IDB WORKING PAPER SERIES Nº IDB-WP-960

Do Children Benefit from Internet Access?

Experimental Evidence from a Developing Country

Ofer Malamud
Santiago Cueto
Julián Cristia
Diether W. Beuermann

Inter-American Development Bank
Department of Research and Chief Economist

November 2018

Do Children Benefit from Internet Access?

Experimental Evidence from a Developing Country

Ofer Malamud*
Santiago Cueto**
Julián Cristia***
Diether W. Beuermann***

* Northwestern University, NBER and CESifo
** GRADE and Pontificia Universidad Católica del Perú
*** Inter-American Development Bank

November 2018

Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

Do children benefit from internet access?: experimental evidence from a developing country / Ofer Malamud, Santiago Cueto, Julian Cristia, Diether W. Beuermann.
p. cm. — (IDB Working Paper Series ; 960)
Includes bibliographic references.
1. Internet and children-Peru. 2. Internet access-Peru. 3. Internet in education-Peru. 4. Internet literacy-Peru. 5. Academic achievement-Peru. I. Malamud, Ofer. II. Cueto, Santiago, 1960- III. Cristia, Julian. IV. Beuermann, Diether. V. Inter-American Development Bank. Department of Research and Chief Economist. VI. Series.
IDB-WP-960

http://www.iadb.org

Abstract[1*]

This paper provides experimental evidence for the impact of home internet access on a broad range of child outcomes in Peru. Children who were randomly chosen to receive laptops with high-speed internet access are compared with i) those who did not receive laptops and ii) those who only received laptops without internet. It is found that providing free internet access led to improved computer and internet proficiency relative to those without laptops and improved internet proficiency compared to those with laptops only. However, there were no significant effects of internet access on math and reading achievement, cognitive skills, self-esteem, teacher perceptions, or school grades when compared to either group. Reasons for the absence of impacts on these key outcomes are explored with survey questions, time-diaries, and computer logs.

JEL classifications: C93, I21, I28
Keywords: Internet access, Education, Academic achievement, Digital skills, Cognitive skills, Technology, Experimental

[*] Malamud: School of Education and Social Policy, Northwestern University, 2120 Campus Drive, Evanston, IL 60208. Corresponding author: ofer.malamud@northwestern.edu.
Cueto: GRADE, Av. Almte. Miguel Grau 915, Lima 15063, Peru
Cristia: Inter-American Development Bank, 1300 New York Ave NW, Washington, DC 20577
Beuermann: Inter-American Development Bank, 1300 New York Ave NW, Washington, DC 20577
We want to especially thank Elena Arias Ortiz (IDB), Mariana Alfonso (IDB), and Jennelle Thompson (IDB) for their significant contributions. This project would not have been materialized without the collaboration and commitment shown by the Dirección General de Tecnologías Educativas in the Ministry of Education of Peru (DIGETE). We thank its former directors Oscar Becerra and Sandro Marcone, respectively, and their excellent team including among others Roberto Bustamente, Carmen Alvarez and Victor Castillo. We also thank Giuliana Avila, Minoru Higa, Olga Namen, Elizabeth Rosales, Claudia Sugimaru, Diego Vera, and Micaela Wensjoe for outstanding research assistance. Financial support from the Inter-American Development Bank, USAID (Grant AID-527-F-12-00002) and the Spencer Foundation (Grant #201300081) is gratefully acknowledged. The views expressed in this paper are those of the authors and should not be attributed to the Inter-American Development Bank or any other institution.

1. Introduction

Despite the rapid worldwide expansion of the internet, large disparities in children's internet access remain. Internet access is practically universal for children in developed countries: over 95 percent of 15-year old students in OECD member countries report having a link to the internet at home (OECD, 2017). In contrast, access to the internet continues to lag for children in developing countries. For example, less than half of 15-year-old students in Algeria, Peru, and Vietnam report having internet access at home (OECD, 2017). In an effort to alleviate this "digital divide," many government and non-governmental organizations are investing substantial resources to expand internet access to children in developing countries.[2] However, rigorous evidence for the impact of home internet access on children's outcomes is currently limited to developed countries and may not generalize to settings where fewer resources can complement or substitute for technology.[3] Accordingly, this paper provides the first experimental evidence for the impact of home internet access on a broad range of child outcomes in a developing country context.

Internet access can potentially affect a range of skills including academic achievement and cognitive skills. If children lack educational materials, internet access may improve the development of academic skills by providing access to educational websites with subject-specific content and exercises (e.g., Khan Academy). Moreover, children can access e-books and other reading materials such as newspapers, blogs, and online encyclopedias (e.g., Wikipedia). On the other hand, internet access may diminish learning if children spend more time on activities that are not conducive to developing academic skills, such as playing online games, and less time reading and doing homework. Finally, internet access affects cognitive skills by exposing children to online activities that alter cognitive processes (Johnson, 2006; Mills, 2014).

To measure the effects of providing internet access, we implemented a randomized experiment in Lima, Peru, between 2011 and 2013. We first provided access to XO laptops for home use to a random sample of 540 children enrolled in grades 3 to 5 in low-achieving public primary schools (in June/July 2011).[4] Then, among children who received these laptops, we

[2] For example, the "Yo Elijo Mi PC" program in Chile provides free internet along with laptops for eligible students. Numerous national programs subsidize internet access more broadly, e.g. Brazil's Plano Nacional de Banda Larga.
[3] See Fairlie and Robinson (2013) and Vigdor et al. (2014) for evidence from the United States, and Faber et al. (2016) for evidence from the United Kingdom. We discuss the findings from these studies in detail shortly.
[4] The XO laptops were developed by the One Laptop per Child (OLPC) program with an emphasis on self-empowered learning and with specialized software intended to encourage such learning.

randomly selected about 350 children to receive free high-speed internet access (in July/August 2012). The laptops included 32 applications selected by the Ministry of Education of Peru for its national program, and we offered training and manuals on how to use them. We also offered tutorials and manuals to children who received internet access in which we showed them how to take advantage of freely available educational websites created by Peru's Ministry of Education and other online resources, such as Khan Academy and Wikipedia.

To evaluate the impacts of our interventions, we conducted a follow up survey in November 2012, approximately 17 months after the laptops were initially distributed and 5 months after the provision of internet access. We also conducted an additional follow-up survey in March 2013 to check for longer-run impacts after the summer vacation. In prior work, we examined only the short-term impact of XO laptops without internet access (Beuermann et al., 2015). In the current study, we compare i) children who were randomly chosen to receive laptops with internet access to ii) those who did not receive laptops and to iii) those who only received laptops without internet. Thus, we are able to estimate the impact of internet access both separately from, and in conjunction with, the impact of the laptops themselves.

Our interventions were successful in increasing children's access to technology at home and led to substantial improvements in digital skills after just 5 months. Children who were offered internet access were 30 percentage points more likely to have internet at home as compared to those who were not offered internet, whether they had laptops or not. Furthermore, children who were offered internet access scored 0.3 standard deviations higher on a test of internet literacy than those who were not offered internet access, whether they had laptops or not. They also scored 1 standard deviation higher on a test that measured proficiency on the XO laptop compared to those who were not offered laptops, but not significantly different from those children who were offered laptops without internet. In addition, children who were offered laptops (with or without internet) had significant improvements on a Windows-based computer test, suggesting that gains in computer literacy were not only limited to the specific XO platform but transferred to skills for using other types of computers.

