EasyChair Preprint

№ 5560

The Impact of Computer and Internet at Home on Academic Results of the Saber 11 National Exam in Colombia

Fernando Barrios Aguirre, Martha Patricia Castellanos Saavedra, Diego Forero and Sandra Yaneth Mora Malagón

May 19, 2021

The impact of computer and internet at home on academic results of the Saber 11 national exam in Colombia

ABSTRACT

The use of a computer and internet connection allows high school and university students to access more relevant information. However, there is no consensus on the effects of the use of these tools on academic results. This work evaluates the impact of computer and internet at home on the results of the Saber 11 test, a national exam taken by all students finishing their secondary education in Colombia, between 2017 and 2019. This impact was estimated from a pooled two-stage least squares (pooled 2SLS) model, applied to data from 1.578.460 Colombian high school students. We found that computer and internet at home had a positive impact on English language performance in the Saber 11 test in Colombia. This work allows a better understanding of the technological effects on educational achievement and provides information for the design of public policies for education in developing countries.

Keywords: Technological skills; high school education; academic results; national exams.
JEL classification: E20, E24, E64, E75

INTRODUCTION

Computer at home and access to the internet provides access to a wide range of educational materials that can further promote self-learning and development of new skills (Bulman & Fairlie, 2016; Shan, 2013). However, computer and internet at home can have a negative effect on academic performance if this technology becomes a distraction or a substitute for other forms of learning such as reading (Fuchs & Woessman, 2004). There is no consensus in the literature on the impact of this technology on educational outcomes, therefore the objective of this research is to evaluate the effects of computer and internet at home on Saber 11 test scores in Colombia between 2017 and 2019.

The Saber 11 test is a standardized assessment of the development of the competencies of students who are close to finishing high school (Colombian Institute for Education Assessment). This standardized exam covers multiple subjects, such as mathematics, critical reading, natural sciences, social and citizen sciences and English language. The results of these five subjects are presented at the individual level on a scale of 0 to 100 points and the overall score is constructed from a weighted average of the scores in the five tests. These scores are generated using the item response theory model, which defines the probability of an individual answering correctly as a function of ability, item difficulty, item discrimination and pseudo-azar (ICFES, 2018).

In Latin America, some empirical research found that students who had a computer or internet at home scored better on PISA or standardized tests (Alderete et al., 2016; Aristizabal et al., 2009; Botello & Rincón, 2014). Additionally, in Peru, Romania and Brazil students who had access to a home computer had higher computer skills (Cristia et al., 2012; Malamud & Pop-Eleches, 2010; Sprietsma, 2012). However, some authors found that the impact of Information and Communication Technologies (ICTs) on academic outcomes depends on student and family background characteristics (Claro, 2010; Tansini & Aguilar, 2011; Sunkel & Trucco, 2010).

In contrast, some research did not find significant effect of ICTs at home on academic outcomes (Aypay, 2010; Beuermann et al., 2013; Cristia et al., 2012; Fairlie & Robinson, 2013; Wittwer & Senkbeil, 2008). Researchers found that computer use was associated with a reduction of homework time. So, the null effects found may be due to negative effects of computer use on the student's self-learning counteracting the positive effects of this technology on educational

outcomes (Beuermann et al, 2013; Fairlie & Robinson, 2013). On the other hand, Wittwer and Senkbeil (2008) found that in Germany the frequency of computer use did not contribute to explain the differences in mathematics among students.

Other research found that computer and internet at home had negative effects on academic performance (Fuchs & Woessman, 2004; Kubey et al., 2001; Scherer 1997). According to Sprietsma (2012), computers can be useful tools for education but for students who have a high likelihood to use them for entertainment they can have negative effects on their educational outcomes. In Peru, a study found that students with a computer at home had lower academic performance because they spent more time to help with household chores than to do homework. In this case, parents used the computer as a reward to encourage their children to help with household chores (Beuermann et al., 2013).

In Colombia, students with computer or internet at home achieved a higher average score on the Saber 11 test and PISA (Aristizabal et al., 2009; Chica et al, 2010). Similarly, Posada and Mendoza (2014) found that students who had access to the internet and whose mothers' educational levels was high were more likely to improve their academic performance. According to researchers, internet at home allow for enhanced access to information which, together with the mother's help in the use of this tool, enables the student to achieve better academic results.

On the other hand, Barrera-Osorio and Linden (2009) using a randomized controlled trial evaluated the effect of the public program *Computadores para Educar* on academic results in Colombia. This program is a public-private partnership to donate computers in public schools and besides training teachers to use computers in specific subjects such as Spanish. The researchers did not find positive effects of this program on academic performance in Spanish or any other area. However, Rodríguez et al. (2011) found that students who completed their high school education in schools benefiting from the *Computadores para Educar* program was more likely to went to college.

The impact of internet or computers at home on students' standardized test scores in Colombia is however unclear. Therefore, this paper addresses the question: What is the impact of computer and internet at home on students' Saber 11 test scores in Colombia between 2017 and 2019? Thus, the main objective of this research is to evaluate the impact of computers or

internet at home on Saber 11 test scores by estimating a two-stage ordinary least squares model that explains the score of a student by their individual and family characteristics and school inputs.

In Colombia, there is little research on the impact of ICTs at home on students' standardized test scores, since the most of studies on these topics are most focused on estimating the effects of ICTs on academic achievement. Thus, this article has two main contributions to the literature. First, it assesses the differential impact that computer or internet at home have on each subject of Saber 11 test. Second, this research contributes to a better understanding of the potential technological impact on Saber 11 test scores and provides preliminary information for the design of public policies on the development of technological skills in secondary school students.

This paper is divided into four sections. The first section presents the theoretical framework to evaluate the effects of computer and internet at home on test scores. The second section has the econometric model and discusses the identification strategy of the estimated effects in the pooled ordinary least squares (POLS) model. The third section shows the descriptive statistics. Finally, the fourth section presents and analyses the research results.

METHODOLOGY

In this paper the effect of computer and internet at home on the Saber 11 test score is evaluated using an educational production function. Like most of the available literature on education, the factors that influence academic results are related to the characteristics of the student, the family and the educational institutions (Coleman, 1966; Gaviria & Barrientos, 2001; Vegas & Petrow, 2008). Thus, in the educational context, the theoretical model proposed is:

$$Y_i = f(CI_i, X_i, Z_i, S_i) \quad (1)$$

Where:

Y_i = The score in the Saber 11 tests of the student i

CI_i = Variable that identifies the possession of computer or internet in the student's home i

X_i = A characteristic vector of student i

Z_i = A vector of family characteristics of student i
S_i = A vector of school inputs

The vector of student characteristics includes variables such as gender, age, employment status and ethnic origin. The inclusion of these variables and not others in the model is justified by their relevance on academic performance and the availability of this information at student level. The student's gender is important because several investigations in Latin America have found that on average men obtain higher scores than women on standardized tests (Abadía & Bernal, 2016; Gaviria & Barrientos, 2001; Niederle & Vesterlund, 2010). For this reason, in this research is included a binary variable equal to 1 if the student is male and 0 if the student is female.

