5 Evaluation of reading achievement of the program school 2.0 in Spain using PISA 2012

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Abstract

In 2009, some Spanish regions implemented the Program School 2.0 with the purpose of introducing digital methodologies at schools. The aim of this paper is to analyse which part of the variation in reading scores is due to this program. For this purpose, we use data from the Program for International Student Assessment (PISA 2009 and 2012) for 15-year old students attending public schools. We estimate a difference-in-difference model and observe that the net effect derived from an increase in the provision of Information and Communications Technology (ICT) at schools has been positive, although small, in participant regions. However, elapsed time since the onset of the program has not equally affected repeater and non-repeater students. Finally, only a moderate use (1-2 times/week) of ICT for doing homework has a positive effect over reading scores.

Keywords: reading, PISA, ICT, Spain.

1. Introduction

The analysis of the implementation of ICT in schools and high schools has sparked debate during the last decade. Some studies have appreciated a substantial improvement of students' achievement as a result of the introduction

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of ICT. Machin, McNally, and Silva (2007) used an instrumental variables approach to control for a potential endogeneity problem of the use of ICT, and concluded that the increase in computer investment had improved academic results in Elementary education. In the same line, Banerjee, Cole, Duflo, and Linden (2004) for India, Barrow, Nmarkman, and Rouse (2009) for the United States and Carrillo, Onofa, and Ponce (2010) for Canada, ascertained a positive influence of ICT over academic results.

However, other analyses have found an insignificant or even negative relationship between both variables. Golsbee and Guryan (2002) concluded that a program implemented in the United States aimed at increasing the computer-to-student ratio had not had any significant effect over students' achievement. For Israel, Angrist and Lavy (2002) observed a negative effect of ICT over Mathematics scores for 4th grade students. Similarly, Leuven, Lindahl, Oosterbeek, and Webbink (2004) concluded that the increase of computer-to-student ratio in Dutch schools had led to worse Language and Mathematics results.

2. The program school 2.0

In July 2009, the Spanish Ministry of Education approved the development of the Program School 2.0, whose objectives were: provide each student with a notebook or digital pad, transform all classrooms into digital classrooms, offer instruction to teachers and prepare new digital contents.

The program was implemented in 5th and 6th grade of Elementary Education and 1st and 2nd grade of High School, but only in public centers. Participation in the Program was not homogeneous across Communities, and the following classification can be established (see CEAPA, 2010):

- Communities that applied the Program in all centers, denoted 'Total Participants' (TP): Andalucía, Aragón, Cantabria, Castilla La Mancha, Castilla-León, Cataluña, Extremadura, Galicia, Navarra, País Vasco, Rioja, Ceuta and Melilla.

- Communities that applied the Program in a fraction of centers denoted as 'Partial Participants' (PP) Asturias, Baleares and Canarias.

- Communities that did not implemented the Program, denoted as 'Non-Participants' (NP): Madrid, Murcia and Comunidad Valenciana.

3. Data

Data come from PISA survey carried out by the Organisation for Economic Cooperation and Development (OECD) every three years to assess the competencies of 15-year-old students in reading, mathematics and science. This paper is focused on students with level ISCED-2A[2] attending public centers. We have a sample of 15,375 observations for the general module and 5,579 observations for the Computer Based Assessment (CBA) module.

To assess the success degree of the Program School 2.0, it is necessary to compare reading scores in 2012 with pre-implementation scores. We incorporate 11,049 observations from PISA 2009 and 1,897 from PISA-Electronic Reading Assessment (ERA).

Table 1 shows reading scores in 2009 and 2012 by type of participation. For non-repeater students, there is no significant difference among the three types of Communities, neither in 2009 nor in 2012. In the modules ERA (2009) and CBA (2012), we appreciate that NP and TP attain higher scores than PP. For 1-year repeaters, mean score for TP was higher than for NP in 2009, but quite the opposite happens in the module CBA (2012).

