Recebido: 07-08-2023 | Aprovado: 12-09-2023 | DOI: https://doi.org/10.23882/rmd.24178

The determinants of school performance in selected MENA countries: what role of the education system's characteristics?

Os determinantes do desempenho escolar em países seleccionados do Médio Oriente e do Norte de África: qual o papel das características do sistema educativo?

ABBAIA Abdelilah,
Researcher, Phd in economics
(abbaia2@yahoo.fr)
Mounia BETTAH,
Professor at FSJES Agdal, Mohammed V University, Rabat
Applied Economics Laboratory (L.E.A)
(mounia_bettah@yahoo.fr)

Abstract: Based on data from the 2011 TIMSS international survey related to the 2nd year of secondary school of eleven MENA countries, this work aims to identify the characteristics of the educational system that influence the students' academic performance in mathematics in these countries, while highlighting the case of Morocco.
The estimation of an empty three-level model, to explain the probability of achieving a score of 400 points or more in mathematics, showed that a significant and non-negligible part (8.04%) of the total variance is due to the differences between the characteristics of the countries. The results of this study showed that, particularly in Morocco, students' academic performance could be improved by providing autonomy to schools to choose the syllabus, by making preschool a obligatory educational cycle and by increasing the volume of time reserved for teaching mathematics.

Keywords: Education, school performance, TIMSS-MENA, multilevel models.

Resumo: Com base nos dados do inquérito internacional TIMSS 2011 sobre o 2.º ano do ensino secundário para onze países do MENA (Médio Oriente e do Norte de África), este estudo tem como objetivo identificar as características do sistema educativo que influenciam o desempenho matemático dos alunos nos países da amostra, destacando o caso de Marrocos. A estimação de um modelo de vácuo de três níveis para explicar a probabilidade de os alunos alcançarem uma pontuação de 400 pontos ou mais em matemática revelou que uma proporção significativa e não negligenciável (8,04%) da variância total se deve a diferenças entre as características dos países. Os resultados deste estudo mostraram que, nomeadamente em Marrocos, o desempenho académico dos alunos poderia ser melhorado concedendo autonomia às escolas na escolha dos programas, tornando o ensino pré-escolar obrigatório e aumentando o tempo consagrado ao ensino da matemática.

Palavras-chave: Educação, desempenho escolar, TIMSS-MENA, modelos multinível.

Résumé : Basé sur les données de l'enquête internationale TIMSS 2011 relatives à la 2ème année de l'enseignement secondaire collégial concernant onze pays de la zone du MENA, ce travail a pour objectif l'identification des caractéristiques du système éducatif qui influent sur la performance scolaire en mathématique des élèves des pays de cet échantillon, tout en mettant en lumière le cas du Maroc.
L'estimation d'un modèle vide à trois niveaux, pour l'explication de la probabilité que les élèves réalisent un score supérieur ou égal à 400 points en mathématiques, a permis de constater qu'une part significative et non négligeable (8,04%) de la variance totale est due aux différences entre les caractéristiques des pays.
Les résultats de cette étude ont montré, que particulièrement au Maroc, le rendement scolaire des élèves pourrait être amélioré en accordant une autonomie aux établissements dans le choix des programmes scolaires, en faisant du préscolaire un cycle d'enseignement obligatoire et en augmentant le volume horaire réservé à l'enseignement des mathématiques.

Mots-clés : Education, performance scolaire, TIMSS-MENA, modèles multiniveaux.

Introduction

Like most developing countries, MENA[1] countries invest significant resources to improve their education systems. According to a World Bank study (2008), these countries have devoted more financial resources to education compared to other countries with similar per capita income levels.

While Morocco devotes nearly 17 percent of government spending to education[2], and despite numerous reforms to its education system, the country remains behind the MENA countries in terms of student performance. Both international and national surveys have revealed that the level of student achievement in Morocco is marked by major weaknesses.

For example, the international TIMSS[3] study conducted in 2011 showed that the country's average score was only 371 points in mathematics, whereas the international average is 500 points (MULLIS et al, 2012). With this score, Morocco is ranked at the bottom of the MENA region.

Moreover, according to the results of the 2008 national study PNEA (Programme National de l'Evaluation des Acquis), conducted by the INE (Instance

[1] Middle East and North Africa.
[2] The share of government spending on education reached 17.2% in 2012 and 16.9% in 2021. These expenditures represent 6.2% in 2012 and 6.8% in 2020 of GDP, respectively (Http://donnees.banquemondiale.org/indicateur).
[3] Trends in International Mathematics and Science Study.

Nationale d'Evaluation du Système de l'Education, de la Formation et de la Recherche Scientifique (INE-SEFRS)) at the national level, 92% of Moroccan students in the 2nd year and 84% in the 3rd year of secondary school achieved scores in mathematics far below the national average. Similarly, in physics-chemistry and life and earth sciences, these percentages reached 86% and 90%, respectively, for students in the 3rd year of the same cycle (INE-CSEFRS (2014)).

Following a comparative approach and based on TIMSS data, this work consists in identifying the educational system characteristics that influence students' mathematics performance in eleven MENA countries that participated in this survey and deducing the main differences between these countries. It is also to determine the main factors of Morocco's performance compared to these countries. To do so, we will apply multilevel models in order to take account of the hierarchical nature of the data.