In addition, the student's age is included as an independent variable because there is evidence of a negative effect between age and academic performance. Older students are more likely to repeat grades or dropout and therefore, they could have lower scores in the Saber 11 test (Abadía & Bernal, 2016; Gaviria & Barrientos, 2001). Also, is included a binary variable for whether a student works. This variable is relevant to determine academic performance because the responsibilities of a job reduce the availability of time to study and therefore, these students may have low levels of educational attainment (Agudelo et al., 2019).

Moreover, among the student characteristics is included a dummy variable that indicates whether or not the student reads every day. According to some research, students who read more frequently obtain higher scores on standardized tests and school grades than who do not read (Cullinan, 2000; Whitten, et al.,2016). Additionally, is included as an independent variable the time per day that the student spent to surf the internet in non-academic activities. This variable has shown that is important not only access to a computer and internet at home, but how students use this technology to improve their academic knowledge (Jaramillo, 2005; Sprietsma, 2012).

Finally, is included a binary variable for whether a student recognizes himself or herself as belonging to an ethnic group. The question concerning ethnic membership in the socioeconomic questionnaire is answered with pen on the Saber 11 answer sheet, this is optional and does not affect the score. This variable is important because in Colombia students who belong to an ethnic group have a lower performance in standardized academic tests

(Sánchez-Jabba, 2011). According to DANE (National Administrative Department of Statistics in Colombia), the country has fourth recognised ethnic groups: indigenous, Afro-Colombians, gypsies and the Raizal population of the Archipelago of San Andrés, Providencia and Santa Catalina.

The second factor in equation (1) is related to the characteristics of the student's family. The importance of these characteristics stems from the fact that there is a positive and significant correlation between the economic and cultural background of parents and the educational achievement of children (Abadía & Bernal, 2016; Gaviria & Barrientos, 2001). In this research, the variables included to evaluate the importance of family characteristics on academic results are: the occupation and education of the parents, the number of people in the household and a binary variable indicating whether or not the student's mother stays at home during the day.

Parental education and occupation have a positive impact on the academic performance of students in Colombia (Gaviria & Barrientos, 2001). According to the literature, parents with more education are better able to help your children with their homework and other learning activities. In addition, wealthier parents may send their children to better and more expensive schools. Finally, a better educational and cultural background in the family contribute to the development of new cognitive skills and this could improve school performance of students (Coleman 1988; Gaviria & Barrientos, 2001; Mullis et al., 2003; Wen 2006; Woessmann, 2003).

The number of people in the household will affect the time and financial resource allocation of parents to the care and instruction of your children. Then, in this research is included a discrete variable that reports the number of people in the household in order to control the attention that the student receives. On the other hand, is important the time that mothers dedicate to the education of their children. Gaviria and Barrientos (2001) found that students whose mothers works have lower results than those whose mother remains at home. For this reason, is included a binary variable for whether the student's mother works.

Finally, to analyze the impact of schools on students' academic performance are included variables related to the type of school (public or private), the highschool schedule and the academic calendar. In Colombia, the academic quality of the school is a major contributor to scores on math and language scores achievement tests (Núñez et al., 2002). Similarly, Castro

et al. (2016), found that students of private high schools score better in standardized tests to those of public school students. Therefore, is included in the model a binary variable equal to 1 if the school is public and 0 if it is private.

Moreover, there is evidence that the socioeconomic level of the schools explains to a large extent the differences in student academic achievement (Castro et al., 2016). In Colombia, schools are stratified by socio-economic status in accordance with cost matriculation and tuition. According to the Ministry of National Education, least expensive schools are also classified in stratum 1 and more expensive schools in stratum 4. Thus, the socioeconomic level of the school is included as a binary variable equal to one if the school's stratum is three or four and equal to zero if it is one or two.

According to Gaviria and Barrientos (2001), students who study at an academic school do better on Saber 11 test. Therefore, a dummy variable equal to 1 is included if the school the student attends is academic and 0 if it is technical or technical-academic. Moreover, in the equation (1) is included a binary variable that take the value 1 if the schedule school is morning or afternoon and 0 if the schedule school in evening or Saturday. This variable is included because students who attend classes at night or on Saturdays are more likely to have lower scores on the Saber 11 test (Bonilla, 2011).

In Colombia there are two academic, calendar A and calendar B, and therefore the Saber 11 exam has two applications during the year. In general, students from B calendar schools take this exam in the first half of the year while those from A calendar take this exam in the second half of the year. The Saber 11 test evaluates the same competencies in the two application periods, but the difference in the questions may affect the results and generate biases in the estimation. This research therefore includes the academic calendar as an explanatory variable of the results in the Saber 11 test.

In econometric terms, the impact of computer and internet possession on the academic results of the Saber 11 test is evaluated with a Pooled Ordinary Least Square (POLS) model. Thus, the equation (1) of the theoretical model is expressed according to the following equation:

$$Score_i = \theta + \beta_1 CI_i + \vartheta^T X_i + \varphi^T Z_i + \omega^T S_i + T + u_i \quad (2)$$

Where $Score_i$ is the score in the Saber 11 tests of the student i ; CI_i is an variable equal to one if student i have a computer or internet at home; X_i is a vector of student characteristics including age, sex and others; Z_i is a vector of family background characteristics including, among other variables, parents' education. S_i is a vector of school characteristics attended by the student i including the academic calendar, the schedule school and a dummy variable indicating whether the school is public or private, T is the year in which the student took the exam Saber 11 and u_i is a mean-zero random error term error.

A computer at home and access to the internet may have positive effects on scores achievement tests mainly for two reasons. First, these tools help to complete academic activities and encourage students to research topics of interest to them or those taught in school. Second, students with computer and internet may have readily available information at any moment, compared to those without access (Apuke & Iyendo, 2018).

Identification strategy

The estimated impact of computer and internet at home on Saber 11 test scores may be biased by unobserved factors that may influence achievement tests, such as academic skills and motivation of students or parents' commitment to their child's education. For example, if students with greater academic ability or whose have parents with a greater interest in the education are more likely to have computers and internet at home, it could overstate the effect of this technology on achievement tests. On the contrary, if students with less academic ability have computer or internet at home, it could understate this effect.

To obtain estimates that are not biased by unobserved variables the impact of computers or internet at home on Saber 11 test scores is evaluated using an instrumental variables approach. This research uses the likelihood that child's parents use a computer and internet at work as instrument for having computer or internet at home. Parents who use internet and computer at work are more likely to have computer or internet at home, but is unlikely that the use of internet and computer at work by the child's parents has impact on Saber 11 test scores. Thus, the instrument is likely exogenous and, therefore, valid to identify the causal impacts of the possession of the computer and the internet on Saber 11 test scores.

DATA

This research uses the Saber 11 database of students assessed between 2017-2019 in Colombia. This database has the student scores on the Saber 11 exam, as well as the socioeconomic information and the student's activities that can explain the performance in the test. The Saber 11 database is available in anonymous form on the ICFES website. Additionally, as part of the Saber 11 examen registration process, the student gives permission to ICFES treat personal data for statistical or research use and this entity must keep personal information confidential and only publish the anonymized database.