Despite the increase in access to technology and the improvements in digital skills, there were no significant effects of internet access on academic achievement. We can rule out impacts larger than 0.08 standard deviations in math and 0.13 standard deviations in reading with 95 percent confidence when comparing children who were offered internet access to those who did

not get laptops. Nor were there any significant effects on a broad set of cognitive skills, as measured by the Raven's Progressive Matrices test, a verbal fluency test, a test of executive functioning, a coding test, a working memory test and a test of spatial reasoning. Similarly, we did not find significant effects on a self-esteem index measured by a self-reported questionnaire. Based on teacher reports, children in the treatment groups were equally likely to exert effort at school when compared with their counterparts in the control group, and there were no differences on grades obtained from administrative school records or in teacher perceptions of children's sociability. There was also no evidence of improvements when we resurveyed children 8 to 9 months after internet provision following the summer vacation, despite the potential benefits of engaging children with the internet to counteract summer learning loss.[5]

Why were there no significant impacts on academic achievement and cognitive skills from providing children with internet access? Though we cannot provide a definitive answer to this question, we consider a number of possible explanations. First, while the intervention itself was not directly linked with pedagogical activities at school, we did provide children with tutorials and manuals to make more effective use of their computers and the internet for educational purposes. Second, while we do not have long-term outcomes, previous research has shown that new technology can have short-term impacts within a year (Malamud and Pop-Eleches, 2012; Banerjee et al., 2007) or even just several months (Muralidharan et al., 2016). Third, it is possible that the impact on internet use was not sufficiently large. Looking at the extensive margin, the fraction of children who report using the internet in the previous week is significantly higher among those who were offered internet access, but the difference is only 6 percentage points (since even children without internet access at home had high rates of internet use). However, based on time-diaries completed by children, we estimate that those who were offered internet access spent an additional 90 minutes of computer use per week, or over 60 percent higher than those who did not receive laptops. Thus, there are substantial differences in internet use on the intensive margin.

So how did children use the additional time with their home computers and what was the effect on time spent on other activities? We use data from computer and internet logs to show that computer and internet use was focused more on entertainment than on learning. This happened in

[5] Many studies find that students score lower on (the same) standardized tests at the end of the summer than at the beginning of the summer, often referred to as summer learning loss. See Alexander et al. (2016) for a collection of recent contributions to the literature on summer learning loss.

spite of our efforts to promote internet use for educational purposes through the provision of training, tutorials and manuals. Furthermore, although the time diaries do not reveal large and consistent changes in the time spent on other activities, there is some evidence of a reduction in time spent watching TV and doing homework. Overall, our analysis underscores the null effects of increasing internet access on the development of academic and cognitive skills, and suggests the need for parents to ensure that technological resources are used in ways that foster better educational outcomes.

Several recent studies estimate the causal impact of home internet access on children's outcomes, but all are based in developed countries.[6] Fairlie and Robinson (2013) find no impacts of home computers with subsidized dial-up internet access on standardized tests or grades using a randomized experiment in California.[7] Vigdor et al. (2014) exploit local variations in broadband internet penetration in North Carolina to show that children who live in areas that receive additional internet providers experience a modest but significant decline in mathematics test scores (and insignificant decline in reading). Lastly, Faber et al. (2016) exploit differences in broadband connection speeds across neighboring residences in England and find no significant impacts on test scores or time spent studying. However, to our knowledge, no previous study has separately identified the added effect of home internet access in an experimental setting.

Accordingly, this paper makes several contributions to the existing literature on technology in education. First, this study represents the first randomized experiment exploring the effects of home internet access implemented in a developing country. Focusing on this setting is especially policy-relevant given that governments and households in the developing world are making significant investments to expand internet connectivity.[8] Second, because our individual-level randomization includes almost 2,000 children with follow-up data, we can provide relatively precise estimates of impacts on a variety of short and medium-term outcomes. Third, our study includes a broad range of outcomes, including not only academic achievement measures but also

[6] Papers that examine the causal impact of home computers *without internet access* on children's outcomes in developing countries include Malamud and Pop-Eleches (2011), Mo et al. (2013) and Beuermann et al. (2015). Papers that evaluate the causal impact of *school-based* internet access in developing countries include Kho, Lakdawala, and Nakasone (2018) and Sprietsma (2007).

[7] Using this same experiment, Fairlie and Kalil (2016) find positive impacts on the likelihood of having a social networking site and time spent communicating with friends, but no effects on school participation and engagement.

[8] The yearly cost of providing (high-speed) internet access is now higher than the cost of most lower-end laptop and desktop computers in many countries. See https://www.forbes.com/sites/niallmccarthy/2017/11/22/the-most-and-least-expensive-countries-for-broadband-infographic/.

a full set of cognitive skills tests, teachers' assessments, time diaries and school grades records. Finally, we use detailed information from computer logs of applications and internet sites that provide objective measures to help us better understand the "black box" of computer use.

The paper is structured as follows. Section 2 describes the experimental design and implementation of the interventions. Section 3 explains our data collection efforts and the empirical strategy we use to analyze the data. Section 4 presents the main impacts of our interventions. Section 5 attempts to open the "black box" of our interventions using survey questions, time-diaries, and computer logs. Section 6 provides a summary of our findings and concludes.

2. Experimental Design

Our experimental study was implemented in several steps. We began by randomly selecting 14 schools from a sample of low-achieving public primary schools.[9] Within these schools, we provided laptops for home use to a random sample of children who were in third to fifth grade in 2011. Then, among children that won laptops, we randomly provided high-speed internet access to a sub-sample of them. The specific timeline of the study is as follows (and shown in Online Appendix Figure A1). We collected baseline data in April/May 2011 and conducted the lottery (and delivered laptops) in June/July 2011. Training for the laptop and a manual for children was offered in August/September 2011. We provided internet access in July/August 2012. Training on internet use and a manual for children was offered in September 2012. Finally, we collected follow-up data in November 2012 and March 2013. Note that Peru's academic school year runs from March to December. It is worth noting that the Ministry of Education had automatically blocked the XO laptops during the first summer of the project (January to March 2012). However, in order to measure the longer-run effects through March 2013, we obtained a waiver, and the laptops were not blocked during the second summer (January to March 2013). The remainder of this section describes the interventions in more detail.

[9] These schools all had morning shifts which enrolled between 400 and 800 students, 4 classes per grade or fewer, a ratio of school computers to students lower than 0.15, and a classroom available for a computer lab in the afternoon.

2.1 Laptops

We first offered XO laptops for home use to 540 randomly selected children in grades 3 to 5.[10] In June/July 2011, we conducted public lotteries for 4 laptops within each class among children whose parents provided written consent. The lotteries were conducted in class and parents were invited to attend in order to assure transparency. These procedures were developed in close coordination with schools, principals, and teachers. The XO laptops were provided by the Ministry of Education of Peru and specifically designed to be used by primary-aged students in developing countries. The laptops had 512 MB of RAM, 2 GB of flash storage, and a Linux operating system. The graphical interface, known as Sugar, was designed to be used by children.[11]

Thirty-two applications, selected by the Ministry of Education for nationwide use, were installed in the distributed laptops. The applications included standard applications such as word processor, drawing software, and calculator; educational games including Tetris, Sudoku and a variety of puzzles; applications to create, edit and play music; two programming environments; and other applications including sound and video recording and certain sections of Wikipedia. The laptops were also pre-loaded with age-appropriate e-books selected by the Ministry of Education.

We provided all beneficiary children with an instruction manual and the opportunity to attend training sessions. The manual was designed for primary school children, with graphical illustrations about how to use the laptop and in-depth practical instruction for 10 government-prioritized applications. Weekly training sessions took place in each school for a seven-week period in August and September 2011. On each Saturday during the training period, there were three two-hour sessions for children arranged by grade. Children did not receive help with schoolwork or any other instruction during these sessions. Average student attendance was about 50 percent, and approximately 70 percent of children attended at least one session.

2.2 Internet

We provided high-speed internet access to a subset of laptop lottery winners who were studying in grades 3 to 5 during the 2011 school year. This intervention was conducted in July and August

[10] In total, 1,048 laptops were distributed to children in grades 1 to 6. However, we focus on children in 3rd to 5th grade because of the difficulties in collecting reliable baseline information from 1st and 2nd grades, and the challenge of tracking 6th graders who moved on to secondary school by the time of the follow-up survey.

[11] The laptops do not run Windows, and they are not compatible with software designed for that operating system. However, most files (e.g., images, sound and text documents) are compatible with the XO environment.

of 2012, approximately 13 months after the start of the first intervention.[12] We randomly chose two among the children that were offered laptops in each class and offered them a high-speed internet connection for the XO laptop.[13] Specifically, we randomly sorted the children who were initially offered laptops and offered internet access to children ranked first and second. If either of these children ended up not receiving internet access (e.g., because the parents did not attend the session when the equipment was provided), we offered internet access to the child ranked in the third position. If two of the children ranked first to third did not receive internet access, then we offered this service to the child ranked fourth. Approximately 80 percent of the internet connections were provided to children ranked first or second—see Online Appendix Table A4. All children who were *offered* internet access are considered as treated for the purposes of our ITT estimates (as described later).