For 2-year repeater students, the mean score for NP was higher than for PP according to PISA-ERA (2009), but no significant differences are observed in electronic reading achievement in 2012.

2. International Standard Classification of Education; 2A: Secondary School Intermediate Level

Table 1. Descriptive statistics for reading scores

	Has participated in School 2.0?			Test for equal means		
	No (1)	Totally (2)	Partially (3)	(1) vs (2)	(1) vs (3)	(2) vs (3)
PISA (2009). General Module						
Total	436.80	446.59	450.79	0.0613	0.0071	0.1266
No rep	490.94	489.83	495.94	0.6274	0.5828	0.1888
1-year rep.	397.22	410.66	416.00	0.0055	0.0082	0.6360
2-year rep.	347.26	342.49	353.60	0.1835	0.1762	0.8312
PISA (2009). ERA						
Total	488.82	481.82	438.28	0.7392	0.0000	0.0000
No rep	522.84	514.80	487.51	0.7627	0.0000	0.0000
1-year rep.	447.51	441.83	409.91	0.2631	0.1692	0.0310
2-year rep.	416.88	410.65	383.09	0.7372	0.0064	0.0157
PISA (2012). General Module						
Total	477.14	480.21	457.54	0.0116	0.6465	0.0596
No rep	515.26	513.98	502.00	0.4394	0.1898	0.3533
1-year rep.	440.54	431.44	421.68	0.2044	0.3079	0.1736
2-year rep.	390.63	381.16	375.27	0.9505	0.6076	0.5060
PISA (2012). CBA						
Total	470.77	477.89	457.48	0.1478	0.1107	0.0066
No rep	507.35	512.51	490.67	0.8205	0.0373	0.0252
1-year rep.	437.98	423.59	420.74	0.0001	0.0861	0.5544
2-year rep.	379.57	380.60	378.91	0.8595	0.6036	0.8675

Table 2 shows the degree of use of ICT at schools and students' households according to the type of participation in the Program School 2.0. In 2009, all Communities exhibited similar levels of technological equipment at schools (0.15-0.16). In 2012, the highest ratio of computer-per-student corresponds to TP Communities (0.65). Regarding the provision of technological equipment, there has been a higher investment in PCs in PP Communities (69%) in comparison with notebooks in TP Communities (31%).

Nearly 20% of students belonging to TP or PP Communities have reported that they use ICT for 'looking for information' at school 'almost every day' or 'every day', as opposed to only 12% in NP Communities. In the context of using ICT for 'practice/drilling' or 'doing homework at school', the percentage is higher in PP Communities (14% and 11%) as opposed to TP Communities (9%).

Finally, around 12% of students of TP or PP have reported to use ICT to do their homework (at home) 'almost every day' or 'every day'.

Table 2. Implementation of ICT at schools and students' households; PISA (2012)

	Autonomous Communities		
	Total participants	Partial participants	No participants
Ratio computers-per-student 2009	0.15	0.15	0.16
Ratio computers-per-student 2012	0.65	0.63	0.57
At classroom, the student has PC (%)	56.6	69.14	61.43
At classroom, the student has Notebook (%)	30.99	20.90	6.97
ICT for looking for information at school (%)			
1-2 times/week	28.74	28.50	27.95
Almost every day/every day	19.95	19.20	12.72
ICT for practice/drilling at school (%)			
1-2 times/week	15.11	19.41	14.8
Almost every day/every day	8.69	14.18	7.08
ICT for doing homework at school (%)			
1-2 times/week	13.27	11.76	10.52
Almost every day/every day	8.94	11.13	5.66
At home, the student uses ICT for doing homework (%)			
1-2 times/week	20.35	23.70	19.46
Almost every day	10.86	12.75	7.51
Every day	4.99	4.18	3.28