This work has a double interest : It is a contribution to analyse the characteristics of mathematics performance of a sample of MENA countries, particularly Morocco, while underlining the factors related to the national education system. It also seeks to identify the causes of our country's low ranking among the MENA countries examined. The results of this work will provide a useful contribution for decision makers to better define the required corrective actions.

After a review of the literature on the determinants of school performance, especially those related to national characteristics, the study will present a comparative statistical analysis of the school performance of the selected countries, with a focus on the case of Morocco. Finally, we present the multilevel models and discuss the estimations results and the main conclusions.

1. School performance and national characteristics : a literature review

Many studies tried to explain school performance by using variables related to national characteristics. These can be grouped into two categories: economic and social characteristics on the one hand, and variables related to the education system on the other hand[4].

1.1. Importance of economic wealth and education spending

Some studies have highlighted the positive effect of the economic growth rate

[4] For more detail on this issue, see Abbaia (2017).

on student performance. Particularly, Hanushek and Woessmann (2006) have shown that there is a positive and significant relationship between school performance and the growth rate of GDP per capita.

Similarly, Lee and Barro (2001) have shown that the economic wealth of the country, as well as the school resources, have a significant effect on the academic performance of students. Indeed, using panel data of many countries, these authors found a positive and significant effect of teacher remuneration on students' test scores. However, the study found a negative, but not significant, effect of education spending on student scores.

Similarly, when Gupta et al. (1999) measured the quality of education by the enrolment and persistence rate of students up to the fourth grade of primary school, they showed that while total spending on education has only a small effect on persistence, the share of spending on primary and secondary education has a positive and significant effect on the quality of education.

Furthermore, in a study of school efficiency and equity in several countries, Hanushek and Luque (2003) used TIMSS 1995 data from 35 countries. The objective was to study the impact of resources such as improved teacher training and smaller class sizes on student academic performance. The results showed, on the one hand, that the effect of resources does not seem to be related to the income level of the country, and that the problem is related to resource inefficiency on the other hand.

In a paper on MENA countries, Heyneman (1997) concluded that the low quality of education in these countries is not due to financial problems, but is rather the result of inefficient management of resource allocation, characterized in these countries by centralized planning.

Heyneman and Loxley (1982) showed that a country's level of economic development, measured by gross national product (GNP), determines the extent of the relationship between school resources and household socio-economic status on the one side and school performance on the other. Using data collected in 1970, these authors showed an important effect of household socio-economic status in developed countries, while the impact of school resources is limited. For developing countries, the results showed a stronger school effect than the household

socioeconomic status one.

Generally speaking, and as concluded by Leclercq (2005), studies seeking to investigate the relationship between education expenditure and school performance have failed to establish a robust empirical pattern.

1.2. Effects of education system characteristics

Among studies on the origins of inequalities in school performance, several factors related to the education system have attracted the attention of researchers. Essentially, these are the degree of school autonomy, the outsourcing of examinations, the adoption of early separation of students into different educational pathways, and the situation of pre-school education.

- ***School autonomy***

Since local decision-makers are the most qualified to make the right decisions and actions in order to improve the quality of education at the local level, several researchers have studied the effect of autonomy or decentralization of school-level policy-making on students' academic performance.

Several studies have revealed that students perform better when the education system has more autonomy in school management (Woessmann (2001, 2003b), Falch and Fischer (2008b), Fuchs and Woessmann (2007), Woessmann, Luedemann, Schuetz and West (2009)).

Using TIMSS 1995 data for some East Asian countries, Woessmann (2003b) showed that the resources allocated and in particular the size of the class did not have a strong impact on student performance. The author also found that school policies, such as school autonomy in terms of salaries (Japan and Singapore), and the regular assignment of homework (Hong Kong, Japan and Singapore), had a significant impact on students' scores.

- ***Examination system***

The outsourcing of examinations is considered by researchers to be a key factor in explaining differences in school performance between students in different education systems. The involvement of an external agency in conducting examinations provides an objective assessment of the quality of education and, consequently, of the performance of local educational managers.

In a study based on 1991 IAEP (International Assessment of Educational Progress) data of several countries, Bishop (1995) found that when the education system is based on examination outsourcing, students perform better in mathematics and geography. According to this author, this positive relationship is associated with higher teacher recruitment requirements.

In some countries, the examination system is managed either at the national or local (regional or provincial) level.

The centralized examination system allows a comparison of students' academic performance and, consequently, of the performance of schools and of the deconcentrated and decentralized services of the government authority in charge of educational affairs. Consequently, centralized testing is used by several researchers to explain differences in student achievement across countries (Bishop (2006), Woessmann (2002, 2005c)).

Using 1995 TIMSS data (39 countries) and TIMSS-Repeated data (38 countries) covering 450,000 students, Woessmann (2002) found that students from countries with a centralized testing system had higher scores in mathematics than students from countries without a centralized testing system.

- ***Early separation and orientation***

Some countries adopt the separation of pupils and early selection model. From the end of elementary school, pupils are oriented, according to their results, towards different educational tracks.

Researchers have considered the early orientation and separation of pupils as important factors in explaining school performance inequalities. Thus, some empirical work carried out in France has shown that the early separation of pupils into unequal tracks produces and increases inequalities in achievement according to social origin (Girard and Bastide (INED, 1966) Baudelot and Establet (1971)). These results have been confirmed by more recent studies : Based on PIRLS, TIMSS, and PISA (Programme for International Student Assessment) data from several countries, Hanushek and Woessmann (2006) have shown that the organization into streams contributes to the widening of inequalities between students from one level to another.