In total, 354 children were offered high-speed internet access at home for eight months until March 2013. We provided 8 additional training sessions and a manual to help children take full advantage of the internet access. The manuals contained guidelines on using the internet safely, tutorials for educational websites produced by Peru's Ministry of Education, instructions on how to search for information using Wikipedia and other virtual libraries, as well as links to Khan Academy and other educational resources. However, children did not receive any help with schoolwork during these sessions. We also attempted to minimize the possibility of exposure to adult content by blocking certain websites and providing guidelines for use to children and parents.

3. Data and Empirical Strategy

3.1 Data

The primary data used in this evaluation were collected directly in baseline and follow-up surveys.[14] We conducted a baseline survey among children in targeted schools during April/May 2011 and collected information on basic demographics, computer literacy, computer and internet use, time use, and detailed information about social networks, as well as a test of cognitive skills (Raven's Progressive Matrices) and standardized tests in math and language ability. We also

[12] Note that this intervention was only announced in June 2012, so children and parents were not aware of this intervention until immediately prior to the start of the intervention itself.
[13] Internet access was provided through Claro, a major telecommunications company in Peru.
[14] In addition, we used administrative data at the school level from the Peruvian Education Statistics Unit and individual-level standardized tests from Student Census Evaluation (ECE) at the Ministry of Education of Peru for the initial selection of schools.

surveyed teachers on their perceptions of student sociability, effort devoted in class, and expected educational attainment.

A first follow-up survey was conducted in November 2012, approximately 5 months after the provision of internet access. It covered most of the topics examined in the baseline survey *plus* a battery of cognitive tests including i) a general cognitive test based on the Colored Raven's Progressive Matrices test together with an additional set of more difficult pattern-recognition questions, ii) a test of verbal fluency that requires children to list all the words they can think of starting with a particular letter ("P") in three minutes, iii) a coding test similar to the one in the Wechsler test, iv) a test of spatial reasoning based on mental rotation exercises, v) a working memory test, and vi) a short test of executive functioning: the Stroop test measuring cognitive interference. We also tested children in three domains of digital skills: i) proficiency in the use of the XO laptops, ii) competence in operating a Windows-based computer, and iii) knowledge and use of the internet. In addition, we administered a detailed time diary to a subsample of 838 children in November 2012 who had attended 4th grade at baseline. These children were interviewed individually and were asked to mention each activity performed during a 24-hour period starting at 7 a.m. the prior day. We supplemented this follow-up survey by collecting official school records on grades corresponding to the 2012 academic year.

A second follow up survey was conducted in March 2013, approximately 8 to 9 months after the provision of internet access and shortly before families were required to return their laptops to the school.[15] Children were administered an abridged questionnaire similar to the one in the previous follow-up, and tested on their digital skills, math and reading ability and one of the cognitive tests (Raven's progressive matrices).

Finally, we extracted log files from the laptops for approximately two-thirds of the XO beneficiaries (with parental consent). This enables us to examine detailed patterns of use in an objective manner without relying on subjective reports from children. The logs recorded the date and time when each session started as well as roughly when every application was opened. They also provide information about every internet site visited by children on these computers.

[15] This survey was only administered to children who attended 3rd and 4th grade in 2011. This because students who were in 5th grade in 2011 graduated from primary school in December 2012 and we were no longer able to track them.

3.2 Empirical Strategy

The empirical framework for our main analysis involves two different comparisons. First, we compare children who were randomly offered laptops with internet access ("Laptop+Internet" treatment) to those who did not win laptops ("No Laptop" control group). Second, we compare children who were randomly offered laptops with internet access ("Laptop+Internet" treatment) to children who won laptops but were not offered internet access ("Laptop Only" control group). We can estimate both of these impacts jointly using the following regression model:

$$Y_{ijk} = \delta_1 LaptopOnly_{ijk} + \delta_2 (Laptop{+}Internet)_{ijk} + X'_{ijk}\beta + \eta_j + \varepsilon_{ijk} \quad (1)$$

where Y_{ijk} denotes an outcome of interest for child *i*, in class *j* and school *k* observed at follow-up. $LaptopOnly_{ijk}$ is an indicator which takes the value of 1 if child *i* in class *j* and school *k* won a laptop but was not offered home internet access, and 0 otherwise. $Laptop{+}Internet_{ijk}$ is a treatment indicator which takes the value of 1 if child *i* in class *j* and school *k* won a laptop and was offered internet access, and 0 otherwise. The omitted category is the "No Laptop" control group. Thus, δ_2 captures the impact of providing internet access for children who neither have access to the internet or to a laptop; and $\delta_3 = \delta_2 - \delta_1$ captures the impact of providing internet access for children who have access to a laptop without internet access (i.e., the added effect of internet over and above the effect of having a laptop only).[16]

In our preferred specifications, X_{ijk} only includes a constant and the baseline value of the corresponding outcome variable (when available) to help improve precision. However, our results are unchanged by the inclusion of additional baseline covariates or by excluding the baseline value of the outcome variables. We always include a class lottery fixed effect, η_j, since the individual randomization was carried out class by class. Finally, ε_{ijk} is an error term that allows for heteroscedasticity across observations.

3.3 Analytical Sample

The main sample used to analyze the effects measured in November 2012 includes 2,126 children attending grades 3 to 5 at baseline whose parents provided consents for participating in the

[16] This second comparison can be estimated directly by $Y_{ijk} = \gamma_1 LaptopOnly_{ijk} + \gamma_2 NoLaptop_{ijk} + X'_{ijk}\beta + \eta_j + \varepsilon_{ijk}$; where the omitted category is the group of children in the "Laptop+Internet" treatment. Then, reversing the signs of the main coefficients in this regression equation, we get that $\delta_2 = -\gamma_2$ and $\delta_3 = \delta_2 - \delta_1 = -\gamma_1$.

study.[17,18] Of these, 1,653 are in the "No Laptop" group, 163 are in the "Laptop Only" group and 310 are in the "Laptop+Internet" group. The attrition rate in this sample from the corresponding baseline sample is 13 percent, and not statistically different across treatment arms.[19,20] Figure 1 describes how we arrived at this final sample from our original sample in more detail and shows the level of compliance within each treatment arm (Online Appendix Figure A2 shows the analogous sample composition for the longer-run follow-up).

[Figure 1 here]

Table 1 provides evidence that the within-school randomization was successful in generating balance between treatment and control groups for our analytical sample.[21] Columns 1, 2, and 3 present the means of the baseline characteristics for the "No Laptop", "Laptop Only", and "Laptop+Internet" groups respectively. Column 4 shows the estimated difference between the "Laptop+Internet" group and the "No Laptop" group while Column 5 shows the estimated difference between the "Laptop+Internet" group and the "Laptop Only" group. Among the 42 estimated differences between treatment and control groups, only two were significant at the 5 percent level or lower. Thus, the randomization of computers and internet was successful in creating balanced treatment and control groups to consistently identify the effects of the intervention through equation (1).

[Table 1 here]

All our results are based on intent-to-treat (ITT) estimates; that is, we consider children who were randomly assigned to the "Laptop Only" or "Laptop+Internet" groups whether or not they actually received a laptop or internet access. Given the 95 percent take-up rate of laptops and

[17] Online Appendix Table A3 shows that children whose parents consented to the study had significantly lower probability of having phone, electricity, computer and internet access but higher scores in reading, cognitive skills, and teacher assessments than those whose parent's did not consent.

[18] This analytical sample is restricted to observations with non-missing values for the corresponding variables at baseline and follow-up so that we have consistent samples in our balance and outcome tables. Our results are essentially unchanged when we relax this restriction, as shown in Online Appendix Table A5.

[19] The likelihood of attrition in the November 2012 survey was slightly higher for males, those without siblings, and lower math scores at baseline. However, these characteristics predict attrition similarly across treatment arms.

[20] The attrition rate in the March 2013 follow-up survey was closer to 25 percent, but also not significantly different across treatment arms. See Online Appendix Table A1 for the differential likelihood of attrition across treatment arms.

