Methodology of Research

The researchers used the PISA 2012 database obtained from the website of OECD. After the deletion of cases with missing values, the data set used in the model contains 304444 student records and 11792 school records from 45 countries. To investigate the effects of human and material resources, the researchers conducted a multilevel regression analysis using HLM models and HLM software developed by Bryk and Raudenbush (1988). First, a baseline or ″null'' model, which determines the proportions of variance within and between schools was estimated. This model (null model) enables researchers to more easily analyze the variance that occurs within schools, mostly tied to student characteristics; the variance that occurs between schools, mostly tied to school characteristics (characteristics of students and teachers); and the variance that lies between countries mostly tied to country characteristics. It also gives us estimates of HLM means and standard deviations. Then we considered two models: (1) a three-level HLM with students nested within schools at level 1, schools nested within countries at level 2, and countries as level 3; (2) separate estimates of two-level models with students nested within schools at level 1 and schools as level 2. These models examine only fixed effects, meaning that the intercept for each variable is allowed to vary, but the slope is not.

In this study, the dependent variable is students' mathematics literacy scores. The PISA index of economic, social and cultural status and student gender were the two student level (level-1) variables. At the school level (level-2) some indices and scales were selected in order to examine the effects of material and human resources on students` math achievement. The Index of Quality of School Educational Resources and the Index of Quality of Physicals' Infrastructure were two material resource variables in PISA 2012. The other school level variables were selected as human resource variables by the researchers. Cumulative Expenditure on Education is the only country level (level-3) variable. The detailed explanation of variables and their descriptive statistics are on the following:

Student Level Variables

Student's PISA index of economic, social and cultural status (ESCS): It is a standardized index, which is derived from other indices which represent occupational status and educational level of parents, information about participants' home possessions etc. Since it combines more information, it is expected to be more reliable than single-item statements (OECD, 2007). The final values have an OECD mean of 0 and a standard deviation of one.

Gender (GENDER): Student gender is a dummy variable indicating whether a student is female or male and it is coded as 1=female and 0=male. Nearly half of the students were female (50.4 %).

School Level Variables

The student-mathematics teacher ratio (SMRATIO): The school size was divided by the total number of mathematics teachers to compute this index. The number of part-time mathematics teachers was weighted by 0.5 and the number of full time mathematics teachers was weighted by 1 (OECD, 2013).

The Index of Quality of School Educational Resources (SCMATEDU): It is derived from school principals' responses to the six items measuring school's capacity. The items are: i) shortage or inadequacy of science laboratory equipment; ii) shortage or inadequacy of instruc-

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 62, 2014

tional materials; iii) shortage or inadequacy of computers for instruction; iv) lack or inadequacy of Internet connectivity; v) shortage or inadequacy of computer software for instruction; and vi) shortage or inadequacy of library materials (OECD, 2013)". A four-point scale is used with the response categories as "Not at all (=1)", "Very little (=2)", "To some extent (=3)", "A lot (=4)". Higher values show better quality of educational resources.

The Index of Quality of Physicals' Infrastructure (SCMATBUI): It is derived from school principals' responses to the three items about physical infrastructure of school buildings. The items are "i) shortage or inadequacy of school buildings and grounds; ii) shortage or inadequacy of heating/cooling and lighting systems; and iii) shortage or inadequacy of instructional space (e.g. classrooms)." A four-point scale is used with the response categories as "Not at all (=1)", "Very little (=2)", "To some extent (=3)", "A lot (=4)". Higher values show better quality of physical infrastructure.

The Index on Teacher-related Factors Affecting School Climate (TEACCLIM): It is derived from school principals' responses to the eleven items to determine to what extent some factors hinder learning of students. The items are "i) students not being encouraged to achieve their full potential; ii) poor student-teacher relations; iii) teachers having to teach students of heterogeneous ability levels within the same class; iv) teachers having to teach students of diverse ethnic backgrounds (i.e. language, culture) within the same class; v) teachers' low expectations of students; vi) teachers not meeting individual students' needs; vii) teacher absenteeism; viii) staff resisting change; ix) teachers being too strict with students; x) teachers being late for classes; and xi) teachers not being well prepared for classes (OECD, 2013)". A four-point scale is used with the response categories as "Not at all (=1)", "Very little (=2)", "To some extent (=3)", "A lot (=4)". Higher values show positive teacher behaviour.