4. Econometric model

Due to space limitations, the econometric analysis is restricted the comparison between NP and TP. To disentangle which part of the score variation is due to the participation in the Program, we propose to estimate a difference-in-difference model. The dependent variable is the reading score of student *i* belonging to school *j* ($Read_{ij}$):

$$Read_{ij} = {}_0 + {}_1X_i + {}_2X_j + {}_3Year_{2012} + {}_4Part_j + {}_3Year_{2012} \cdot Part_j + \varepsilon_i + \mu_j + \upsilon_{ij}$$

Where X_i refers to characteristics of the student and his/her family (nationality, age when arrived at Spain, language spoken at home, immigrant mother/father, lives with only one parent, minutes per week devoted to reading at home, having more than 100 books at home, level of education of father/mother, relation with economic activity of father/mother); X_j refers to school characteristics (size of municipality, class size, proportion of girls at class, proportion of immigrants students); $Part_j$ takes the value 1 if the Community has participated in School 2.0; $Year_{2012}$ takes the value 1 in 2012; $Year_{2012} \cdot Part_j$ denotes the interaction between participation in School 2.0 and year 2012; ε_i and μ_j denote student and school unobservable characteristics, and υ_{ij} is a random error term. For the estimation of the model, the methodology proposed by OECD (2009) has been followed.

4.1. Results for PISA (2009) and PISA (2012)

A higher ratio of computers-per-student, as illustrated in Table 3, has a negative effect over reading score for non-repeaters (-75.93 points) and 2-year repeaters (-141.35 points). However, for the case of TP this negative effect is offset by a positive one (86.04 for non-repeaters, 154.87 for 2-year repeaters).

The starting year of the Program has meaningfully influenced reading scores. It is negative for non-repeaters and 1-year repeaters, although smaller in absolute value for those who started in 2009 as compared to 2010. This could indicate that there is a learning curve and students need some time to come to terms with the new teaching methodology. On the other hand, the difference in the estimated coefficients between non-repeaters and 1-year repeaters is thought-provoking. It could be that new teaching methodologies have involved a step backward for 1-year repeater students.

GDP[3] per capita has been introduced as a proxy of regional purchasing power. The interaction with participation in the Program is positive and significant, although with a very small magnitude. Therefore, the results of the Program School 2.0 have not been conditioned by regional economic differences.

3. Gross Domestic Product

Table 3. Difference-in-difference regression for reading scores

	No repeater		1-year repeater		2-year repeater	
	Coef	**t**	**Coef**	**t**	**Coef**	**t**
Computers-per-student	-75.93	-3.40	-63.98	-1.24	-141.35	-4.03
Growth rate of computers-per-student 2007-2012	0.99	2.23	1.04	1.35	1.74	2.62
Has notebook/digital pad in school	-5.28	-2.55	-11.12	-3.41	-13.40	-3.01
Participation in School 2.0	9.35	1.36	0.53	0.03	15.05	1.27
Year 2012	17.64	2.49	32.68	3.28	63.62	5.54
Interaction with participation in School 2.0:						
Computers-per-student	86.04	3.52	81.55	1.52	154.87	4.46
Notebook at school	-2.85	-0.95	4.90	1.13	4.05	0.56
Year 2012	-14.35	-1.36	-15.46	-0.92	-54.51	-2.23
Growth rate computers-per-student 2009-2012	-1.18	-2.48	-1.24	-1.53	-1.78	-2.53
Program started in 2009	-14.90	-3.33	8.84	0.60	-59.68	-3.30
Program started in 2010	-19.56	-5.07	-2.65	-0.17	-29.67	-2.41
Constant	428.22	56.56	383.59	30.11	280.06	19.69
N	**14,200**		**6,102**		**1,762**	
R^2	**0.1558**		**0.1306**		**0.2140**	

4.2. Results for PISA-ERA (2009) and PISA-CBA (2012)

Using the special modules of ERA (PISA, 2009) and CBA (PISA, 2012), the difference-in-difference model has been estimated to determine the influence of the Program School 2.0 over the development of digital competences (see Table 4). Explanatory variables are the same as in Table 3.