According to an OECD study (2005e), countries with earlier orientation in their education systems performed on average less than countries with more

integrated education systems in the PISA 2000 tests.

- ***Preschool education status***

Preschooling is intended to prepare children through pre-learning, mentoring, and familiarization with the learning environment for elementary school in order to ensure that they have every opportunity to succeed.

Preschooling is intended to prepare children through pre-learning, mentoring, and familiarization with the learning environment for elementary school in order to ensure that they have every opportunity to succeed.

Using 1995 TIMSS and TIMSS-R data for 54 countries, Schuetz, Ursprung, and Woessmann (2008) concluded that a long preschool duration improves equality of opportunity for school success. In addition, the preschool cycle duration adopted by the education system weakens the effect of the family's socioeconomic background on school performance.

Schuetz (2009) showed, in a paper based on the 2003 PISA data, that pre-school attendance is positively associated to student scores. The author also concluded that the effect of pre-primary attendance on test scores is greater in countries with higher per-pupil spending on pre-primary education, in those countries with a large share of private schools, and also in countries with well-trained and well-paid preschool teachers.

2. Statistical analysis of school performance : focus on the Moroccan case

This study is based on a secondary analysis of the 2011 TIMSS database for eleven MENA countries that participated in this survey. It focuses on 2nd year secondary school students. Our sample is composed of 73,260 students from 2,387 schools across 11 MENA countries :

Table 1: Characteristics of samples by country

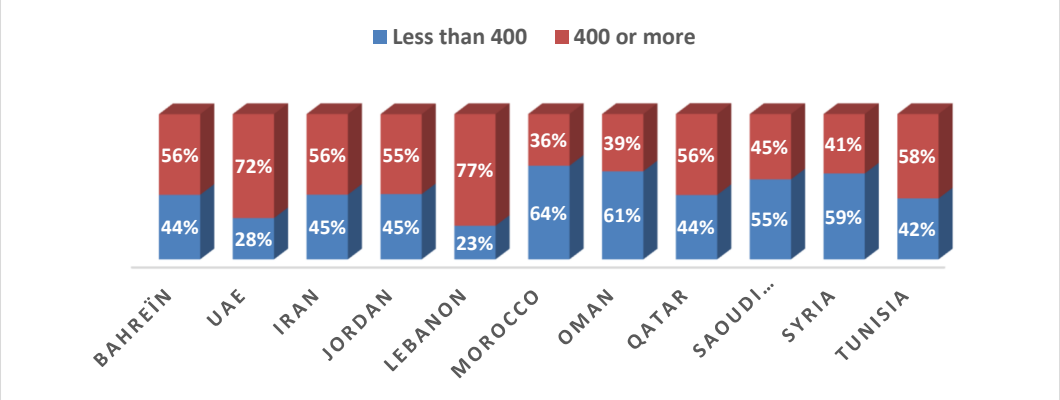
Countries	Number of schools *	Number of students*	Country average score in mathematics **	**Math score of 400 or higher (% of students)****
Bahreïn	95	4 640	409	**56**
United Arab Emirates	458	14 089	456	**72**
Iran	238	6 029	415	**55**
Jordan	230	7694	406	**55**
Lebanon	147	3974	449	**77**
Morocco	279	8985	371	**36**
Oman	323	9542	366	**39**
Qatar	109	4422	410	**56**
Saoudi Arabia	153	4344	394	**45**
Syria	148	4413	380	**41**
Tunisia	207	5128	425	**58**

*Sources : * 2011 TIMSS database ; **authors' calculations from 2011 TIMSS database.*

Evidence from Table 1 shows that, compared to the countries in our sample, Moroccan students achieved the lowest scores in mathematics. With an average score of 371, Morocco placed second to last followed by Oman with a score of 366. The United Arab Emirates followed by Lebanon occupied the first and second places with average scores of 456 and 449 respectively.

Moreover, graph 1 shows that 64% of Moroccan students and 61% of Omani students have scores below 400 points, recording, thus, the highest percentages of students with scores that can be considered as « very low»[5].

Graph 1: Distribution of students by score



Sources : 2011 TIMSS database, authors' calculations.

This study aims to analyze, through a comparative approach, Moroccan

[5] It is important to stress that the TIMSS study considers any score between 400 and 475 points as low. Therefore, we have qualified any score below 400 points as very low level.

educational performance compared to MENA countries and to identify the causes of the low ranking of Morocco among these countries.

2.1. National characteristics of the selected countries

Two sets of national-level variables of our sample are used in this study. The first category includes economic and social characteristics. Essentially, it concerns spending on education and the literacy rate. The second category concerns variables related to education systems.