[21] Note that Table 1 shows balance for children that were observed at both baseline and follow-up. Online Appendix Table A2 shows that baseline characteristics are also balanced for the full sample of randomized children at baseline (including those who were not observed at follow-up).

the 81 percent take-up rate of internet in our analytical sample, the ITT estimates are relatively similar in magnitude to the treatment on the treated (TOT) estimates that scale up our estimates by the rates of take-up.[22] However, scaling up the estimates by the rates of computer and internet access and use reported by children, as discussed in sections 4.1 and 4.2, would yield substantially larger impacts.

4. Main Impacts

This section presents the estimated impacts of our interventions on computer access and use, internet access and use, computer and internet skills, academic achievement, cognitive skills, self-esteem, school grades, and other teacher assessments. Most of the tables are structured in a similar fashion: the means of outcomes for the "No Laptop," "Laptop Only," and "Laptop+Internet" groups are shown in columns 1, 2, and 3 respectively; the difference between the "Laptop+Internet" group and the "No Laptop" group in column 4; and the difference between the "Laptop+Internet" group and the "Laptop Only" group in column 5.

4.1 Computer Access and Use

Panel A of Table 2 presents our findings related to self-reported computer access and use. Column 4 shows that children randomly assigned to receive laptops with internet access were approximately 40 percentage points more likely to report having a computer at home compared to those in the "No Laptop" group. This represents a large and significant effect on access to home computers but it is noteworthy that 54 percent of children in the "No Laptop" control group already own a computer.[23] Unsurprisingly, column 5 shows no significant impact of simply providing internet access on computer ownership relative to children in the "Laptop Only" group who were provided laptops without internet access.

[Table 2 here]

[22] We have estimated equation (1) instrumenting actual take-up with the indicators for random assignment and results remain mostly unchanged. These results are available upon request.

[23] Note that only 43 percent of children in the control group report having a home computer at baseline, suggesting that some of them acquired a computer after (and, perhaps, because of) our intervention. Although we did not collect information about the nature of other computers in the household, these are unlikely to be XO laptops since such computers were not commercially available.

There were also significant differences in computer use when comparing children in the "Laptop+Internet" group to those in the "No Laptop" group in column 4. Consistent with the nature of our intervention, children who were randomly assigned to receive laptops with internet were 32 percentage points more likely to use computers at home during the previous week compared to those in the "No Laptop" group. However, these same children in the "Laptop+Internet" group were 11, and 6 percentage points less likely to use computers in internet cafes, and friend's houses respectively than those in the "No Laptop" group. Therefore, it seems that children who won a laptop and internet access substituted computer use at home for use outside the home. Again, column 5 shows no significant impacts of providing internet access on computer use relative to children in the "Laptop Only" group.

4.2 Internet Access and Use

Panel B of Table 2 presents our findings on self-reported internet access and use. Compared to children in either the "Laptop Only" or "No Laptop" group in columns 4 and 5 respectively, those randomly assigned to receive laptops with internet were 30 to 33 percentage points more likely to report having internet at home. Thus, the internet intervention was successful in increasing connectivity. Nevertheless, around 40 to 44 percent of children in the control groups also report access to the internet (this fraction was around 31 to 34 percent at baseline).[24]

We also observe that the internet intervention led to increased internet utilization at home. Children in the "Laptop+Internet" group were 27 and 22 percentage points more likely to report using internet at home during the previous week compared to those in the "No Laptop" and "Laptop Only" group respectively. However, those children who were randomly assigned laptops with internet access did report a decrease in the likelihood of using internet in internet cafés (a significant decrease of 10 percentage points when compared to the "No Laptop" group). This suggests that there was some substitution away from internet use outside the home and towards internet use on children's personal computers.

[24] These rates of internet access are similar to home internet penetration of 36 percent among households in Metropolitan Lima in 2012 based on the Peruvian National Household Survey. This penetration is higher than in other regions of Peru (especially the poorer highlands and Amazon regions where rates are below 10 percent).

4.3 Skills

Table 3 presents the impacts of internet access on a broad set of skills. Compared to children in the "No Laptop" group, those who were randomly assigned to receive laptops with internet access scored 1 standard deviation higher on an "XO test" measuring XO-specific laptop knowledge (column 4). Similarly, we observe a positive impact on a "PC test" which measured skills related to using a Windows-based computer. Children in the "Laptop+Internet" group scored 0.21 standard deviations higher than those in the "No Laptop" group. It thus appears that XO skills are transferable (at least to some degree) to Window-based platforms. However, there is no additional impact of internet access over and above the effect of receiving a laptop without internet access for either the XO test or the PC test (column 5). This confirms that the provision of internet access itself did not improve those digital skills that were not specifically related to internet use.

[Table 3 here]

In our "Internet test" of internet knowledge and skills, we observe that children in the "Laptop+Internet" group scored 0.33 and 0.26 standard deviations higher than those in the "No Laptop" and "Laptop Only" groups respectively. This confirms that the internet intervention served to improve children's internet skills. In other words, the impact on internet skills is almost wholly captured by the additional impact of internet access over and above the effect of receiving a laptop without internet access. The combined impact of our XO test, PC test, and internet test is captured by a digital skills index that is also standardized accordingly. We attempted to gauge the magnitude of our impacts on digital skills by comparing them to differences in digital skills between children with and without home computers and internet in the control group. We find that providing children with access to computers and internet at home effectively closes the gap in digital skills between those with and without home computers.

We administered standardized math and reading tests, but we did not find significant impacts of providing internet access relative to either control group. These estimated impacts of zero are also quite precise. None of the estimates are larger than 0.05 standard deviations in magnitude. Using our academic achievement index which combines the standardized scores in math and reading, we can rule out positive impacts larger than 0.08 standard deviations with 95 percent confidence when comparing children with internet access to those who did not get laptops. This is consistent with previous evidence provided by Beuermann et al. (2015) and Cristia et al.

(2017). We also administered a battery of cognitive tests which included the Raven's Progressive Matrices, verbal fluency, executive functioning, coding, working memory, and spatial reasoning. Again, our results reveal no impacts of providing internet access compared to either of the control groups. Using our cognitive skills index which combines the standardized scores across all of these tests, we can rule out positive impacts larger than 0.09 standard deviations with 95 percent confidence when comparing children with internet access to those who did not get laptops. This contrasts with previous findings in Malamud and Pop-Eleches (2011) and Cristia et al. (2017) who found significant effects of exposure to computers on the Raven's Progressive Matrices test. Finally, we applied a survey instrument that yielded a self-esteem index but also found no evidence of significant effects.[25]

4.4 Grades and Teachers' Perceptions

Table 4 presents results based on teacher evaluations. We collected administrative data regarding official school grades for the 2012 academic year running from March to December. We computed indicators for the likelihood of being promoted to the next grade (Pass grade), for being assigned to summer school because of poor performance during the academic year (Need summer school), and for failing the academic year (Fail grade). We also computed the percentage of courses in which students obtained the highest possible letter grade awarded by their teacher (Percentage of top grades). Columns 4 and 5 in the top panel of Table 4 shows that there are no significant impacts of providing internet access on any of these measures.

[Table 4 here]

We also surveyed teachers on their perceptions of their students' social popularity, effort at school and expected educational attainment.[26] For the first two dimensions, we asked teachers how they evaluate each pupil in their classroom: below average, average, or above average. Regarding educational expectations, the options reported by teachers consisted of whether the

[25] There is an extensive literature in psychology examining the effect of the internet on social involvement and psychological well-being, starting with a seminal paper by Kraut et al. (1998).

[26] Teachers' perceptions could have been affected if they knew their students' treatment status. However, this is not likely because of several reasons. First, internet randomization was conducted privately by the research team and only internet winners were contacted. Second, laptops were provided for home use and students were not allowed to take them to school. Third, most of the teachers surveyed did not witness the initial provision of computers in 2012 because this took place in the prior year and teachers typically do not follow the same cohort of students over time.

child was expected to attain primary, secondary or post-secondary education. We then constructed summary indicators that take the value of one if the teacher reported the highest possible outcome for the pupil and zero otherwise. As shown in the bottom panel of Table 4, we did not observe any significant impact of providing internet access on teacher's perceptions of social popularity or effort at school (although there was a marginally significant difference of 5 percentage points between the "Laptop+Internet" and the "No Laptop" groups in the likelihood of expecting the child to complete university education).