The Saber 11 is a standardized test applied to students in their eleventh grade in high school and it is commonly used as major criterion for admission to higher education programs in Colombia. This exam consists of 254 multiple-choice questions and is administered biannually in April and November during two four-hour session. The questions are distributed as follows: 50 mathematics questions, 41 critical reading questions, 50 social science questions, 58 natural science questions and 55 English questions (See Annex 1 for some samples of the questions). The test of math evaluates the ability of students to interpret, represent and solve math problems in statistics, geometry, algebra and calculus. Similarly, the critical reading test measures the student's ability to understand, interpret and critically evaluate a text.

The social sciences test evaluates the knowledge of students in history, geography, political constitution and citizen competencies. The natural sciences test is composed of three thematic areas: biology, physics and chemistry. This module evaluates the student's ability to understand and use natural science concepts and theories to solve problems. Finally, the English test evaluates the student's ability to complete conversations and read and understand articles in English. In this test the student's performance level is measured according to the six levels of the Common European Framework of Reference for Languages (A1, A1, A2, B1, B1, B2, C1, C2).

The analysis takes into account only students who lives in Colombia aged between 14 and 25 years old. This excludes 2,8 percent of the sample. The main justification for removing students over 25 years of age is that they entail a heterogeneity in socioeconomic, family and academic conditions in comparison to those of median age, which may bias the results. Also are excluded students who obtained zero points in total score or in the mathematics and language modules.

In addition, students who had null values in the independent variables of this research are excluded from the analysis. In the end, there is a sample of 1.578.460 students attending 10.855 schools.

The variable of interest is the possession of computer or internet in the student's home. This variable was constructed using the following socioeconomic questions from Saber 11: Does your household have internet connection? or Do you have a computer at home? When the answer is affirmative in either of these two questions, the binary variable that identifies the possession of a computer or internet in the student's home is equal to one and zero otherwise.

Also is included as a categorical variable the time that the student spent exploring the internet for non-academic activities and corresponds to the question: usually, how much time do you spend per day surfing the internet? (exclude academic activities). This variable takes the value 1 if the student has dedicated at least 30 minutes to surf the internet, 2 if the student surfs between 30-60 minutes, 3 if the student surfs between 1-3 hours and 4 if the student surfs more than 3 hours per day.
The econometric estimation also included gender and age of the students. The latter is a discrete variable that report the age of the student at the time of registration of the Saber 11 test. The student's gender is a dummy variable equal to one if the student's sex is male and zero if it is female. Moreover, is included a variable that shows whether the student works. This variable is equal to one if the young has dedicated at least one hour to work in the previous week of registration for the Saber 11 test.

In addition, some family background characteristics of the student are included as independent variables. One of these is parents' education, this variable was obtained from the questions: What is the highest grade level completed by your mother? and What is the highest grade level completed by your father? In order to avoid potential selection bias, for each student was selected the education of the parent with the highest educational level. Parents' education is a categorical variable and it is split in fourth categories: less than high school, high school, bachelor degree and postgraduate degree.

Another important measure is the number of people in the household. This is a discrete variable whose minimum value is equal to one and corresponds to the question: including you, how many people live in your house or apartment? Similarly, in the group of socioeconomic

characteristics, is included a variable that indicates whether the student's mother works. This variable is a dummy equal to one if the student in the socioeconomic questionnaire of the Saber 11 indicated that your mother worked in the last year.

Finally, the econometric model includes independent variables associated with the school. One of these is a binary variable that take the value 1 if the schools that students attend is public and 0 if it is private. Another variable is the educational modality of the school, this is a dummy variable equal to one if the school is only academic and zero if the educational modality of the school is technical/academic or technical. Furthermore, is included the socioeconomic level of the schools. This is a dummy variable equal to one if socioeconomic level of the schools is three or four and zero if it is one or two. Also is included a binary variable equal to one if the schedule school is daytime and zero if it is nighttime or saturday.

In addition, the school's academic calendar is included as a binary variable equal to 1 if the school belongs to calendar A and 0 if it belongs to calendar B. In Colombia, academic calendar A starts in February and ends in November and calendar B starts in September and ends in June. In calendar A are all public schools while private schools can choose any of them. However, the most private schools with a higher economic level or focused on bilingualism develop their academic activities in the B calendar. The quality of education is the main difference between schools in the two academic calendars. In particular, B-calendar schools have better results in standardized tests than A-calendar schools.

The instrumental variable used in this research is a binary variable equal to one if the student's father or mother uses a computer and the internet at work and zero otherwise. This variable is used on the assumption that parents' employment will affect the likelihood of having computer or internet at home but parents' employment does not affect the student's academic performance. For the construction of this variable is used the information that the student register in the socioeconomic questionnaire on the employment of your mother and father. Based on the technological intensity, the jobs are divided into two groups: jobs most likely to use computer and internet and jobs which are less likely to use this technology.

The sets of occupations with most likely to use computer and internet are: managerial and administrative positions, professional work (e.g., doctor, lawyer, engineer) or businessman. On the contrary, the occupations with less likely to use computer and internet are: construction and

farm workers, clean-up workers, household chores, works in the sectors sales and service, self-employed workers (e.g., plumber, electrician, machine operator or vehicle driver) or informal sector business owners. People who are neither in work nor in education are classified in the category of occupations with less likely to use computer and internet because they may not have the enough money to invest in this technology.

RESULTS

Table 1 presents the descriptive statistics of the students' Saber 11 test scores evaluated between 2017 and 2019. This analysis is carried out by group and differentiates the scores obtained between students with access to a computer or internet at home and those who did not have access to this technology at home. As illustrated in Table 1, students with home computer or internet access scored higher on all tests, compared to those without access.

Table 1. Differences in Saber 11 scores between students with and without computer or internet at home, 2017-2019

Variable	Group (Students with or without computer or internet at home)	Obs.	Mean	Std. Dev.	Min	Max
Students with Computer or Internet at Home	with	1.118.169	0,71		0	1
Students without Computer or Internet at Home	without	460.291	0,29		0	1
Students with Computer or Internet at Home in 2017	with	366.967	0,70		0	1
Students without Computer or Internet at Home in 2017	without	157.159	0,30		0	1
Students with Computer or Internet at Home in 2018	with	376.675	0,71		0	1
Students without Computer or Internet at Home in 2018	without	153.623	0,29		0	1
Students with Computer or Internet at Home in 2019	with	372.597	0,71		0	1
Students without Computer or Internet at Home in 2019	without	151.439	0,29		0	1
Global score Saber 11 test	total	1.578.460	255,2	50,8	113	450
	with	1.118.169	264,1	47,6	113	450
	without	460.291	233,7	42,8	119	449
Math score Saber 11 test	total	1.578.460	51,3	12,0	17	100
	with	1.118.169	53,1	12,0	17	100
	without	460.291	46,8	10,7	17	100
Critical Lecture score Saber 11 test	total	1.578.460	53,4	10,2	20	100
	with	1.118.169	55,0	10,1	20	100

	without	460.291	49,4	9,2	21	100
Natural sciences score Saber 11 test	total	1.578.460	50,6	10,6	21	100
	with	1.118.169	52,1	10,7	21	100
	without	460.291	46,8	9,2	21	100
Civic and social science score Saber 11 test	total	1.578.460	49,0	12,0	18	100
	with	1.118.169	50,8	12,1	18	100
	without	460.291	44,6	10,4	18	100
English score Saber 11 test	total	1.578.460	50,7	12,4	20	100
	with	1.118.169	53,1	12,8	13	100
	without	460.291	44,8	9,1	13	100
Daily internet use	with	1.082.775	2,7	1,0	0	4
	without	456.353	1,7	1,1	0	4