The Index of Teacher Shortage (TCSHORT): It is derived from school principals' responses to the four items about factors which are a lack of: i) qualified science teachers; ii) qualified mathematics teachers; iii) qualified <test language> teachers; and iv) qualified teachers of other subjects (OECD, 2013). A four-point scale is used with the response categories as "Not at all (=1)", "Very little (=2)", "To some extent (=3)", "A lot (=4)". Higher values show higher teacher shortage at a school.

The Index of Teacher Morale (TCMORALE): It is derived from school principals' responses to the four items measuring teacher morale. The items are "i) the morale of teachers in this school is high; ii) teachers work with enthusiasm; iii) teachers take pride in this school; and iv) teachers value academic achievement". A four-point scale is used with the response categories as "Strongly agree (=4)", "Agree (=3)", "Disagree (=2)", "Strongly disagree (=1)" Higher values show more positive teacher morale.

Country Level Variable

Cumulative Expenditure (CUMEXP): The values of cumulative expenditure variable were quoted from the PISA data and they fall between 7124,63 and 197597,57 (in equivalent USD converted using purchasing power parity). It indicates the total expenditure on education per student from the age of 6 to 15. Since there was a high correlation between spending on education and per capita GDP (r = 0.94 across all participating countries and economies (OECD, 2013).), the researchers preferred one of them.

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 62, 2014

Table 1. Descriptive Statistics of Variables.

VARIABLE	MEAN	S.D.	MIN.	MAX.
PISA index of economic, social and cultural status **(ESCS)**	-0,19	1,1	-5,95	3,21
Gender **(GENDER)**	0,50	0,50	0	1
The *student-mathematics teacher ratio* **(SMRATIO)**	118,58	99,98	0,5	2391
The *index of quality of school educational resources* **(SCMAT-EDU)**	-0,08	1,09	-3,59	1,98
The *index of quality of physicals' infrastructure* **(SCMATBUI)**	-0,09	1,04	-2,75	1,31
The *index on teacher-related factors affecting school climate* **(TEACCLIM)**	-0,09	1	-4,93	2,85
The *index of teacher shortage* **(TCSHORT)**	0	1,03	-1,09	3,60
The *index of teacher morale* **(TCMORALE)**	-0,04	0,99	-3,98	1,45
The cumulative expenditure on education **(CUMEXP)**	66413,0	38235,8	7124,6	

Hierarchical Linear Model (HLM)

Because of the hierarchical structure of the data two-level and three-level HLM models were used in the study. In these models, Level 1 is individual, the other levels are aggregate levels. Every aggregate level is broadened by the modeling of its relations. Three-level and two-level full models used in the study are on the following.

Three-Level Full Model:

$$\text{Level 1: } Y_{ijk} = \pi_{0jk} + \pi_{1jk}(GENDER) + \pi_{2jk}(ESCS) + e_{ijk}$$

$$\text{Level 2: } \pi_{0jk} = \beta_{00k} + \beta_{01k}(SCMATBUI) + \beta_{02k}(SCMATEDU) + \beta_{03k}(SMRATIO) + \beta_{04k}(TCMORALE) + \beta_{05k}(TCSHORT) + \beta_{06k}(TEACCLIM) + r_{0jk}$$

$$\pi_{1jk} = \beta_{10k}$$

$$\pi_{2jk} = \beta_{20k}$$

$$\text{Level 3: } \beta_{00k} = \gamma_{000} + \gamma_{001}(CUMEXP) + u_{00k}$$

$$\beta_{01k} = \gamma_{010}$$

$$\beta_{02k} = \gamma_{020}$$

$$\beta_{03k} = \gamma_{030}$$

$$\beta_{04k} = \gamma_{040}$$

$$\beta_{05k} = \gamma_{050}$$

$$\beta_{06k} = \gamma_{060}$$

$$\beta_{10k} = \gamma_{100}$$

$$\beta_{20k} = \gamma_{200}$$

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 62, 2014

In the individual level (L1); Y_{ijk}: Dependent variable, π_{0jk}: School mean, e_{ijk}: Deviation of students from their school mean; π_{1jk} and π_{2jk}: Regression slopes of the predictors.