4.5 Heterogeneous Effects

In addition to showing the average impacts of the intervention on the full sample, we also looked for heterogeneous effects by individual characteristics. We focused on differences by gender and baseline academic achievement, as shown in Table 5.[27] The impact of our interventions on access and use of home computers and internet by gender is similar. Girls show higher impacts on digital skills as compared to boys, although these differences are not significant at the 5 percent level. There are no statistically significant impacts on academic achievement, cognitive skills, and socio-emotional skills for either girls or boys with the exception of the effects of internet provision on socio-emotional skills for girls. We also looked whether there were statistically significant differential effects between boys and girls for the outcomes presented in Table 5 and could not reject that the effects are similar across genders at the 5 percent level with the sole exception of the effect of internet provision on socio-emotional skills (larger for girls).

[Table 5 here]

The impact of our interventions on access and use of home computers by baseline academic achievement is also similar, with slight higher rates for children with higher baseline achievement. The impacts on digital skills are larger for children with higher baseline achievement, and significantly different from those with lower baseline achievement in the Laptop+Internet group. Again, there are no significant impacts on academic achievement, cognitive skills, and socio-emotional skills for either high or low achievers, with the exception of positive effects of internet provision on academic achievement for high achievers. Moreover, we checked whether there are

[27] Previous research by Banerjee et al. (2007), Bai et al. (2016), and Mo et al. (2017) suggests there may be heterogeneous impacts of technology by baseline ability and gender. On the other hand, Linden (2008) and Muralidharan et al. (2016) did not find significantly different impacts by these characteristics.

differential statistically significant effects across low and high achievers and found that we cannot reject that the effects are the same with the exception of a larger effect of internet provision on internet use for high achievers.

Online Appendix Table A6 presents the differential impacts of our intervention by prior computer and internet access. Not surprisingly, the impacts on access and use of home computers are larger in magnitude for children that reported no baseline availability of a computer or internet at home. However, positive effects on digital skills are similar regardless of baseline access and there are no significant impacts on academic achievement, cognitive skills, or socio-emotional skills for any of these subgroups. Finally, Online Appendix Table A7 presents the differential impacts of our intervention by children's grade at baseline. The estimated impacts are mostly similar by grade, although the effects on use and digital skills appear to be larger for the youngest cohorts in a few cases.

4.6 Longer-Run Effects

The results from the second follow-up survey in March 2013 are presented in Table 6, and mostly mirror the main findings from the earlier follow-up survey conducted in November 2012. We continue to observe a pronounced impact of our interventions on measures of digital skills. Children in the "Laptop+Internet" group scored over 1 standard deviations higher than those in the "No Laptop" group on a test of XO proficiency, and 0.30 standard deviations higher on a test of internet proficiency. However, as in our earlier survey, there were no significant effects on academic achievement in math and reading, scores on the Raven's Progressive Matrices test, or on our measure of self-esteem.

[Table 6 here]

4.7 Spillovers

We also checked for the possibility of spillover effects by taking advantage of social network data reported by all children at baseline. In particular, we focused on children who did not win the XO lottery and split them into three subgroups: i) those reported as close friends of children who won the XO lottery and were assigned to receive internet access, ii) those reported as close friends only of children who won the XO lottery but were not assigned to receive internet access, and iii) those

not mentioned as a close friend of any child who won the lottery.[28] Under the assumption that children who were not close friends with the lottery winners experienced little or no spillovers, we can interpret the differences between groups i) and ii) and between groups i) and iii) as alternative measures of the spillover effect of internet access. However, Online Appendix Table A8 indicates no significant spillover effects.[29]

5. Opening the Computer's "Black Box"

In this section, we explore some of the possible mechanisms that may explain why we do not observe significant impacts of internet access on the key child outcomes in our study. To do this, we use traditional survey questions, as well as detailed time-diaries, and computer logs that capture information about which laptop applications were used and which internet websites were visited by the children who received XO laptops.

5.1 Time Use

Table 7 shows the impact of internet access on a broad set of activities measured through time diaries applied to a random sub-sample of 838 children who were in 4th grade at baseline. These measures represent the number of minutes that the child reported being engaged in each activity during the previous day. Columns 1, 2, and 3 show that time spent on computer or laptop is substantially lower than the time spent watching TV, doing homework, playing without a computer or even doing domestic chores. Across all three groups, the reported time spent on a computer or laptop ranges from 20 to 34 minutes per day.

Nevertheless, the provision of internet access does lead to significantly more time spent using a computer or laptop based on the children reports. Relative to the children in the "No Laptop" group, those who were randomly assigned to receive laptops with internet used a computer an additional 13 minutes per day, or 1.5 hours per week. This represents an increase of over 60 percent, and very similar to the impact on the reported number of minutes spent using a computer

[28] Specifically, we estimate the following OLS regression equation: $Y_{ijk} = \sigma_1 Friend_{Laptop_{ijk}} + \sigma_2 Friend_{Internet_{ijk}} + X'_{ijk}\beta + \eta_j + \lambda N_{ijk} + \varepsilon_{ijk}$ where we control for the number of participating children who report child i as a close friend, N_{ijk}, because children with more participating friends are also more likely to have a lottery winner among their friends

[29] We cannot rule out the possibility that internet-connected laptops generated positive externalities to everyone in the school (regardless of how closely they were connected to the lottery winners). However, in previous work, Beuermann et al. (2015) showed relatively little evidence of such spillovers for laptops without internet access.

specifically at home. Relative to the children in the "Laptop Only" group, the impact is smaller and insignificant, at 5 minutes per day, or half an hour per week. Still, despite the lack of significance, this represents an increase of over 15 percent.

[Table 7 here]

There is some evidence that providing internet access leads to substitution away from other activities. We see that children in the "Laptop+Internet" group spend almost 30 minutes less time watching TV as compared to those in the "Laptop Only" group. Meanwhile, children in the "Laptop+Internet" group spend about 8 minutes less time doing homework as compared to those in the "No Laptop" group. However, there are also instances where exposure to internet appears to increase time spent on certain activities (e.g. domestic chores, working outside the home), albeit not significantly. It is possible that internet access makes children more efficient at completing homework assignments such that they spend less time on homework and frees up time for other activities. In terms of the type of computer use children engaged in, we observe increases of 5 and 8 minutes per day on computer games relative to the "No Laptop" and "Laptop Only" groups, and an increase of about 7 minutes per day using computers for homework as compared to the "No Laptop" group.

To summarize: despite some significant effects, the magnitudes are quite small relative to the overall time use. Still, an increase in computer use of 90 minutes per week is not trivial.

5.2 Type of Computer and Internet Use

We also examine how children use their computers and the internet in more detail in Table 8. Compared to those in the "No Laptop" group, children who were randomly assigned to receive laptops with internet were significantly more likely to use their computers to do homework (10 percentage points) and to play games (11 percentage points). There were also positive impacts of internet access over and above the effect of having a laptop itself in terms of using the computer to watch videos (11 percentage points) but a negative effect on using it to listen to music (10 percentage points).

[Table 8 here]

Regarding how children use the internet, we observe that those in the "Laptop+Internet" group are significantly more likely to use the internet to search for information (13 percentage points) and watch videos (11 percentage points) relative to those in the "Laptop Only" group. There is also evidence that those in the "Laptop+Internet" group were more prone to play online games, search information, and use educational programs than those in the "No Laptop" group.

5.3 Activity Logs

In addition to time-use diaries and survey questions about time-use, we gathered more objective assessments of computer use through log files which record the date and time when each application is opened. We focus on a measure of extensive use based on the fraction of days in which a particular application, or set of applications, is opened.[30] Furthermore, we classify applications into four broad categories to facilitate the analysis: entertainment, learning, information, and communication. However, because these log files were only available for 290 children who received free laptops, this might not be a completely representative sample. Indeed, Online Appendix Table A9 shows that children whose logs were obtained appear to have somewhat lower reading scores and higher computer access at baseline compared to their counterparts without logs, although these differences are only marginally significant.[31]

Figure 2 uses these logs to show how computer use evolved over the course of our study for children who received laptops with and without internet access. During July/August 2011, immediately after children received their laptops, laptop use was relatively high. Specifically, laptops were used on average 40 percent of days. However, there was a steady decline over the subsequent months so that, by December 2011, laptop use was only 16 percent. Following the distribution of internet access to a subsample of children in July/August 2012, their levels of use increased sharply while those who did not receive internet access reduced use even further. These patterns are consistent with strong novelty effects, especially considering that laptop use for those that received internet access also decreased over time.