Source: ICFES- Saber 11, 2017-2019

A sample of 1,578,460 students who took the Saber 11 test in Colombia between 2017 and 201 shows that 71% of the students have a computer or internet at home and this percentage do not vary over the three years in the sample. Additionally, on average students scored 255 points on the Saber 11 out of a possible 500. According to descriptive statistics, there are differences in Saber 11 scores between students with and without computer or internet at home. In particular, students with home computer or internet access scored on average 12 points higher than students without access.

Scores obtained on each subject of the Saber 11 test are approximately 52 points out of a possible 100. As in the total score of this test, the students with computer or internet at home obtain scores above the average in each subject of the Saber 11 test. In particular, students with access to a computer or internet at home obtained around two points above the average. In contrast, students who did not have this technology scored around four points below the average.

Table 1 shows that children who do have a home computer or internet spend on average between 30 minutes and 1 hour to surf the internet in non-academic activities. As expected, students with a computer or internet at home spend more time browsing internet in non-academic activities. Specifically, 60% of the students used the internet a little more than an hour to surf the internet in non-academic activities, compared with 26% to those without access. This would mean that children who were users of home computers did spend much less time on academic activities and may tend to achieve less well than children who did not use computers.

The table 2 presents the descriptive statistics of the independent variables for individual, parental, family, and school characteristics that affect academic results.

Table 2. Descriptive Statistics, 2017-2019

Variable	Obs	Mean	Min	Max
Male sex	727.745	0,46	0	1
Age	1.578.460	17	14	25
Student Works	482.001	0,31	0	1
People at home	874.437	2-4	2	> 10
Students' parents with a highschool degree	966.424	0,63	0	1
Mother works	807.606	0,56	0	1
Student belongs to ethnicity	99.505	0,07	0	1
Academic highschool	1.358.923	0,88	0	1
Public highschool	1.164.983	0,74	0	1
Highschool stratum	660.780	0,42	0	1
calendar A Highschool	1.526.483	0,97	0	1
Student read daily	33.466.909	0,44	0	1
Bilingual highschool	29.407	0,02	0	1

Source: ICFES- Saber 11, 2017-2019

According to the descriptive statistics obtained from table 2, the 46 % of students who took the Saber 11 examen are men and 54% women. This finding is consistent with the distribution of schooling rates by gender in Colombia. The average age of the students who took this test was 17 years old at the time of enrollment, and the majority were students at academic highschool. Moreover, the 31% of students reported that they had worked part-time during the week prior to exam enrollment. This value is relatively high because in this research were excluded students from high school by cycles or validation.

The average size of the student's household had 4 or 5 people and 7% of the students recognizes himself or herself as belonging to an ethnic group in Colombia. In addition, sixty-three percent of students have parents whose highest level of education attained was high school. Likewise, approximately 19% of students have parents employed in managerial, professional or administrative jobs. Finally, 88 % of the students were enrolled in academic programs and 74 % attended public schools. On the other hand, 42 % of the students who presented Saber 11 between 2017 and 2019 studied in schools of socioeconomic level three or four.

Table 3 shows the effect of computer or internet at home on students' Saber 11 test scores in Colombia between 2017 and 2019. Three estimated effects are presented in this table: the first evaluates the impact of only computer at home on students' Saber 11 test scores; the second estimated effect shows the impact of only internet at home on students' Saber 11 test scores and the third estimated effect is the impact of computer or internet at home on students' Saber 11 test scores. These estimated effects include independent variables for individual, parental, family, and school characteristics that affect academic results.

According to the results, students who had computers or internet at home obtained higher test scores compared to those without access. A two-stage pooled ordinary least square model shows that students with computer or internet at home scored one more point on a Saber 11 test than students without this technology, although this result was not statistically significant. However, students who have a computer but not internet at home obtained lower scores on Saber 11 test. On the other hand, students who used daily internet had approximately two more points on a Saber 11 test than students who use computers less often. However, the use of the internet had decreasing marginal returns on score test as more time spend surfed in the internet the student scored 0.2 points less.

Table 3. Estimation of the model by OLS with IV

VARIABLES	(2) Total Score Saber11 Test	(3) Total Score Saber11 Test	(4) Total Score Saber11 Test
Students with computer at home	0.97		
	(0.86)		
Students with internet at home		1.29	
		(0.99)	
Students with computer or Internet at home			1.05
			(0.95)
Daily internet use	2.13***	2.01***	2.07***
	(0.22)	(0.30)	(0.29)
Daily internet use squared	-0.22***	-0.20***	-0.21***
	(0.04)	(0.04)	(0.04)
Male sex	10.53***	10.52***	10.53***
	(0.10)	(0.10)	(0.10)
Age	-35.10***	-35.13***	-35.11***
	(0.50)	(0.49)	(0.50)
Age squared	0.81***	0.81***	0.81***
	(0.01)	(0.01)	(0.01)
Student read daily	12.03***	12.04***	12.03***
	(0.10)	(0.10)	(0.10)
Student works	-7.88***	-7.86***	-7.88***
	(0.12)	(0.12)	(0.12)
People at home	-1.93***	-1.93***	-1.93***
	(0.06)	(0.06)	(0.06)
Parent education	7.62***	7.61***	7.62***
	(0.08)	(0.08)	(0.08)
Mother works	-0.65***	-0.67***	-0.66***
	(0.12)	(0.13)	(0.13)
Student belongs to ethnicity	-17.15***	-17.12***	-17.16***
	(0.23)	(0.25)	(0.24)
Academic highschool	2.79***	2.77***	2.78***
	(0.15)	(0.15)	(0.15)
Public highschool	-2.23***	-2.22***	-2.23***
	(0.13)	(0.13)	(0.13)
Highschool stratum	18.99***	18.94***	18.99***
	(0.20)	(0.28)	(0.22)
Night or saturday school	-24.46***	-24.48***	-24.50***
	(0.19)	(0.19)	(0.19)
Calendar A Highschool	-25.31***	-25.32***	-25.31***
	(0.25)	(0.25)	(0.25)
Observations	777,754	777,639	1,207,666
R-squared	0.37	0.37	0.36

Robust standard errors in parentheses
*** p <0.01, ** p <0.05, * p <0.1

The results show that men scored on average 10 points higher than women on the Saber 11 test, after controlling for observable characteristics. These results are comparable to those obtained by several investigations in Latin America that found gender differences in favour of males in mathematics and science performance in the higher scores become more pronounced (Abadía & Bernal, 2016; Gaviria & Barrientos, 2001; Niederle & Vesterlund, 2010). Different hypotheses have been put forward by researchers to explain this gap gender in standardized tests. One set of issues relates to unobserved factors such as motivation, expectations, school and cultural environment. Another hypothesis states that women have a slightly higher propensity to anxiety than men in test in highly competitive environments (Gneezy et al., 2003; Niederle & Vesterlund, 2010; Paserman, 2010; Shurchkov, 2012).