Table 2 : Countries' socio-economic characteristics

Pays	Spending on education/GDP[6]	Education expenditure per pupil (in constant US $ 2009)[7]	Expenditure per secondary school pupil (% of GDP per capita)[8]	Literacy rate [9] (%)
Bahreïn	2,50	---	10	94,56
United Arab Emirates	1,20	2 773	12	90,03
Iran	4,79	830	20,28	85,02
Jordan	4,95	474	14,79	92,55
Lebanon	2,04	462	3,73	89,61
Morocco	5,56	459	30,73	67,08
Oman	4,19	2 320	14,38	86,94
Qatar	2,45	6 157	10,29	96,28
Saoudi Arabia	5,14	1 151	18,11	94,43
Syria	4,60	411	14,95	85,08
Tunisia	6,27	762	24,42	79,13

Source : World Bank data (http://donnees.banquemondiale.org/indicateur)

Table 2 reveals that although Morocco has limited resources and has made a significant budgetary effort to improve education, it has not performed as well as other countries such as Qatar, Bahrain, and the UAE in terms of both quantity and quality of education. Indeed, according to different studies, in all disciplines and at all grades studied, students' scores remain low compared to other countries participating in these programs. On the quantitative side, Morocco has the lowest

[6] Data refer to the year 2008 or the closest year for which information is available.
[7] This is the average expenditure over the period 2002-2010, all cycles combined.
[8] This is the share recorded in 2009 or the closest year.
[9] This rate represents the percentage of people aged 15 and over who are literate. It is the rate recorded in 2010 or the nearest year.

literacy rate among all the countries in our sample. While this rate is close to 90% in these countries, it is only 67.08% in Morocco.

The variables related to national education systems (Table 3) were extracted from the TIMSS[10] database. They include the time devoted to mathematics, the school's autonomy in choosing the syllabus, the mandatory nature of pre-school education, the pupil/teacher ratio, and the requirement of a professional qualification examination for teachers.

Table 3 : Countries' education systems characteristics

Pays	Mandatory pre-school education *	Requirement of a professional qualification examination for teachers *	School autonomy in curriculum choice *	Time spent on mathematics (% of school time)*	Secondary school pupil-teacher ratio [11]**
Bahreïn	Non	Non	Oui	17	12
United Arab Emirates	Oui	Non	Oui	15	17
Iran	Non	Non	Non	12	20
Jordan	Oui	Non	Non	15	20
Lebanon	Oui	Non	Oui	17	14
Morocco	Non	Oui	Non	13	26
Oman	Non	Oui	Oui	17	20
Qatar	Oui	Non	Non	17	11
Saoudi Arabia	Oui	Oui	Oui	12***	11
Syria	Oui	Oui	Oui	13	25
Tunisia	Oui	Oui	Non	11	17

Source :
** : 2011 TIMSS database (http://timssandpirls.bc.edu/timss2011/international-database.html) (T11_G8_CQ_Data) ;*
*** : World Bank data (http://donnees.banquemondiale.org/indicateur)*
**** : Author's estimate [12].*

The analysis of these variables shows that the budgetary effort deployed by

[10] This database is available on the IAE website (http://timssandpirls.bc.edu/timss2011/international-database.html) T11_G8_CQ_Data. For more information on these data, see Pierre Foy, Alka Arora, and Gabrielle M. Stanco (2013).
[11] This is the ratio recorded in 2011 or the closest year.
[12] Dividing the average number of hours spent on mathematics by the number of hours of instruction.

Morocco has not led to an improvement in student learning conditions, compared to other countries such as Qatar, Saudi Arabia or Bahrain, which have achieved remarkable performance in this area. For example, data in Table 3 show that Morocco's student-teacher ratio (26 students per teacher) remains the highest in the world.

Observing these data, especially the unfavorable situation of Morocco, raises the following questions that we are going to answer in the following paragraph : 1/ what are the factors that favor school performance in a country, particularly in Morocco ? 2/ why do some countries achieve higher performance than others ? what are the national characteristics that promote these achievements ?

3. Models presentation and results discussion

This paper aims to identify the factors associated with the education system that affect school performance across a sample of MENA countries, focusing on Morocco. Particularly, we estimate the differences in school performance between these countries and assess the effect of national characteristics on the probability of achieving a score of 400 points or more in the TIMSS mathematics test.

Our data are constructed of three hierarchical levels. In addition to the student and school levels, the third level involves countries.

The model has the following form :

$$\log\left[P_{ijk}/(1-P_{ijk})\right] = \beta_{0jk} + \beta_{1jk}X_{ijk} \quad \text{(Level 1)}$$

$$\beta_{0jk} = \beta_{00k} + \beta_{01k}Z_{jk} + \mu_{0jk} \quad \text{(Level 2)}$$

$$\beta_{1jk} = \beta_{100}$$

$$\beta_{00k} = \beta_{000} + \beta_{001}W_k + \upsilon_{00k} \quad \text{(Level 3)}$$

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

Replacing, in the level 1 models, , β_{0jk} and β_{1jk} with their values, we obtain the following complete model

$$\log\left[P_{ijk}/(1-P_{ijk})\right] = \beta_{000} + \beta_{100}X_{ijk} + \beta_{010}Z_{jk} + \beta_{001}W_k + \upsilon_{00k} + \mu_{0jk}$$

With :

- $P_{ijk} = \Pr(Y_{ijk} = 1)$: the probability that student i from school j in country

k achieves a score greater than or equal to 400 in mathematics ;

- β_{000} : is the average constant for all countries ;
- X_{ijk} : the vector of explanatory variables related to the student and his/her family environment ;
- β_{100} : represents the vector of explanatory variable effects X_{ijk} ;
- Z_{jk} : the vector of explanatory variables related to school (level 2 variables) ;
- β_{010} : represents the vector of level 2 explanatory variable effects(Z_{jk}) ;
- W_k : vector of explanatory variables related to the national context (level 3 variables) ;
- β_{001} : is the vector of explanatory variable effects in level 3 (W_k) ;
- μ_{0jk} : is the gap between each institution and the constant (it is a random variable with zero mean and variance σ_{μ}^{2}) ;
- υ_{00k} : represents the gap of each country with respect to the constant (it is a random variable with zero mean and variance σ_{υ}^{2}).