[30] These logs also recorded the date and time when every application is closed so it is possible to estimate the intensive margin of use in terms of minutes, although this is an upper bound because we cannot be certain that children were actually using the computer throughout the time that an application remained open. Using this alternative measure yields results that are broadly similar to those from extensive margin.

[31] Online Appendix Table A10 also reveals some baseline differences between the "Laptop Only" and the "Laptop+internet" treatments among children for whom we have computer logs, although only two (out of 19 estimated coefficients) are significant at the 10 percent level.

[Figure 2 here]

The specific types of use are disaggregated in Table 9 which presents data based on logs collected from July to November 2012 (i.e., after internet was provided). Children who received a laptop without internet access opened computer applications on 17 percent of days. Among children who also received internet access, this level of use was over 11 percentage points, or 65 percent, higher. And unsurprisingly, the increase in use was dominated by internet applications. Among the non-internet applications, those classified as entertainment represented the largest category of use, though closely followed by learning applications. Of course, even these learning applications were educational games that were available on the XO platform chosen by the Ministry of Education. The use of applications associated with either information or communication was substantially lower. These patterns are also disaggregated by gender and baseline academic achievement in Online Appendix Table A11, and by prior computer and internet access in Online Appendix Table A12.

[Table 9 here]

5.4 Internet Logs

Our activity logs were supplemented by internet logs which recorded the date and time when each website was accessed. We constructed an analogous measure of use based on the fraction of days on which a particular website, or set of websites, is opened. We also classified the websites into the same broad categories of entertainment, learning, information, and communication. Table 10 describes the patterns of internet use among the 119 children who received internet access, logs were recovered, and had effective internet activity within the period in which internet was provided. Table 10 also disaggregates internet use by gender, baseline academic achievement, and baseline internet access.

[Table 10 here]

As with the evidence from the activity logs, the largest category of internet websites is classified as entertainment, although communication is almost as large (and, indeed, identical when rounding). The websites classified within the information and learning categories were visited much less often. This is also reflected in the specific websites visited, with Facebook, YouTube, and Twitter being the most popular sites. The use of communication-related websites,

and Facebook in particular, was especially high among girls in our sample. Furthermore, children who did not have prior access to the internet showed higher use in every category as compared to those that already had access prior to our interventions.

6. Conclusion

This paper examines the effect of internet access on the development of children's academic, cognitive, and digital skills. We present findings from a randomized experiment in which free laptops and internet were provided for home use to children in Lima, Peru. These interventions were successful in increasing children's exposure to technology at home and led to substantial improvements in digital skills. We find that children who were randomly chosen to receive laptops with internet access showed higher computer and internet proficiency relative to those who did not receive laptops. They also had higher internet proficiency compared to those who received laptops without internet. On the other hand, we did not observe any significant impacts on academic achievement and on a large battery of cognitive skills. There were also no impacts on children's grades or on teacher's assessments of their sociability, academic effort and expectations of their eventual educational attainment.

We explore the reasons for the lack of impacts, showing that while computer and internet use do increase significantly following our respective interventions, there is a pronounced drop in use over time. Moreover, computer use remains substantially lower than reported time spent watching TV, playing without a computer and doing domestic chores, and we do not find much evidence of substitution away from these activities. Regarding how computers are used, we find that the largest category is entertainment. Thus, providing children with computers and internet at home appears to engage children in digital activities that are focused less on information or learning and more on entertainment that do not translate into improved academic achievement, cognitive or socio-emotional skills.

Our results indicate that providing children with access to computers and internet at home (together with some training) effectively closes the gap in digital skills between those with and without home computers and internet. Therefore, to the extent that improving children's digital skills is a relevant goal for an educational system, providing access to computers and internet at home may be one way to achieve this. However, it may also be possible to achieve these gains at a lower cost. For example, Bet et al. (2014) show sizeable increases in digital skills from relatively

minor increases in access to shared computers at schools in Peru. There is also some evidence that the provision of school-based internet can generate gains in student learning (Kho, Lakdawala, and Nakasone, 2018; Sprietsma, 2007). Perhaps the utilization of school-based internet is monitored more closely than internet at home. In contrast, increased access to such technology at home which is used mainly for entertainment activities does not appear to improve academic achievement, cognitive or socio-emotional skills, which are arguably the more important outcomes of such interventions.

References

Alexander, K., S. Pitcock. and M. Boulay. 2016. *The Summer Slide: What We Know and Can Do About Summer Learning Loss*. New York, United States: Teachers College Press.

Angrist, J., and V. Lavy. 2002. "New Evidence on Classroom Computers and Pupil Learning." *Economic Journal* 112: 735–765.

Bai, Y. et al. 2016. "The Impact of Integrating ICT with Teaching: Evidence from a Randomized Controlled Trial in Rural Schools in China." *Computers & Education* 96: 1-14.

Banerjee, A. et al. 2007. "Remedying Education: Evidence from Two Randomized Experiments in India." *Quarterly Journal of Economics* 122: 1235–1264.

Bet, G., J. Cristia and P. Ibarrarán. 2014. "The Effects of Shared School Technology Access on Students' Digital Skills in Peru." IDB Working Paper WP-476. Washington, DC, United States: Inter-American Development Bank.

Beuermann, D. et al. 2015. "One Laptop per Child at Home: Short-Term Impacts from a Randomized Experiment in Peru." *American Economic Journal: Applied Economics* 7(2): 1-29.

Bruhn, M., and D. McKenzie. 2009. "In Pursuit of Balance: Randomization in Practice in Development Field Experiments." *American Economic Journal: Applied Economics* 1: 200–232.

Cristia, J. et al. "Technology and Child Development: Evidence from the One Laptop per Child Program." *American Economic Journal: Applied Economics* 9(3): 295 - 320.

Faber, B., R. Sanchis-Guarner and F. Weinhardt. 2016. "ICT and Education: Evidence from Student Home Addresses." NBER Working Paper 21306. Cambridge, United States: National Bureau of Economic Research.

Fairlie, R. and A. Kalil. 2016. "The Effects of Computers on Children's Social Development and School Participation: Evidence from a Randomized Control Experiment." NBER Working Paper 22907. Cambridge, United States: National Bureau of Economic Research.

Fairlie, R. and J. Robinson. 2013. "Experimental Evidence on the Effects of Home Computers on Academic Achievement among Schoolchildren." *American Economic Journal: Applied Economics* 5(3): 211–240.

Gallego, F., O. Malamud and C. Pop-Eleches. 2017. “Parental Monitoring and Children’s Internet Use.”. NBER Working Paper 23982. Cambridge, United States: National Bureau of Economic Research.

Goolsbee, A., and J. Guryan, 2006. “The Impact of Internet Subsidies in Public Schools.” *Review of Economics and Statistics* 88(2):336-347.

International Telecommunication Union (ITU). 2013. “ICT Facts and Figures 2013.” New York, United States: ITU. http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2013.pdf

Johnson, G. 2006. “Internet Use and Cognitive Development: A Theoretical Framework.” *E-learning* 3. DOI:10.2304/elea.2006.3.4.565.

Kho, K., L.K. Lakdawala and E. Nakasone. 2018. “Impact of Internet Access on Student Learning in Peruvian Schools.” Department of Economics Working Paper 2018-3. East Lansing, United States: Michigan State University.

King, G. et al. 2007. “A ‘Politically Robust’ Experimental Design for Public Policy Evaluation, with Application to the Mexican Universal Health Insurance Program.” *Journal of Policy Analysis and Management* 26: 479–506.

Kraut R. et al. 1998. “Internet Paradox: A Social Technology that Reduces Social Involvement and Psychological Well-Being.” *American Psychologist* 53:1017–1031

Linden, L.L. 2008. “Complement or Substitute?: The Effect of Technology on Student Achievement in India.” InfoDev Working Paper 22928. Washington, DC, United States: World Bank.