In the first aggregated level (L2); π_{0jk}: School mean, β_{00k}: Country mean, r_{0jk}: Deviation of schools from their country mean, β_{01k}, β_{02k}, β_{03k}, β_{04k}, β_{05k}, β_{06k}: The regression slopes of the predictors, β_{10k} and β_{20k}: Average regression slopes.

In the second aggregated level (L3); β_{00k}: Country mean, γ_{000}: Grand mean, u_{00k}: Deviation of countries from grand mean, γ_{001}: regression slope *of the predictor CUMEXP*, γ_{010}, γ_{020}, γ_{030}, γ_{040}, γ_{050}, γ_{060}, γ_{100}, γ_{200}: Average regression slopes.

Two-Level Full Model:

$$\text{Level 1: } Y_{ij} = \pi_{0j} + \pi_{1j}(GENDER) + \pi_{2j}(ESCS) + e_{ij}$$

$$\text{Level 2: } \pi_{0j} = \beta_{00} + \beta_{01}(SCMATBUI) + \beta_{02}(SCMATEDU) + \beta_{03}(SMRATIO) + \beta_{04}(TCMORALE) + \beta_{05}(TCSHORT) + \beta_{06}(TEACCLIM) + r_{0j}$$

$$\pi_{1j} = \beta_{10}$$

$$\pi_{2j} = \beta_{20}$$

In the individual level (L1); Y_{ij}: Dependent variable, π_{0j}: School mean, e_{ij}: Deviation of students from their school mean; π_{1j} and π_{2j} are regression slopes of the predictors.

In the aggregated level (L2); π_{0j}: School mean, β_{00}: Grand mean, r_{0j}: Deviation of schools from grand mean, β_{01}, β_{02}, β_{03}, β_{04}, β_{05}, β_{06}: The regression slopes of the predictors. β_{10}, β_{20}: Average regression slopes.

Results of Research

In this section, firstly the results from three-level HLM model are presented. The variation at all three levels of the empty model is significant. For mathematics literacy, approximately 43% occurs within schools, 34% between schools, and 23% between countries. Table 1 also shows the extent to which the fully specified model can explain the variation that exists among students, schools and countries.

Table 2.Variance decomposition for mathematic literacy (45 Countries).

Model	Within Schools	Between Schools	Between Countries
Empty	0.43	0.34	0.23
Full	0.49	0.37	0.14

Note. The empty models contain only intercepts at each level. All table values are significant at *p<0.05

The results pertaining to the relationships between students' mathematics literacy scores and the countries' cumulative expenditures on education (CUMEXP), students' gender and economic, social and cultural status (ESCS), the indices representing human and material resources are presented in Table 2. The country level variable (CUMEXP) and the student level variables describing their economic, social and cultural status and gender are included in the regression models, because the aim is to control and estimate the well-known effects associated with human and material resources.

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 62, 2014

Table 3. Three-level fixed effects estimates for mathematic literacy.

	Coeff.	SE	df	p
Intercept	453.91	8.27	43	0.000
CUMEXP	0.0006*	0.000	43	0.013
SCMATBUİ	-1.98	2.08	1742	0.342
SCMATEDU	12.25*	1.92	7520	0.000
SMRATİO	-0.03	0.01	1324	0.073
TCMORALE	8.81*	2.19	11785	0.000
TCSHORT	-2.13	2.41	4500	0.376
TEACCLİM	1.29	1.69	11785	0.443
GENDER	-13.70*	2.42	1842	0.000
ESCS	13.68*	2.48	304434	0.000
*p<0.05				

As shown in Table 3, at the country level the only factor significantly related to the student scores is the cumulative expenditure of countries (CUMEXP). It is unrealistic to expect an increase by an entire point in country mean achievement of mathematical literacy for one dollar increase on the expenditure. Nonetheless, were the expenditure to improve by only 1 $ at country level, mathematics literacy scores would increase by 0,0006 points. To illustrate, Turkey is among the low performing countries with a mean mathematical literacy score of 428.42. Were it had a CUMEXP value equal to the mean of the countries selected in the present study, the country's mean mathematical literacy score would increase about 28 points.