3.1. Estimating the empty model

The empty model[13] estimation enables us to estimate the share of the variance that is due to differences between countries, between schools and between students.

Table 4 : Empty (three-level) model explaining the probability of achieving a score of 400 points or more in mathematics

Fixed effects	
Constant	-0,2646 (0,2087) ***
Random effects	
Constant β_{00k}	2,0424 (0,0771) ***
Constant β_{000}	0,4663 (0,2037) ***
-2LogL	81 610
Number of countries	11
Number of institutions	2 387
Number of students	73 260

**** : significant at the 1% level; (estimated standard deviations are shown in parentheses).*
Source : TIMSS, authors' calculations.

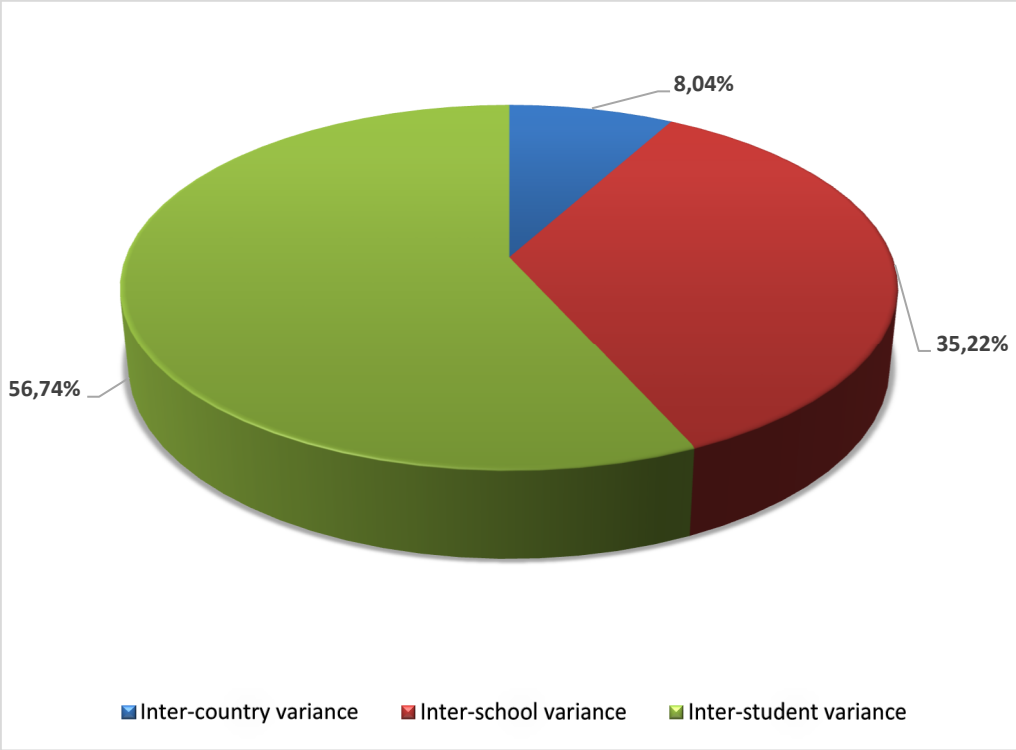
Based on the outputs of Table 4, we find that there is significant variance at

[13] Also called variance decomposition model

the higher level of the data (country level in our case), which justifies the use of multilevel models to analyze the effects of national characteristics on student academic performance.

Furthermore, our results show that the intra-country correlation coefficient is equal to 0.0804 (0.4663/0.4663+2.0424+3.29). Thus, 8.04% of the total variance is due to differences between countries[14].

Graph 2 : Distribution of total variance between data levels



Source: TIMSS, authors' calculations

3.2. A global model estimation

After checking the relevance of adopting multilevel models, we will then estimate a global model including all our explanatory variables.

Table 5 : Multilevel models explaining the probability of achieving a score of 400 points or more in mathematics

[14] Abbaia (2018), in a work that focused on the same sample of countries, showed that the share of inter-school variance in the total variance varies between 55% in Lebanon and 27% in Jordan.

Définition des variables	Coefficient	Standard error	Odds-Ratio
Fixed effects			
Constant	18,41***	2,24	
Individual variables			
• Sex of the student (1 if girl 0 if boy)	-0,14***	0,02	0,86
• Age of the student (in years)	-0,47***	0,01	0,62
• Time spent on homework (1 if 45 min or more; 0 if less than 45 min)	0,11***	0,02	1,12
Family variables			
• Use of the language of instruction in the home			
- Rarely or never	Réf.	Réf.	Réf.
- Often	0,19***	0,03	1,21
- Always	-0,02ns	0,02	0,97
• Number of books in the household			
- More than 25	Réf.	Réf.	Réf.
- Between 10 and 25	-0,44***	0,02	0,64
- Between 0 and 10	-0,64***	0,02	0,52
• Highest level of parental education			
- Primary or less	Réf.	Réf.	Réf.
- More than elementary and less than high school	0,25***	0,02	1,29
- High school or more	0,79***	0,02	2,20
School context variables			
• Average household income in the region			
- Low	Réf.	Réf.	Réf.
- Medium	0,41***	0,06	1,51
- High	0,80***	0,11	2,24
• Parent participation in school activities			
- Low	Réf.	Réf.	Réf.
- Medium	0,28***	0,06	1,32
- High	0,82***	0,07	2,28
• Level of discipline and safety in the school			
- Low	Réf.	Réf.	Réf.
- Medium	0,08ns	0,07	1,08ns
- High	0,35***	0,07	1,42
• Availability of computers in the school			
- 1 for every 6 or more students	Réf.	Réf.	Réf.
- 1 for every 3 to 5 students	0,19**	0,07	1,21
- 1 for every 2 students or less	0,17**	0,08	1,18
National variables			
• Mandatory nature of preschool (1 if yes; 0 otherwise)	0,87***	0,12	2,40
• Requirement of a professional qualification examination for teachers (1 if yes; 0 if no)	-2,50***	0,25	0,08
• Autonomy of the schools in the choice of the program (1 if yes; 0 otherwise)	1,55***	0,20	4,75
• Time devoted to mathematics (as a percentage of total teaching time)	0,06*	0,03	1,06
• Student/teacher ratio	-0,13***	0,01	0,87
• Expenditure on education (as a percentage of GDP)	0,48***	0,09	1,63
• Literacy rate	-0,16***	0,01	0,84
Fixed effects	Variance		
Constant (school) β_{00k}	1,468***		