According to the results in Table 3, younger students on average scored higher on the Saber 11 than older students. This could be due to the fact that the latter have a higher likelihood to repeat grades or dropout. Similarly, students who studied during the evening and saturday got low scores on the Saber 11 tests. Students who worked during the day scored about eight points lower on the Saber 11 test possibly because they could not have had enough time to study. On the other hand, students who had read at least 30 minutes per day obtained on average 12 more points on Saber 11 test than students who read less often.

There was a strong correlation between the education of parents and the students' Saber 11 test score. Students with parents with a bachelor's degree scored on average 7 points more than students whose parents had a lower level of education. By contrast, students whose mother worked got around 0,6 points lower than students whose mother stayed at home. Furthermore, the number of people in the household had a negative effect, for example, for each additional person in the household the students obtained an average of two points less in the Saber 11 test.

Differences in test scores of students who attend public and private schools were significant and most of which seem to be attributable to schools' socio-economic characteristics. Students enrolled in private schools scored 2 points higher than students enrolled in private schools on average on the Saber 11 test. Similarly, the economic level of the school was one of the major factors contributing to improvements on Saber 11 scores, in particular students enrolled in schools of higher economic level obtained an average 12 points higher than students from other

types of schools. Likewise, students enrolled in schools with calendar B, in which are most of the private schools, scored on average 25 points more than students in calendar A.

The instrument used in this model is exogenous and significant, since the Cragg-Donald Wald F test is greater than 10 in the first stage. The Hansen J test is greater than 1%, 5% and 10% and the null hypothesis of exogeneity is not rejected (Durbin-Wu-Hausman endogeneity test). This would suggest that the pooled ordinary least square estimation does not differ significantly from the estimation by instrumental variables, thus the pooled ordinary least square estimation does not present inconsistency problems due to endogeneity in the model (See Appendix).

Table 4 presents the same estimated effects for the different subjects evaluated in Saber 11 test: mathematics, critical reading, English, social and civic sciences, and natural sciences. The results show that students with home computer or internet access scored 5 points higher on English tests, compared to those without access. Nevertheless, computer or internet at home had a negative impact on natural sciences and the civic and social science score.

Table 4. Estimation of the model by OLS with IV

VARIABLES	(1) Math score	(2) Critical Lecture score	(3) English score	(4) Civic and social science score	(5) Natural sciences score
Students with computer or Internet at home	0.10	0.62**	4.91***	-0.49**	-0.93***
	(0.23)	(0.26)	(0.25)	(0.32)	(0.27)
Daily internet use	0.74***	0.35***	0.67***	0.32***	0.61***
	(0.05)	(0.06)	(0.08)	(0.07)	(0.06)
Daily internet use squared	-0.13***	-0.01***	-0.13***	-0.04***	-0.08***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Male sex	3.71***	0.79***	1.12***	1.64***	2.38***
	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)
Age	-8.44***	-5.35***	-6.02***	-7.14***	-7.22***
	(0.09)	(0.08)	(0.10)	(0.12)	(0.11)
Age squared	0.19***	0.12***	0.14***	0.17***	0.17***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Student read daily	1.92***	2.25***	2.35***	2.94***	2.19***
	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
Student works	-1.18***	-1.49***	-1.61***	-1.81***	-1.42***
	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
People at home	-0.41***	-0.54***	-0.51***	-0.66***	-0.42***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)
Parent education	1.48***	1.32***	1.72***	1.58***	1.37***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Mother works	-0.15***	-0.06	-0.43***	-0.15***	-0.17***

	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Student belongs to ethnicity	-3.93***	-3.25***	-2.14***	-3.37***	-3.47***
	(0.06)	(0.05)	(0.06)	(0.06)	(0.05)
Academic highschool	0.53***	0.48***	0.68***	0.62***	0.45***
	(0.03)	(0.03)	(0.04)	(0.04)	(0.03)
Public highschool	-0.06	-0.29***	-1.95***	-0.65***	-0.38***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Highschool stratum	4.07***	3.22***	4.46***	3.87***	3.47***
	(0.04)	(0.05)	(0.06)	(0.05)	(0.05)
Night or saturday school	-5.63***	-4.02***	-4.91***	-4.93***	-5.08***
	(0.04)	(0.03)	(0.05)	(0.05)	(0.04)
Calendar A Highschool	-5.21***	-3.84***	-6.91***	-5.13***	-5.62***
	(0.05)	(0.05)	(0.07)	(0.06)	(0.06)
Bilingual highschool			6.55***		
			(0.09)		
Observations	1,207,66	1,207,66	1,047,526	1,207,66	1,207,66
R-squared	0.31	0.29	0.40	0.28	0.30

Robust standard errors in parentheses
*** p <0.01, ** p <0.05, * p <0.1
Source: Author's calculation based on ICFES-Saber11, 2017-2019

The results show that computer and internet at home rose 5 points the English score and 0,6 points on critical lecture score. This technology had a positive but not significant impact on math scores. On the contrary, there was a negative and significant impact on social science and natural science scores. In all areas the use of the internet had positive and significant impact. However, consulting the internet for more than 30 additional minutes has negative effects on the score obtained in Saber 11 test.

Men significantly outperformed women in all subjects but gender differences on scores was greatest in math and science. However, men outperformed women just by less than one score points in critical lecture critical. Similarly, the age of the student has a greater negative effect on the math score. On the other hand, family characteristics, and especially those related to parents' education had a positive, while the number of people in the household had a negative effect on the Saber 11 scores. Finally, students in a bilingual school scored about 7 additional points in their English score.

DISCUSSION

According to results, in Colombia students who had a computer or internet at home scored better in Saber 11 test between 2017 and 2019. However, this technology did not improve the

performance in all subjects evaluated and its greatest positive impact was on English scores. These results are similar to those obtained by some research for Latin America that found a positive and significant effect of the use of information and communication technologies on students' educational outcomes (Aristizabal et al, 2009; Botello & Rincón, 2014). While these findings are preliminary, they help to understand the importance of ICTs on education and self-learning.

However, is important a further research to identify the mechanisms which lead to a positive correlation between the possession of computer and internet at home and the scores obtained in the Saber 11. For example, it is likely that students who have computers or internet at home have parents with higher education and better socioeconomic conditions. In this case, family background characteristics could be the mechanism through which the technology improves academic performance. Furthermore, it is necessary to identify what activities carried out by students on the computer or internet enhance academic results.