At the student level, model includes two basic variables: gender and ESCS, which are among the common factors in the literature expected to play a role in the students' math literacy performance. The coefficients for gender and ESCS are found to be statistically significant. The findings suggest that student's mathematics literacy scores increase for each unit of ESCS. The expected scores are about 14 points higher if the students' ESCS is one unit higher. There is a similar difference between males and females. Female test scores were about 14 points lower in mathematics than those of males on average. In most countries males have higher achievement scores than females.

Material Resources

The model includes two variables pertaining to material resources at the school level. The only significant positive effect on students' mathematics literacy score is associated with the index of quality of school educational resources (SCMATEDU) which is obtained by measuring principals' perceptions of material resources hindering instruction at their school. The coefficient for SCMATEDU is positive, as would be expected, indicating that math literacy scores improve with increased quality of school educational resources: a one unit increase in the index is associated with an increase in achievement of about 12 points on math literacy scores. The other non-significant coefficient shows the effect of the index of quality of physicals' infrastructure (SCMATBUI) which is obtained by evaluating the physical infrastructure: school buildings and grounds; heating/cooling and lighting systems and instructional space.

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 62, 2014

Human Resources

The model includes four variables pertaining to human resources at the school level. Again there is one variable, index of teacher morale (TCMORALE), having a positive effect on students' math achievement. The coefficient for TCMORALE indicates that a one unit increase in this index is associated with an increase in achievement of about 9 points on math literacy scores. As noted earlier in this study TCMORALE has a standard deviation of 0.99, which means a one standard deviation increase in this variable is associated with a 9 points of increase in student scores. Surprisingly, other teacher-related factors, school climate and teacher shortage, identified as significant predictors of achievement by many previous research appears to have no significant effect on mathematical literacy achievement in the present study. This result emphasizes the priority of the teacher morale in education.

The Effects of Human and Material Resources among Countries

The results of separate within-country analyses obtained through two-level hierarchical linear models provide some hints to answer the question "How do the effects of human and material resources change among countries?" Table 3 displays the estimates of regression coefficients for each country, with adjustment for the ESCS and gender.

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 62, 2014

Table 4. The estimates of regression coefficients for each country.