Constant (country) β_{000}	0,013***
-2LogL	76 944
Deviance (from the empty model)	4 666

ns: not significant; significant at the 10% threshold;** significant at the 5% threshold;*** significant at the 1% threshold.*

4. Results discussion

Besides student and family variables and school variables, school system characteristics have a significant effect on students' academic performance.

Our results show that the pupil/teacher ratio, as well as the requirement of a professional qualification examination for teachers, have a significant and negative effect on the probability of achieving a score of 400 points or more in mathematics.

Furthermore, educational expenditure, the amount of time devoted to mathematics teaching, the compulsory nature of pre-school education, and the autonomy of schools in the choice of curriculum have a positive and significant effect on the academic performance of students.

4.1. Compulsory nature of pre-school education

Although pre-school education is available in all the countries in our sample, in some countries compulsory pre-school education has not yet been adopted.

Our results show that students from countries with compulsory pre-school education are more likely to achieve high scores in mathematics than students from other countries. The probability of achieving a score of 400 points or more in mathematics is multiplied by 2.40 for the former compared to the latter.

An education system with compulsory pre-school education ensures good preparation for all students before they enter primary school. In contrast, when pre-school education is not compulsory, only students from wealthy families attend this level of education[15]. As a result, a significant proportion of students are doubly penalized. On the one hand, students who do not attend preschool find it difficult to keep up with the learning pace of preschoolers. This leads to an increase in

[15] When it is not compulsory, pre-school education is chargeable in most countries. In Morocco, while several stakeholders (Ministry of Education, local authorities, associations, etc.) have made efforts to provide pre-school education for all children, few students, especially in rural areas, benefit from this cycle before joining primary school.

inequalities between students. On the other hand, the syllabus for the first year of primary school is often inappropriate for students who did not attend preschool. Generally, these programs are designed for students who have acquired the basic knowledge and skills taught in preschool[16,17].

4.2. Teacher Qualification Examination Requirement

The estimation results show that students from countries whose education system requires teachers to pass a professional qualification exam are less likely to achieve a high score compared to other students. The probability of achieving a score of 400 points or more in mathematics among the former is increased by 0.08 times compared to the latter.

By requiring teachers to take a professional qualification exam, policymakers seek to ensure that teachers have mastered the skills necessary to practice their profession.

Usually, a teacher's successful completion of the professional qualification exam leads to the teacher's tenure. Thus, it could be said that, after tenure, the teacher no longer makes the effort necessary to provide high-quality instruction.

4.3. School autonomy in the choice of curriculum

The estimation results show that students from countries with school autonomy in curriculum choice are more likely to perform well in mathematics than other students. The probability of achieving a score of 400 points or more in mathematics is increased by a factor of 4.75 for the former compared to the latter.

Thus, the autonomy granted to the school in the choice of curriculum is associated with an increase in the accountability of school managers. With this autonomy in curriculum choice, school officials no longer have the opportunity to justify weak academic performance of their students by the inadequacy of the curriculum to the needs of those students.

Moreover, autonomy in curriculum choice allows schools to take into account

[16] Here we could refer to the prerequisites that non-preschool students lack.
[17] This problem could be solved by giving schools the autonomy to choose programs according to the students' initial level.

the economic, social and cultural characteristics of the region. For example, because rural students spend more time providing support to their parents who work in agriculture, and because of the high rate of parental illiteracy in rural areas, a rural school would have to choose a curriculum that avoids a heavy emphasis on homework.

4.4. Time dedicated to mathematics teaching

Results show that the percentage of time spent on mathematics instruction positively and significantly affects the probability of achieving a high score in mathematics. Increasing the percentage of time spent on mathematics instruction by one point increases the probability of achieving a score of 400 points or more by 6%.

This result is similar to those of Fuchs and Woessmann (2007). These authors showed that the amount of time spent on instruction, measured in minutes per year at the school level, has a positive and significant effect on students' math and science scores.

4.5. Pupil/ teacher ratio [18]

The estimation results reveal that the number of pupils per teacher, measured at the country level, has a negative effect on the probability of achieving a score of 400 points or more in mathematics among students. All else being equal, increasing the student-teacher ratio by one translates into a 13% reduction in the probability of achieving a score of 400 points or more in math.