Machin, S., S. McNally and O. Silva. 2007. “New Technology in Schools: Is There a Payoff?” *Economic Journal* 117: 1145–1167.

Malamud, O., and C. Pop-Eleches, C. 2011. “Home Computer Use and the Development of Human Capital.” *Quarterly Journal of Economics* 126: 987–1027.

Mills, K.L. 2014. “Effects of Internet Use on the Adolescent Brain: Despite Popular Claims, Experimental Evidence Remains Scarce.” *Trends in Cognitive Science* 18(8): 385–387.

Mo, D. et al. 2013. “Can One-to-One Computing Reduce the Digital Divide and Educational Gap? The Case of Migrant Schools in Beijing.” *World Development* 46: 14–29.

Mo, D. et al. 2015. “Persistence of Learning Gains from Computer Assisted Learning: Experimental Evidence from China.” *Journal of Computer Assisted Learning* 31(6): 562-581.

Muralidharan, K., A. Singh and A. J. Ganimian. 2016. “Disrupting Education? Experimental Evidence on Technology-Aided Instruction in India.” NBER Working Paper 22923. Cambridge, United States: National Bureau of Economic Research.

OECD. 2017. *PISA 2015 Results (Volume III): Students’ Well-Being*, Paris, France: OECD Publishing. http://dx.doi.org/10.1787/9789264273856-en

Subrahmanyam, K., and P. Greenfield. 1994. “Effects of Video Game Practice on Spatial Skills in Girls and Boys.” *Journal of Applied Developmental Psychology* 15:13–32.

Sprietsma, M. 2007. “Computers as Pedagogical Tools in Brazil: A Pseudo-Panel Analysis.” ZEW Discussion Paper 07-040. Mannheim, Germany: Centre for European Economic Research.

Vigdor, J., H. Ladd and E. Martínez. 2014. “Scaling the Digital Divide: Home Computer Technology and Student Achievement.” *Economic Inquiry* 52: 1103–1119.