This research has some limitations. First, since we do not have detailed information on the time and use of internet and computers at home, it is not clear how this technology influences test scores. Second, the relationship between Saber 11 test scores and the use of technologies may be affected by unobserved factors such as student discipline leading to wrong inferences. Third, the use of technology for academic purposes depends to a large extent the computer skills of students along with the knowledge they may acquire in schools.

CONCLUSIONS

This research finds that computer or internet at home had a positive impact on the Saber 11 test score in Colombia between 2017 and 2019. However, the results at the subject level show that the greatest positive impact of this technology is in English. In mathematics and critical reading there is evidence of a positive correlation, although only significant for the latter subject. Finally, having a computer or internet at home reduces the result of social and natural sciences in Saber 11 by approximately one point.

Daily use of the internet had a positive correlation with scores obtained in all academic areas of Saber 11. However, it had marginal diminishing returns in the scores, since students who spent more time browsing scored lower than those who browse less often. On the other hand,

educational levels of parents were highly correlated with the technological disposition at home. Thus, it could be thought that the technological capacities in the home and the absorption of technologies of the family members, approximated by the possession of a computer and the internet, are also associated with higher scores and a greater cognitive capacity in the children.

These results are an approximation to the technological effects on educational achievement and provides information for the design of public policies in the development of technological skills. However, it is necessary to understand the mechanisms by which the internet and the computer at home improve students' Saber 11 test results. Likewise, it is necessary to know which are the activities developed by students on the computer or internet that benefit the results in standardized tests.

REFERENCES

- Abadía, L., Bernal, G. (2016). Brechas de género en el rendimiento escolar a lo largo de la distribución de puntajes: evidencia pruebas saber 11°. Vniversitas Económica, 16(9): 1-34. [Abadía, L., Bernal, G. (2016). Gender gaps in school performance across the distribution of scores: evidence from saber 11 tests. Vniversitas Económica, 16(9): 1-34]
- Agostini, C. Willington, M. (2012). Acceso y uso de internet en Chile: evolución y factores determinantes. Persona y Sociedad, 26 (1), 11-42. [Agostini, C. Willington, M. (2012). Internet access and use in Chile: evolution and determining factors. Persona y Sociedad, 26 (1), 11-42]
- Agudelo, M., Martínez, D. y Ospina, O. (2019). Educación de los padres y desempeño escolar. Revista Espacios, 40(23), 1-25. [Agudelo, M., Martínez, D. y Ospina, O. (2019). Parental education and school performance. Revista Espacios, 40(23), 1-25]
- Alderete,M. Formichella,M.(2016). Efecto de las tic en el rendimiento educativo: el Programa Conectar Igualdad en la Argentina. Revista de la cepal 119, 89-107. [Alderete,M.Formichella,M.(2016). Effect of ICTs on educational performance: the program Conectar Igualdad in Argentina. Revista de la cepal 119, 89-107]
- Apuke, O., Iyendo, T. (2018). University students' usage of the internet resources for research and learning: forms of access and perceptions of utility. Heliyon, 4(12)
- Aristizabal, G., Caicedo, M., and Escandón D. (2009). Las Tecnologías de la Información y Comunicación como determinante en el rendimiento académico escolar, Colombia 2006-2009. Ponencia presentada en XXI Jornadas de la Asociación de Economía de la Educación, Oporto, Portugal. [Aristizabal, G., Caicedo, M., and Escandón D. (2009). Information and Communication Technologies as a determinant of school academic achievement, Colombia 2006-2009. Ponencia presentada en XXI Jornadas de la Asociación de Economía de la Educación, Oporto, Portugal]
- Aypay Ahmet. (2010) Information and communication technology usage and achivement of turkish students in PISA 2006. TOJET, 9(2).
- Barrera-Osario, and Leigh L. Linden. (2009). The Use and Misuse of Computers in Education: Evidence from a Randomized Controlled Trial of a Language Arts Program. Working Paper, Columbia University.
- Gaviria, A, Barrientos, J (2001). Determinantes de la calidad de la educación en Colombia. Archivos de economía, DNP, No.159. [Gaviria, A, Barrientos, J (2001). Determinants of the quality of education in Colombia. Archivos de economía, DNP, No.159]
- Beltran, Daniel, Das, Kuntal and Fairlie, Robert W. (2010). Are Computers Good for Children?
- Beuermann, D. W., Cristia, J. P., Cruz-Aguayo, Y., Cueto, S., & Malamud, O. (2013). Home Computers and Child Outcomes: Short-Term Impacts from a Randomized Experiment in Peru. Technical Report National Bureau of Economic Research
- Bonilla, L. (2011). Doble jornada escolar y calidad de la educación en Colombia. Documentos de trabajo sobre economía regional 143, Banco de la República. [Bonilla, L. (2011). Double school day and quality of education in Colombia. Documentos de trabajo sobre economía regional 143, Banco de la República]
- Botello, A. L. H., & Rincón, G. A. (2014). La influencia de las TIC en el desempeño académico de los estudiantes en América Latina: Evidencia de la prueba PISA 2012. Lima: Memorias Virtual Educa, Memorias VE2014.

[Botello, A. L. H., & Rincón, G. A. (2014). The influence of ICT on student academic performance in Latin America: Evidence from the PISA 2012 test. Lima: Memorias Virtual Educa, Memorias VE2014.]