The pupil/teacher ratio strongly affects the learning conditions of the students. A large class size can weaken the concentration and motivation of students in the classroom. If the teacher is unable to give equal attention to all students in a large class, he or she will focus on the good students and marginalize the weak ones. In addition, in such conditions, the teacher often resorts to lectures. This direct method of teaching[19], characterized by the absence of any interactivity and feedback, is not appropriate for high school students.

On the other hand, large class sizes provide a fertile field for anti-learning

[18] This variable provides information on the effort made by the state in terms of investment in the construction of schools on the one hand, and in the recruitment of teachers on the other.
[19] This is also known as the transmissive model. In this approach to teaching, the student is considered a receiver of knowledge given by the teacher.

practices such as violence and indiscipline[20], which requires an extra effort to manage classroom discipline on the part of the teacher. In his review of the literature on empirical work dealing with teacher burnout, Byrne (1999) concluded that a poor classroom climate plays a fundamental role in the emergence of teacher stress[21].

4.6. Education Expenditures

The findings show that the share of the country's wealth devoted to education spending has a positive and significant effect on the probability of students achieving a score of 400 points or more in mathematics. An increase in the percentage of the country's wealth devoted to education spending by one point results in a 63% improvement in the probability of achieving a score of 400 points or more in math.

Two factors may explain the positive effect of the share of the country's wealth devoted to education spending :

On the one hand, the allocation of the appropriate financial resources to the field of education leads to the improvement of learning conditions among students. Indeed, by bringing schools closer to students[22], providing the necessary teaching materials, creating and managing boarding schools and school canteens, public decision-makers guarantee students the conditions to achieve good academic results.

On the other hand, significant financial resources devoted to the remuneration and training of teachers contribute to the improvement of their level of competence and motivation, which has a positive impact on the academic performance of students.

4.7. Literacy rate

Contrary to all intuition, our results show that the higher the literacy rate in the country, the less chance students have of achieving a score of 400 points or more.

This result can be explained by the fact that in oil countries such as Saudi Arabia, Bahrain, Qatar and Oman which have high literacy rates ; 95%, 95%, 96%

[20] Martin, Morcillo, and Blin (2004) define undisciplined behavior as violations of order and discipline necessary for the proper conduct of the lesson.
[21] These are mainly discipline problems, apathy, lack of motivation, lack of effort as well as verbal and physical aggression.
[22] In particular, through the creation of schools in rural and isolated areas.

and 87% respectively, the percentage of students who achieved a score of 400 points or more in mathematics did not exceed 45%, 56%, 56% and 39% respectively. In contrast, in countries such as Tunisia and Lebanon where the proportion of students with a score of 400 points or more is 58% and 77% respectively, the literacy rates are only 80% and 90% respectively.

It appears, for example, that in oil-producing countries, educational efforts are much more focused on quantitative than qualitative aspects.

Contrary to all intuition, our results show that the higher the literacy rate in the country, the less likely it is that students will achieve a score of 400 points or more.

This result can be explained by the fact that in oil-producing countries such as Saudi Arabia, Bahrain, Qatar and Oman, which have high literacy rates of 95%, 95%, 96% and 87% respectively, the percentage of students with a score of 400 points or more did not exceed 45%, 56%, 56% and 39% respectively. However, in countries such as Tunisia and Lebanon where the proportion of students with a score of 400 points or more is 58% and 77% respectively, the literacy rates are only 80% and 90% respectively.

It seems, therefore, that in oil-producing countries, efforts in the field of education are much more concentrated on quantitative aspects than on qualitative ones.

Conclusion

This research aims to identify the characteristics of the education system that policymakers can influence in order to improve the academic performance of students in MENA countries and Morocco in particular.

Thus, our analysis took into account variables related to the countries' education systems, such as school autonomy regarding curriculum choice and the compulsory nature of preschool education. To do so, we used the 2011 TIMSS data for the second year of secondary school.

Considering variables belonging to hierarchical levels (students, schools and countries), it was necessary to estimate multilevel models in order to overcome the weaknesses of classical models when using nested data.

The estimation of a three-level empty model, to explain the probability of students achieving a score greater than or equal to 400 points in mathematics, found

that a significant and significant part (8.04%) of the total variance is due to differences between country characteristics. The remainder is related to differences between schools (35.22%) and students (56.74%).

The inclusion of national variables in the model showed that in Morocco, students' academic performance could be improved by granting autonomy to schools in the choice of curricula, making preschool a compulsory education cycle, and increasing the volume of time reserved for mathematics instruction.

In addition, reducing class sizes would contribute to improve the learning and teaching conditions and the academic performance of students.

The results also showed that the requirement of a professional qualification exam for teachers has a negative effect on students' academic performance in mathematics.

References

Abbaia A., Mourji F. (2018). Inégalités sociales et performances scolaires : quel rôle palliatif des politiques publiques en matière d'éducation ? *Symposium International « Les logiques et la portée des modèles économiques : vers un éclairage du modèle du Maroc » 21 – 23 mars 2018, Casablanca (Maroc).*

Abbaia A., (2017). Analyse des performances scolaires et des aspirations des élèves au Maroc : Application des modèles multiniveaux. *Thèse de Doctorat - FSJES, Université Hassan II Casablanca*.

Abbaia, A. (2018). Evaluation des inégalités contextuelles de performance scolaire : la place du Maroc parmi quelques pays de la zone MENA. *Revue « Al-Madrassa Al-Maghribiya », numéro double 7, 8*.