	Student Level Factors		School Level-Material Resources			School Level-Human Resources		
	GENDER	ESCS	SCMATBUI	SCMATEDU	SMRATIO	TCMORALE	TCSHORT	TEACCLIM
Singapore	0,73	***22,95**	-4,19	5,67	0,13	***12,12**	5,26	***13,78**
Korea	-7,14	***24,17**	-14,58	0,81	***-0,41**	***30,83**	8,44	2,91
Finland	-0,15	***28,16**	-0,98	-1,49	-0,01	-1,49	-1,77	3,00
Poland	-1,22	***29,83**	-10,44	7,98	***0,49**	5,48	-15,73	4,88
Estonia	-5,00	***19,49**	-4,86	-7,27	***0,13**	***10,07**	-2,10	3,39
Japan	***-14,47**	4,01	-2,63	5,92	0,17	***21,87**	3,07	0,56
Netherlands	***-17,88**	***8,4**	10,28	6,33	-0,09	***20,08**	6,56	-25,43
Canada	***-11,81**	***22,72**	-4,92	3,54	0,07	***6,93**	2,11	***9,16**
United Kingdom	*-8,16	***22,78**	-3,67	-6,56	0,14	***11,57**	***-22,15**	5,32
Denmark	***-17,7**	***31,57**	-0,57	13,55	0,74	-4,97	12,45	3,09
Australia	***-10,82**	***21,98**	1,34	***10,97**	***0,21**	5,02	-4,21	***9,45**
New Zealand	***-10,25**	***32,03**	-0,96	2,77	0,17	0,76	***-14,21**	***15,84**
Luxembourg	***-21,65**	***16,98**	-16,37	8,15	-0,13	1,48	-17,31	-2,69
Norway	**-1,32**	***24,69**	-3,02	-10,87	0,02	3,49	-12,54	***15,32**
Ireland	***-14,92**	***22,92**	***-8,6**	2,50	-0,11	0,57	-4,49	*14,46
Belgium	***-16,8**	***16,79**	-3,25	-1,64	-0,12	***17,43**	-10,97	***21,03**
Iceland	4,13	***25,46**	1,66	2,17	0,22	6,24	-7,27	-0,80
Spain	***-16,67**	***25,6**	***5,27**	1,00	***0,05**	***11,41**	-1,59	2,53
Sweden	2,60	***29,78**	-1,47	6,07	0,22	5,78	***-9,52**	-3,73
Germany	*-24,55	*8,74	***-18,72**	4,47	0,08	10,01	***-27,17**	-2,34
Latvia	-1,40	***21,8**	-1,58	6,65	***0,22**	-0,61	0,83	-0,38
USA	***-7,54**	***24,64**	0,78	6,94	***-0,21**	14,11	***-12,96**	-1,73
Slovak Republic	***-20,77**	***22,44**	0,39	-2,22	-0,08	-7,81	***-21,63**	2,40
Croatia	***-24,73**	***9,84**	-6,35	-3,25	***-0,3**	5,15	-8,09	-0,43
Portugal	***-10,65**	***22,97**	11,34	6,80	***0,5**	10,31	-1,26	5,82
Italy	***-24,5**	***5,73**	***12,17**	***11,8**	0,01	5,86	-0,61	-11,19
Austria	***-27,47**	***12,17**	-8,00	4,65	***0,38**	***-28,77**	***-23,09**	-0,09
Slovenia	***-27,71**	2,80	-2,19	8,04	-0,03	-1,89	***16,71**	11,75
Lithuania	*-5,89	***19,61**	-6,45	9,79	0,00	***13,02**	-7,31	2,03
France	***-19,39**	***18,87**	***-18,69**	***12,52**	***-0,25**	7,44	2,54	10,29
Israel	***-14,84**	***23**	0,74	-6,77	***0,66**	13,52	12,09	***19,72**
Thailand	2,57	***5,65**	-5,26	5,79	***-0,07**	0,37	1,41	***17,72**
Hungary	***-25,62**	***7,28**	-12,36	1,39	***-0,21**	7,34	2,06	6,63
Turkey	***-21,54**	***4,98**	-6,09	***27,96**	-0,04	***21,81**	7,80	3,63
Malaysia	3,59	***11,78**	-9,66	***23,88**	0,09	-1,37	***11,89**	*15,39
Czech Republic	-19,33	11,42	-6,97	-5,19	-0,02	0,11	-23,33	-0,15
Uruguay	***-16,2**	***15,25**	***13,98**	13,40	0,07	0,13	0,48	11,42
Mexico	***-15,08**	***5,22**	2,60	***14,32**	0,03	0,61	1,61	0,19
Bulgaria	***-8,68**	***10,42**	***-18,61**	***27,55**	-0,07	***13,19**	7,78	**2,50**
Montenegro	*-10,23	*12,53	-7,08	-5,84	-0,01	9,17	-9,57	9,45
Chile	***-25,74**	***8,59**	1,83	11,54	0,11	2,13	**-6,80**	***14,92**
Jordan	***-35,55**	***9,94**	-5,48	8,28	0,09	***10,16**	-5,02	2,37
Colombia	***-23,51**	***8,16**	***9,86**	***14,13**	-0,04	6,38	4,18	-5,06
Tunisia	***-24,46**	***3,63**	-5,17	-0,47	-0,22	4,32	-4,58	-11,24
Peru	***-26,45**	***7,62**	1,38	***23,99**	0,03	***14,15**	2,11	-5,86

*Results in bold are statistically significant at the .05 level.

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The researchers compared the 25 high performer countries with a mean mathematics scores above the average (459.89) and 20 low performer countries with a mean mathematics scores below the average in terms of the effects of resources, gender and ESCS. Table 4 displays the number of statistically significant ($p < 0.05$) regression coefficients for each factor. Gender and ESCS are well-known significant variables in most of the countries. But the effects of human and material resources differ widely across the countries. Heyneman and Loxley (1983), who prepared a research report for the World Bank, expressed a stronger relationship between school and teacher quality and academic achievement in low-income countries than in high-income countries for primary schools. This proposition is valid for the index of quality of school educational resources. The index of quality of school educational resources is significant in 4% of high performer countries, while it is significant in 40 % of low performers. As expected, a similar result is obtained if the countries are ranked in terms of their cumulative expenditures on education. 24 countries' cumulative expenditures on education are above the average (66799.8 $) and SCMATEDU is a significant predictor only in three of those: Australia, Italy and France. The index of teacher morale is significant in 36% of high performer countries, while it is significant in 30% of low performers. It has only negative effect in Austria among the high performers. An interesting result of our analysis is about the countries in which both of the factors (SCMATEDU and TCMORALE) are significant. These are the countries whose cumulative expenditures are under the average and also they are low performers: Bulgaria, Turkey and Peru.