- Bulman, G. y R. Fairlie (2016), Technology and education: Computers, software and the Internet, NBER Working Paper Series, No. 22237.
- Cai, Zhihui, Xitao Fan, and Jianxia Du. (2017). Gender and attitudes toward technology use: A meta-analysis. Computers & Education, 105, 1-13.
- Castellanos, M. y Briceño, J. (2015) ¿Pueden las TIC Impactar en la Calidad Educativa en Colombia? Libro Educación Científica y Ciudadanía en el Siglo XXI. ISBN en España impreso 978-84-16133-65-9 e ISBN en Colombia ebook 978-958-8433-56-1. Editorial Universidad Autónoma de Colombia, 485- 498. [Castellanos, M. y Briceño, J. (2015) Can ICT have an impact on the quality of education in Colombia? Libro Educación Científica y Ciudadanía en el Siglo XXI. ISBN en España impreso 978-84-16133-65-9 e ISBN en Colombia ebook 978-958-8433-56-1. Editorial Universidad Autónoma de Colombia, 485- 498]
- Castro, L, F. Ortiz, and D. F. Lemus. (2016). Construction of a family socioeconomic index for the students who present the Saber 11 test. Statistics on the Evaluation of Education, 6, 73-84.
- Castro, A.J., Díaz, R.M., &Tobar, B.J. (2016). Causas de las diferencias en desempeño escolar entre los colegios públicos y privados: Colombia en pruebas SABER 11- 2014. Documentos de trabajo FCEA, 26, 7- 43. [Castro, A.J., Díaz, R.M., &Tobar, B.J. (2016). Causes of differences in school performance between public and private schools: Colombia in SABER 11 tests- 2014. Documentos de trabajo FCEA, 26, 7- 43.]
- Centro Nacional de Consultoría. (2015). Evaluación de impacto y de la sostenibilidad de Computadores para Educar en la calidad de la educación en las sedes educativas beneficiadas. CNC. Computadores para Educar. Bogotá. (Colombia). Disponible en: http://www.computadoresparaeducar.gov.co/PaginaWeb/index.php/es/estudio-de-impacto-del-centro-nacional-de-consultoria [Centro Nacional de Consultoría. (2015). Evaluation of the impact and sustainability of Computadores para Educar on the quality of education in the beneficiary schools.CNC. Computadores para Educar. Bogotá. (Colombia). Disponible en: http://www.computadoresparaeducar.gov.co/PaginaWeb/index.php/es/estudio-de-impacto-del-centro-nacional-de-consultoria]
- Chica S, Galvis D, Ramírez A. (2009). Determinantes Del Rendimiento Académico En Colombia: Pruebas ICFES Saber 11, Revista Universidad EAFIT 2010, 46(160), 48-72. [Chica Gómez S, Galvis Gutiérrez D, Ramírez Hassan A. (2010). Determinants of Academic Performance in Colombia: ICFES Saber 11 Test, 2009. EAFIT University Journal 46 (160), 48-72]
- Claro, M (2010). Impacto de las TIC en los aprendizajes de los estudiantes: estado del arte. Revista de la cepal 339, 1-28. [Claro, M (2010). Impact of ICT on student learning: a review. Revista de la cepal 339, 1-28]
- Coleman, James S. 1988. Social capital in the creation of human capital. American Journal of Sociology 94: S95–S120.
- Cristia, J., Ibarraran, P., Cueto, S., Santiago, A., Severín, E. (2012). Technology and child development: Evidence from the one laptop per child program.
- Cullinan, B. (2000). Independent reading and school achievement. Research Journal of the American Association of School Librarians, 3, 1-24.
- Duarte, J., M.S. Bos y J.M. Moreno (2012), Calidad, igualdad y equidad en la educación Colombiana (Análisis de las pruebas SABER 2009), Notas Técnicas, IDB-TN-396, Banco Interamericano de Desarrollo, Washington, DC. [Duarte, J., M.S. Bos y J.M. Moreno (2012), Quality, equality and equity in Colombian education (Analysis of the SABER 2009 tests), Notas Técnicas, IDB-TN-396, Banco Interamericano de Desarrollo, Washington, DC.]
- Fairlie, R., Robinson, J. (2013). Experimental Evidence on the Effects of Home Computers on Academic Achievement among Schoolchildren. American Economic Journal: Applied Economics, 5 (3), 211-240
- Felisoni, Daniel Darghan, and Alexandra Strommer Godoi. (2018). Cell phone usage and academic performance: An experiment." Computers & Education, 117, 175-187.
- Fiorini, M. (2010). The effect of home computer use on children's cognitive and non-cognitive skills. Economics of Education Review, 29(1), 55–72.
- Firth, Joseph, et al. (2019). The "online brain": how the Internet may be changing our cognition." World Psychiatry, 18(2), 119-129.
- Fuchs, T. & Woessmann, L. (2005). Computers and Student Learning: Bivariate and Multivariate Evidence on the Availability and Use of Computers at Home and at School (Working Paper, No. 8). Institute for Economic Research at the University of Munich.
- Gneezy, U; Niederle, M; Rustichini, A. (2003). Performance in Competitive Environments: Gender Differences. The Quarterly Journal of Economics, 118 (3), 1049-1074
- Grant, M., & Behrman, J. (2010). Gender Gaps in Educational Attainment in Less Developed Countries. Population And Development Review, 36(1), 71-89.
- Huang, Chiungjung. (2018). Social network site use and academic achievement: A meta-analysis." Computers & Education, 119, 76-83.
- ICFES (2018). Guía de diseño, producción aplicación y calificación del examen Saber 11. [ICFES (2018). Design, Production, Application and Scoring Guide for the Saber 11 Examination]
- Jaramillo, P(2005). Uso de tecnologías de información en el aula. ¿qué saben hacer los niños con los computadores y la información?. Revista de Estudios Sociales, 20, 27-44. [Jaramillo, P(2005). Use of information technologies in the classroom. What do children know how to do with computers and information? Revista de Estudios Sociales, 20, 27-44]