Baudelot, C., & Establet, R. (1971). L'école capitaliste en France. Paris, Éditions Maspero. Paris : Éditions Maespro.

Bishop, J. (2006). Drinking from the fountain of knowledge: Student incentive to study and learn–externalities, information problems and peer pressure. Handbook of the Economics of Education, 2, 909-944.

Bishop, J. H. (1995). The impact of curriculum-based external examinations on school priorities and student learning. *International Journal of Educational Research, 23*(8), 653-752.

Bishop, J. H. (1997). The effect of national standards and curriculum-based exams on achievement. *The American Economic Review, 87*(2), 260-264.

Byrne, B. M. (1999). The nomological network of teacher burnout: A literature review and empirically validated model. Understanding and preventing teacher burnout: A sourcebook of international research and practice, 15-37.

Falch, T., & Fischer, J. A. (2008b). Public sector decentralization and school performance: International evidence. Norwegian University of Science and Technology, Department of Economics NTNU Working Paper 4/2008 (October).

Foy, P., Arora, A., & Stanco, G. M. (2013). TIMSS 2011 User Guide for the International Database. *TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College and International Association for the Evaluation of Educational Achievement (IEA).*

Fuchs, T., & Woessmann, L. (2007). What Accounts for International Differences in Student Performance. A Re-Examination Using PISA Data. *Empirical Eco. 32*(2–3), 433–462.

Girard, A., Bastide, H. (1966). Les facteurs psychologiques et sociaux de l'orientation et de la sélection scolaires. In *Population et l'enseignement. Paris : P.U.F.*

Gupta, M. S., Tiongson, M. E., & Verhoeven, M. (1999). Does higher government spending buy better results in education and health care? *International Monetary Fund [IMF], Working Paper 99/21, February.*

Hanushek, E. A., & Kimko, D. D. (2000). Schooling, labor-force quality, and the growth of nations. *American economic review, 90*(5), 1184-1208.

Hanushek, E. A., & Luque, J. A. (2003). Efficiency and equity in schools around the world. *Economics of education Review, 22*(5), 481-502.

Hanushek, E. A., & Woessmann, L. (2006). Does educational tracking affect performance and inequality? Differences-in-differences evidence across countries. *The Economic Journal, 116*(510), C63-C76.

Heyneman, S. P. (1997). The quality of education in the Middle East and North Africa (MENA). *International Journal of Educational Development, 17*(4), 449-466.

Heyneman, S. P., & Loxley, W. A. (1982). Influences on academic achievement across high- and low-income countries: A re-analysis of IEA data. *Sociology of education, 55*(1), 13-21.

Instance Nationale d'Evaluation du Système de l'Education, de la Formation et de la Recherche Scientifique (INE-SEFRS), Conseil Supérieur de l'Education, de la Formation et de la Recherche Scientifique. (2014). La mise en œuvre de la Charte Nationale d'Education et Formation 2000-2013. Rapport Analytique.

Leclercq, F. (2005). The relationship between educational expenditures and outcomes. Document de Travail. DT/2005-05 DIAL, Paris.

Lee, J. W., & Barro, R. J. (2001). Schooling quality in a cross–section of countries. *Economica, 68*(272), 465-488.

Martin, F., Morcillo, A., & Blin, J. F. (2004). Le vécu émotionnel des enseignants confrontés à des perturbations scolaires. Revue des sciences de l'éducation, 30(3), 579-604.

Mondiale, B. (2008). The road not traveled: Education reform in the Middle East and North Africa. Washington, DC: The World Bank

Mourji, F., & Abbaia, A. (2013). Les déterminants du rendement scolaire en mathématiques chez les élèves de l'enseignement secondaire collégial au Maroc : Une analyse multiniveaux. *Revue d'économie du développement, 21*(1), 127-158.

Mullis, I. V., Martin, M. O., Foy, P., & Arora, A. (2012). TIMSS 2011 international results in mathematics. International Association for the Evaluation of Educational Achievement. Herengracht 487, Amsterdam, 1017 BT, The Netherlands.

OCDE (2005e). De l'école à la vie active : Une transition difficile pour les jeunes adultes peu qualifiés. OCDE, Paris.

Schütz, G. (2009). Does the quality of pre-primary education pay off in secondary school? An international comparison using PISA 2003 (No. 68). Ifo Working Paper.

Schütz, G., Ursprung, H. W., & Woessmann, L. (2008). Education policy and equality of opportunity. *Kyklos, 61*(2), 279-308.

Woessmann*, L. (2001).* Why Students in Some Countries Do Better: International Evidence on the Importance of Education Policy. *Education matters, 1*(2), 67-74.

Woessmann, L. (2002). How central exams affect educational achievement: International evidence from TIMSS and TIMSS-Repeat. Harvard University Program on Education Policy and Governance Working Paper No. PEPG/02-10.

Woessmann, L. (2003). Schooling resources, educational institutions and student performance: the international evidence. *Oxford bulletin of economics and statistics, 65*(2), 117-170.

Woessmann, L. (2005). The effect heterogeneity of central examinations: evidence from TIMSS, TIMSS-Repeat and PISA. *Education Economics, 13*(2), 143-169.

Woessmann, L., Luedemann, E., Schuetz, G., & Martin, R. (2009). West (2009) School Accountability, Autonomy and Choice around the World ». EdwardWorld. Edward Elgar.