Table 5. Percentage distribution of estimated effect of variables on student performance*.

	High Performers			Low Performers		
	Statistically Significant Percent (Country Num.)		Statistically Non-significant	Statistically Significant Percent (Country Num.)		Statistically Non-significant
SCMATBUİ	12% (3)	Positive: 2 Negative: 1	88% (22)	**25% (5)**	Positive: 3 Negative: 2	75% (15)
SCMATEDU	4% (1)	Positive: 1 Negative: 0	96% (24)	40% (8)	Positive: 8 Negative: 0	60% (12)
SMRATİO	36% (9)	Positive: 6 Negative: 3	64% (16)	**25% (5)**	Positive: 2 Negative: 3	75% (15)
TCMORALE	36% (9)	Positive: 9 Negative: 0	64% (16)	**30% (6)**	Positive: 5 Negative: 1	70% (14)
TCSHORT	24% (6)	Positive: 0 Negative: 6	76% (19)	**15% (3)**	Positive: 2 Negative: 1	85% (17)
TEACCLİM	28% (7)	Positive: 7 Negative: 0	72% (18)	**20% (4)**	Positive: 4 Negative: 0	80% (16)
GENDER	64% (16)	Positive: 0 Negative: 16	36% (9)	85% (17)	Positive: 0 Negative: 17	15% (3)
ESCS	96% (24)	Positive: 24 Negative: 0	4% (1)	**90% (18)**	Positive: 18 Negative: 0	10% (2)

*Factors having a significant effect on students' math achievement in the previous three-level model are written in bold

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 62, 2014

Discussion

In this study, the effects of human and material resources on math literacy were examined by using PISA 2012 data. We used multilevel regression techniques to narrow the human and material resources in 45 countries. It is found that besides the CUMEXP, gender and ESCS, the effects of teacher morale and the quality of school educational resources are statistically significant on students' math literacy. The effects of CUMEXP, gender and ESCS vary considerably across countries and this finding is in line with preliminary investigations. Moreover, per capita GDP can also be considered as a basic factor that affects student achievement. Thus, we cannot evaluate human and material resources separately from these factors.

According to the results of this study, it is seen that the quality of school educational resources has a priority among the material resources. Particularly, it has a significant effect in a greater number of low performer countries than the index of quality of physical infrastructure. Moreover, it is concluded that the effectiveness of SCMATEDU differs widely across the countries, which is in line with other resource variables. It was observed that low performers and poor countries should invest more in the quality of school educational resources. The variability in the effectiveness of factors was also emphasized in the past studies. Fermanich (2003) analyzed the data gathered from the Minneapolis Public Schools and found a statistically significant variability in the effectiveness of schools and teachers on student achievement in math.

Another result of this study verifies the proposition "money is not everything in education". Human resources, particularly teacher morale should not be neglected in the education systems. Keeping this in mind, there is a need for further studies on the factors possible to affect teacher morale such as teacher salaries, which may also have an indirect effect on students' test scores. The countries whose per capita GDP is high and provide teachers higher salaries tend to perform better in mathematics (OECD, 2013).

Conclusions

Besides gender and index of economic, social and cultural status, human and material resources influence students' math literacy achievements. Overall, the quality of school educational resources and teacher morale, have significant impact on students' math literacy achievements. Limited resources should be allocated carefully to provide equal opportunity to citizens. According to PISA 2012 data, the quality of school educational resources should have a priority among material resources. For example, governments should give a thought on the ways of improving computer based education and instructional materials rather than constructing better buildings. Countries also need to invest in developing and retaining effective teachers. The teacher is the main factor who prepares the educational surroundings and is responsible for the students' learning. The index of teacher morale has significant effect not only in many low-income countries, but also it has significant effect in many high-income ones. Thus, policy makers should consider projects for enhancing teacher morale and motivation. The effects of human and material resources vary considerably across countries. The quality of school educational resources is more important in low-income and low performer countries. But these countries should not neglect to invest on human resources. Two basic factors, human and material resources must be considered together.

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PROBLEMS
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