- Jones S. (2002). The Internet Goes to College: How students are living in the future with today's technology. Pew Internet and American Life Project, Washington DC, 3-20.
- Kim, So Young, et al. (2017). The associations between internet use time and school performance among Korean adolescents differ according to the purpose of internet use. PLoS One, 12 (4), 1-19
- Kubey, R., Lavin, M. and Barrows, J. (2001). Disminución del uso de Internet y del rendimiento académico colegiado: hallazgos iniciales. Revista de comunicación, 51 (2), 366-382. [Kubey, R., Lavin, M. and Barrows, J. (2001). Declining Internet use and collegiate academic performance: initial findings. Revista de comunicación, 51 (2), 366-382]
- Lera-Lopez, F., Gil, M. & Billon, M. (2009). El uso de Internet en España: Influencia de factores regionales y socio-demográficos. Investigaciones Regionales, 16, 93-115. [Lera-Lopez, F., Gil, M. & Billon, M. (2009). Internet use in Spain: Influence of regional and socio-demographic factors. Investigaciones Regionales, 16, 93-115]
- Niederle M, Vesterlund L. 2010. Explaining the gender gap in math test scores: the role of competition. Journal of Economic Perspectives, 24 (2), 129-144
- Malamud, O., Pop-Eleches, C. (2010). Uso de computadoras en el hogar y desarrollo del capital humano. National Bureau of Economic Research, 15814, 1-54. [Malamud, O., Pop-Eleches, C. (2010). Home computer use and human capital development. National Bureau of Economic Research, 15814, 1-54]
- Matthews D, Schrum L. (2003). High speed internet use and academic gratifications in college residence. The Internet Higher Educ, 6, 125-144.
- Mullis, R., Rathge, R., & Mullis, A. (2003). Predictors of academic performance during early adolescence: A contextual view. International Journal of Behavioral Development.
- Núñez, J., Steiner, R., Cadena, X. & Pardo, R. (2002). ¿Cuáles colegios ofrecen mejor educación en Colombia? Documento CEDE 2002-3, Bogotá: Centro de Estudios sobre Desarrollo Económico (CEDE), Universidad de los Andes. [Núñez, J., Steiner, R., Cadena, X. & Pardo, R. (2002). Which schools offer the best education in Colombia? Documento CEDE 2002-3, Bogotá: Centro de Estudios sobre Desarrollo Económico (CEDE), Universidad de los Andes]
- OECD (2015), Students, Computers and Learning: Making the Connection, PISA, OECD Publishing. ISBN 978-92-64-23955-5 (PDF).
- Paserman, M (2010). Gender Differences in Performance in Competitive Environments? Evidence from Professional Tennis Players. Boston University.
- Pereira, S., Fillol, J., & Moura, P. (2019). El aprendizaje de los jóvenes con medios digitales fuera de la escuela: De lo informal a lo formal. Comunicar: Revista Científica de Comunicación y Educación, 27(58), 41-50. [Pereira, S., Fillol, J., & Moura, P. (2019). Young people's learning with digital media outside of school: From informal to formal. Communicate: Scientific Journal of Communication and Education, 27 (58), 41-50.]
- Porlán, R., Martin del Pozo, R., Rivero, A., Harres, J., Azcarate, P. y Pizzato, M. (2010). El cambio del profesorado de ciencias I: marco teórico y formativo. Enseñanza de las Ciencias, 28 (1), 31-46. [Porlán, R., Martin del Pozo, R., Rivero, A., Harres, J., Azcarate, P. and Pizzato, M. (2010). The change in science teachers I: theoretical and training framework. Science Teaching, 28 (1), 31-46.]
- Posada, J. & Mendoza, F. (2014). Determinantes del logro académico de los estudiantes de grado 11 en el periodo 2008 – 2010. Una perspectiva de género y región. Estudios sobre calidad de la educación en Colombia, Working paper. ICFES. [Posada, J. & Mendoza, F. (2014). Determinants of academic achievement of grade 11 students in the period 2008 - 2010. A gender and regional perspective. Estudios sobre calidad de la educación en Colombia, Working paper. ICFES]
- Richardson, Michelle, Charles Abraham, and Rod Bond. (2012). Psychological correlates of university students' academic performance: a systematic review and meta-analysis. Psychological bulletin, 138, 312-353.
- Robert, W, Michael, J, John R. (2001). Disminución del uso de Internet y del rendimiento académico colegiado: hallazgos iniciales. Journal of Communication, 51 (2), 366–382. [Robert, W, Michael, J, John R. (2001). Declining Internet use and collegiate academic performance: initial findings. Journal of Communication, 51 (2), 366–382]
- Rodríguez, C, Sánchez, F, Márquez, J. (2011). Impacto del Programa Computadores para Educar" en la deserción estudiantil, el logro escolar y el ingreso a la educación superior". Universidad de los Andes-CEDE [Rodríguez, C, Sánchez, F, Márquez,J. (2011). Impact of the Computadores para Educar Program "on student dropout, school achievement, and entry to higher education." University of the Andes-CEDE]
- Rodríguez, K., Sánchez, F. y Márquez, J. (2011). Impacto del Programa "Computadores para Educar, en la deserción estudiantil, el logro escolar y el ingreso a la educación superior. Documento CEDE, 2011-15. ISSN 1657-5334, marzo de 2011. [Rodríguez, K., Sánchez, F. and Márquez, J. (2011). Impact of the "Computers to Educate" Program on student dropout, school achievement and entry to higher education. CEDE Document, 2011-15. ISSN 1657-5334, March 2011]
- Rozgonjuk, Dmitri, and Karin Täht. (2017). To what extent does Internet use affect academic performance? Using Evidence from the large-scale PISA study." Annu. Rev. Cyberther. Telemed. 15, 39-44.
- Sánchez-Jabba, A. (2011). Etnia y rendimiento académico en Colombia. Revista de Economia del Rosario, 14 (2) 189-227. [Sánchez-Jabba, A. (2011). Ethnicity and academic performance in Colombia. Revista de Economia del Rosario, 14 (2) 189-227]
- Scherer K. (1997). College life online: Healthy and unhealthy Internet use. J College Stud Dev, 38(6), 655-665.
- Shan, J. (2013). ICT in Education: A critical literature review and its implications. International Journal of Education and Development using Information and Communication Technology (IJEDICT), 9(1), 112 - 125.

- Shurchkov, O. (2012). Under Pressure: Gender Differences in Output Quality and Quantity Under Competition and Time Constraints, Journal of the European Economic Association 10(5): 1189-1213.
- Sprietsma, M. (2012). Computers as pedagogical tools in Brazil: a pseudo-panel analysis. Economía de la educación, 20 (1), 19–32.
- Sunkel, G. y D. Trucco (2010). Nuevas tecnologías de la información y la comunicación para la educación en América Latina: riesgos y oportunidades. CEPAL, 167. [Sunkel, G. y D. Trucco (2010). New information and communication technologies for education in Latin America: risks and opportunities. CEPAL, 167]
- Tansini, R., Aguilar, R. (2011). Computers at home and schoolchildren's outcome in Uruguay. Latin American and Caribbean Economic Association (LACEA)
- Tella A. (2007). University of Botswana undergraduates use of internet: Implications on Academic Performance. J Educ Media Lib Sci, 45(2), 161-185.
- Unesco (2011). Estándares UNESCO de competencia en TIC para docentes. Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura, Francia. [Unesco (2011). UNESCO ICT competence standards for teachers. United Nations Educational, Scientific and Cultural Organization, France.]
- Universidad Nacional de Colombia (2017). Informe final del estudio de medición y evaluación de impacto de CPE 2014-2018. Contrato de Consultoría No. 153 [Universidad Nacional de Colombia (2017). Final report of the study to measure and evaluate the impact of Computadores para Educar 2014-2018. Contrato de Consultoría No. 153]
- Vegas, E; Petrow, J. (2008). Raising Student Learning in Latin America: The Challenge for the Twenty-First Century. Latin American Development Forum. Washington, DC: World Bank.
- Wen, Dongmao (2006). School choices in compulsory education stage and its impact on vulnerable groups in China's urban areas. Peking University Education Review 4 (2): 12–23.
- Whitten, C; Labby, S; Sullivan, S. (2016). The impact of Pleasure Reading on Academic Success. The Journal of Multidisciplinary Graduate Research. 4(2), 48-64.
- Wittwer, J. y Senkbeil, M. (2008). ¿El uso de la computadora por parte de los estudiantes en casa está relacionado con su desempeño matemático en la escuela? Computers & Education, 50 (4), 1558-1571. [Wittwer, J. y Senkbeil, M. (2008). Is students' computer use at home related to their mathematics performance in school? Computers & Education, 50 (4), 1558-1571]
- Woessmann, L. (2003). Schooling resources, educational institutions and student performance: the international evidence, Oxford Bulletin of Economics and Statistics, 65 (2), 117-170.
- Young B. (2006). A study on the effect of internet use and social capital on the academic performance. Dev Society, 35(1), 107-123.

Append. Table 5. The First stage model of students with computer or Internet at home.

VARIABLES	(1) Students with computer or Internet at home
Parents uses computer at work	0.09***
	(0.00)
Daily internet use	0.19***
	(0.00)
Daily internet use squared	-0.02***
	(0.00)
Male sex	0.03***
	(0.00)
Age	-0.04***
	(0.00)
Age squared	0.00***
	(0.00)
Student Works	-0.03***
	(0.00)
People at home	-0.01***
	(0.00)
Parent education	0.04***
	(0.00)
Mother works	0.04***
	(0.00)
Student belongs to ethnicity	-0.10***
	(0.00)
Academic highschool	0.02***
	(0.00)
Public highschool	0.01***
	(0.00)
Highschool stratum	0.15***

	(0.00)
Night or saturday school	-0.00
	(0.00)
Student read daily	-0.01***
	(0.00)
Highschool calendar A	0.04***
	(0.00)
Observations	778,476
R-squared	0.30

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1