The variable year 2012 is significant and negative for non-repeaters (-90.23 points) and for 2-year repeaters (-151.41 points). This variable affects both PP and NP, and may gather a group of sociological determinants that have damaged the intrinsic value of education and learning. For the same group of students, the participation in the Program School 2.0 has implied an additional decrease of reading scores (-58.76 and -124.82 points, respectively).

Table 4. Difference-in-difference regression for electronic reading scores

	No repeater		1-year repeater		2-year repeater	
	Coef	**t**	**Coef**	**t**	**Coef**	**t**
Computers-per-student	0.00	-0.04	0.01	0.60	-0.01	-0.05
Growth rate of computers	-0.33	-0.96	-0.96	-2.74	-0.01	-0.13
Notebook at school	-23.36	-1.72	3.59	0.18	-27.77	-1.24
Uses ICT for homework						
1-2 times/month	7.20	0.48	21.83	1.35	-12.91	-0.88
1-2 times/week	55.62	4.66	-0.19	-0.01	-54.68	-3.39
Almost all days	5.67	0.36	0.15	0.01	-20.41	-1.08
Participation in School 2.0	-58.76	-2.45	-15.45	-0.59	-124.82	-4.14
Year 2012	-90.23	-4.51	24.37	-1.06	-151.41	-3.19
Interaction with School 2.0						
Computers-per-student	21.55	1.02	1.54	0.12	13.42	0.72
Notebook at school	33.78	1.78	-30.54	-1.63	35.77	1.58
Year 2012	81.00	1.72	-6.67	-0.20	136.23	1.57
Growth rate computers	0.36	0.67	0.86	2.12	0.27	0.26
ICT for homework						
1-2 times/month	33.74	2.48	24.65	1.37	31.512	1.43
1-2 times/week	-14.20	-1.19	7.79	0.37	104.77	5.14
Almost all days	34.84	1.65	19.14	0.85	56.33	1.71
Constant	505.76	13.66	414.98	10.23	535.49	9.68
N	**4,933**		**1,609**		**499**	
R^2	**0.2700**		**0.3092**		**0.6334**	

Using ICT for doing homework is only significant for the category 1-2 times/ week for non-repeaters (55.62 points) and 2-year repeaters (-54.68 points). The interaction between participation in School 2.0 and ICT for homework 1-2 times/ week is positive and significant for 2-year repeater students (+104.77). This result implies that, for this specific group, there has been a remarkable difference in the benefit derived from the use of ICT at home between NP and PP.

5. Conclusions

Our results show that the increase in the provision of computers has different effects over reading scores based on the teaching methodology applied. The

increase in the provision of computers in total participant Communities leads to positive (although small) effects over academic performance. For TP and NP, the negative effect of the variable year 2012 is quite alarming. We should analyse which combination of factors has damaged reading scores (i.e. implication of families in children's education, influence of depressive economic contexts…).

Regarding the use of ICT at home, a moderate use (1-2 times/week) has positive effects for non-repeater students, although a negative one for 2-year repeater students. However, the interaction of participation and ICT for homework 1-2 times/week shows a positive and significant effect for 2-year repeater students, which offsets the previous negative one. The implications of these results are twofold: (1) intensive use of ICT at home (almost every day or every day) does not affect academic results, but positive results emerge when they are used as a complement tool; and (2) the appropriate use of ICT (guided by specific teaching contents) may be stimulating for repeater students and help them to improve their academic performance.

Regarding previous literature that ascertained a positive impact of ICT over student assessment, two different explanations are offered to explain the divergence of results. On one hand, ICT should be considered as an additional 'input' in the student's learning function, because the student can obtain more information and access more easily to learning resources at school and at home (and at any moment). On the other hand, the benefits derived of ICT are conditioned by the ability of the centers to modify their teaching methods, so that teachers and ICT become complementary. The availability of data including future cohorts of students participating in School 2.0 will dig into the relationship of ICT and student performance in Spain.

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