Figure 1. Sample Composition

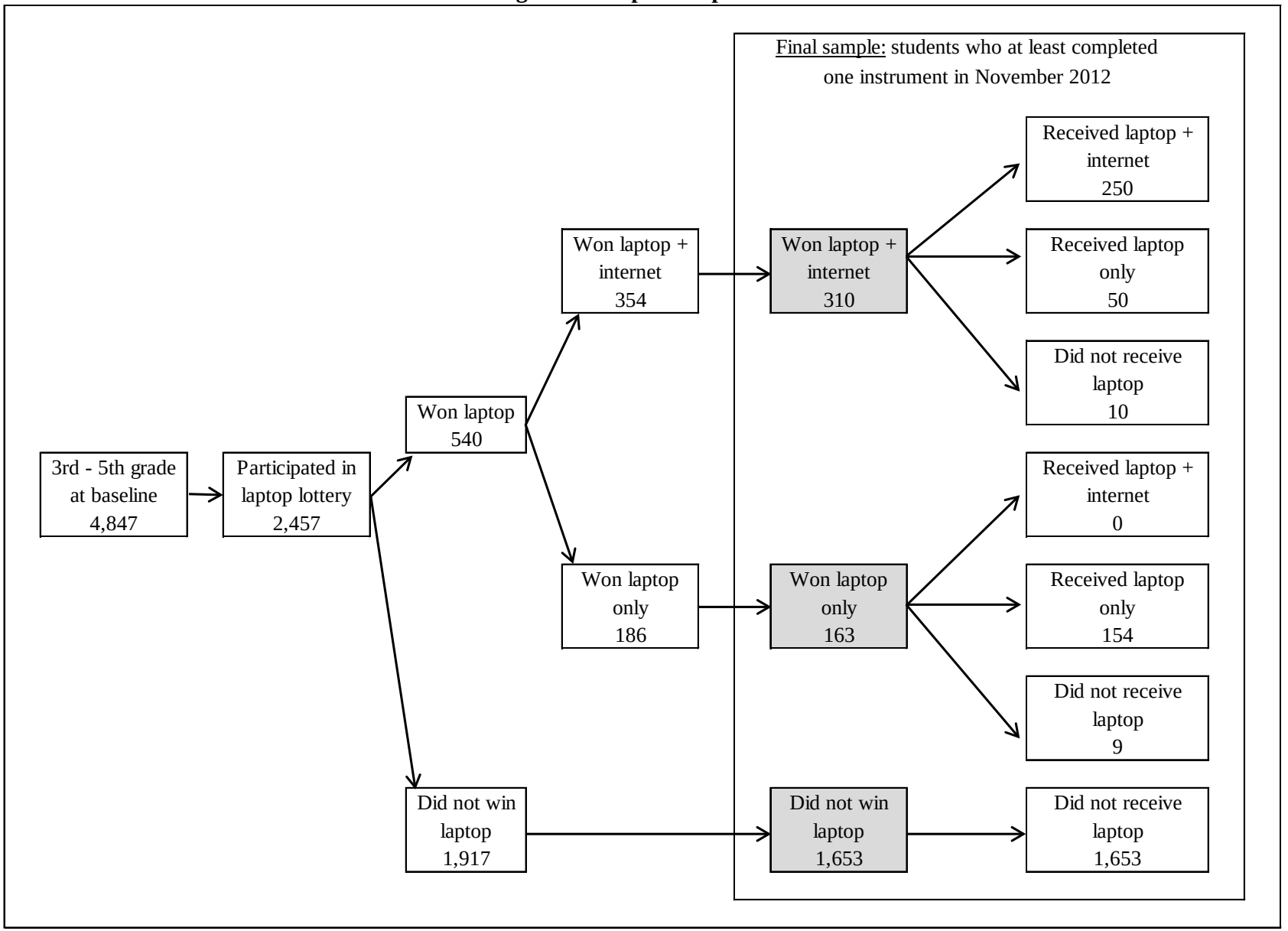

Figure 2. Evolution of Laptop Use by Treatment Status

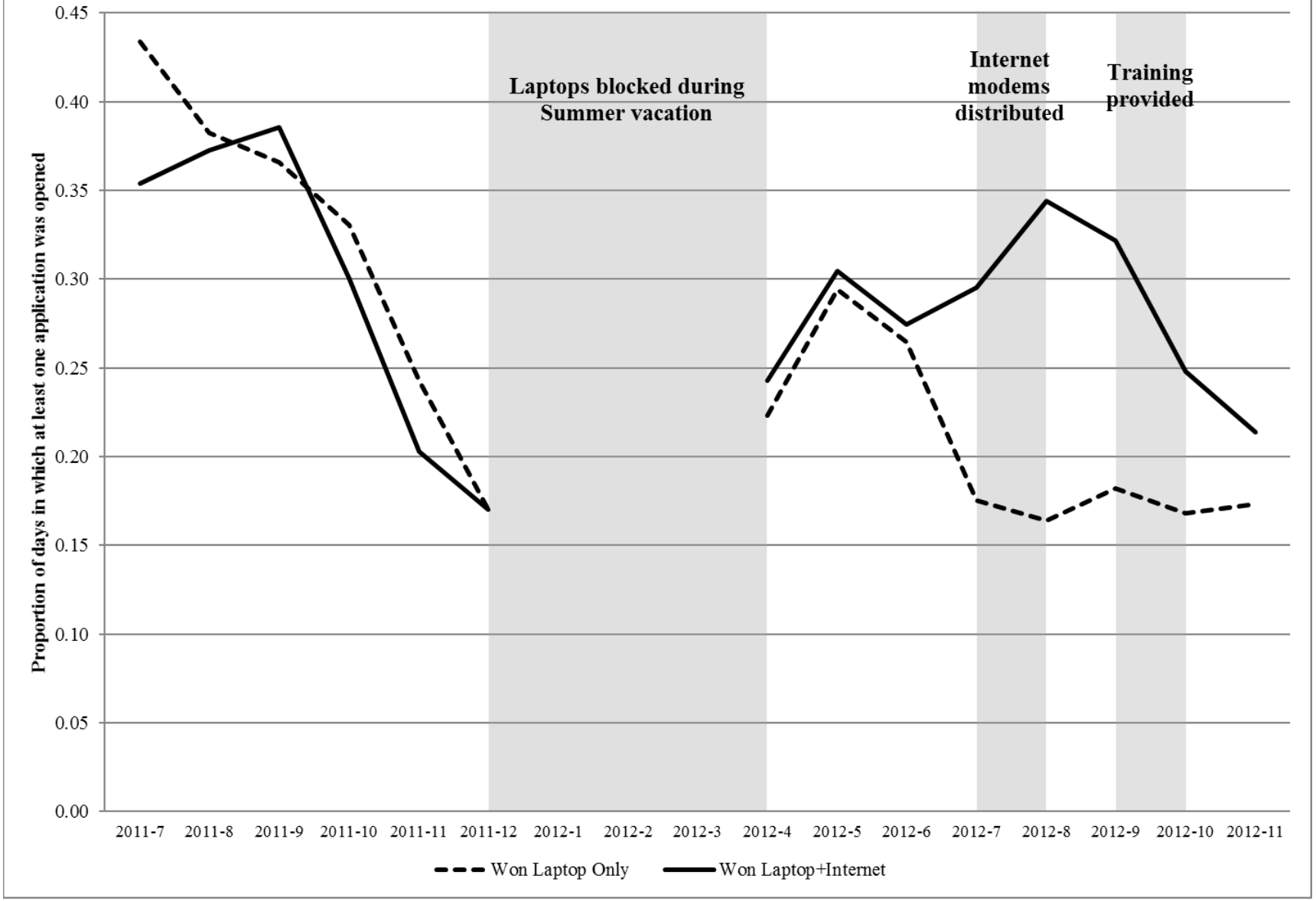

Table 1. Baseline Balance

	Raw means			Adjusted Differences		
	No laptop	laptop-only	Laptop + internet	Laptop + internet	Internet	Observations
	(1)	(2)	(3)	(4)	(5)	(6)
Socio-demographic characteristics						
Age	9.53	9.55	9.40	-0.07	-0.07	1,987
				(0.05)	(0.08)	
Male	0.47	0.51	0.50	0.03	-0.00	1,987
				(0.03)	(0.05)	
Number of siblings in household	2.23	2.42	2.26	-0.01	-0.20	1,985
				(0.10)	(0.15)	
Father lives at home	0.79	0.77	0.81	0.03	0.04	1,979
				(0.03)	(0.04)	
Father works outside home	0.88	0.85	0.88	0.00	0.03	1,976
				(0.02)	(0.04)	
Mother works outside home	0.53	0.50	0.51	-0.03	0.03	1,986
				(0.03)	(0.05)	
Phone	0.47	0.48	0.45	-0.03	-0.05	1,959
				(0.03)	(0.05)	
Electricity	0.91	0.89	0.90	-0.01	0.01	1,964
				(0.02)	(0.03)	
Car	0.29	0.26	0.24	-0.04	-0.02	1,944
				(0.03)	(0.04)	
Access						
Computer or laptop at home	0.43	0.44	0.43	-0.01	-0.03	1,809
				(0.03)	(0.05)	
Internet at home	0.34	0.31	0.32	-0.02	0.00	1,792
				(0.03)	(0.05)	
Use						
Computer or laptop last week	0.86	0.89	0.86	0.01	-0.03	1,813
				(0.02)	(0.03)	
Internet last week	0.78	0.77	0.79	0.02	0.02	1,808
				(0.03)	(0.04)	
Digital skills						
PC and internet literacy test	-0.01	0.03	-0.09	-0.06	-0.11	1,916
				(0.06)	(0.09)	
Self-reported PC and internet skills	0.01	0.00	0.06	0.08	0.07	1,916
				(0.06)	(0.09)	
Academic achievement						
Math	0.03	-0.05	0.01	0.06	0.12	1,897
				(0.06)	(0.09)	
Reading	0.00	-0.08	-0.06	-0.00	0.10	1,793
				(0.06)	(0.10)	
Cognitive skills						
Raven's progressive matrices	0.01	-0.06	0.06	0.15	0.18	1,902
				(0.06)**	(0.09)**	
Teachers' perceptions						
High skills in making friends	0.53	0.52	0.54	0.02	0.06	2,015
				(0.03)	(0.05)	
High academic effort in class	0.45	0.47	0.42	-0.03	-0.03	2,014
				(0.03)	(0.05)	
Expected to complete university	0.63	0.68	0.64	0.02	-0.01	2,015
				(0.03)	(0.04)	

Notes: This table presents statistics and estimated differences between laptop + internet winners (treatment group), non-winners (control group 1), and laptop-only winners (control group 2) who participated in the laptop lottery. Column (1) presents control group 1 means; column (2) presents control group 2 means; column (3) presents treated group means; column (4) presents estimated adjusted differences and standard errors between the treatment group and control group 1; column (5) presents estimated adjusted differences and standard errors between the treatment group and control group 2. Estimates in columns (4) and (5) result from OLS regressions with class fixed-effects. OLS regressions are restricted to students who comply with the following requirements: (a) participated in the laptop lottery; (b) third to fifth grade at baseline; (c) answered the specific outcome of interest at baseline and follow-up. Scores in Digital skills, Academic achievement, and Cognitive skills are normalized by subtracting the mean and dividing by the standard deviation of non-winners who participated in the laptop lottery. Baseline data was collected in April 2011 and follow-up in November 2012. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 2. Effects on Computer and Internet Access and Use Based on Survey Responses

	Raw means			Effects		
	No laptop	laptop-only	Laptop + internet	Laptop + internet	Internet	Observations
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Computer access and use						
Access						
Computer or laptop at home	0.54	0.91	0.95	0.40	0.04	1,809
				(0.02)***	(0.03)	
Use						
Last week	0.90	0.97	0.95	0.05	-0.02	1,813
				(0.02)***	(0.02)	
Use by place (last week)						
Home	0.53	0.80	0.86	0.32	0.06	1,891
				(0.03)***	(0.04)	
Internet café	0.46	0.41	0.34	-0.11	-0.07	1,891
				(0.03)***	(0.05)	
School	0.46	0.41	0.41	-0.05	-0.01	1,882
				(0.03)*	(0.05)	
Friend's house	0.25	0.16	0.19	-0.06	0.02	1,884
				(0.03)**	(0.04)	
Panel B: Internet access and use						
Access						
Internet at home	0.44	0.40	0.73	0.30	0.33	1,792
				(0.03)***	(0.05)***	
Use						
Last week	0.87	0.87	0.92	0.06	0.06	1,808
				(0.02)***	(0.03)*	
Use by place (last week)						
Home	0.47	0.52	0.73	0.27	0.22	1,875
				(0.03)***	(0.05)***	
Internet café	0.46	0.43	0.35	-0.10	-0.08	1,873
				(0.03)***	(0.05)*	
School	0.37	0.33	0.32	-0.04	-0.02	1,871
				(0.03)	(0.05)	
Friend's house	0.21	0.17	0.17	-0.04	0.00	1,864
				(0.02)	(0.04)	

Notes: This table presents estimated effects between laptop + internet winners (treatment group), non-winners (control group 1), and laptop-only winners (control group 2) who participated in the laptop lottery. Column (1) presents control group 1 means; column (2) presents control group 2 means; column (3) presents treated group means; column (4) presents estimated adjusted differences and standard errors between the treatment group and control group 1; column (5) presents estimated adjusted differences and standard errors between the treatment group and control group 2. Estimates in columns (4) and (5) result from OLS regressions controlling for class fixed effects and the baseline value of the outcome (when available). OLS regressions are restricted to students who comply with the following requirements: (a) participated in the laptop lottery; (b) third to fifth grade at baseline; (c) answered the specific outcome of interest at baseline and follow-up. Baseline data were collected in April 2011 and follow-up in November 2012. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 3. Effects on Skills

	Raw means			Effects		
	No laptop	laptop-only	Laptop + internet	Laptop + internet	Internet	Observations
	(1)	(2)	(3)	(4)	(5)	(6)
Digital skills						
XO test	0.00	0.93	0.96	1.00	0.09	1,916
				(0.07)***	(0.11)	
PC test	0.00	0.16	0.15	0.21	0.03	1,854
				(0.06)***	(0.09)	
Internet test	0.00	0.06	0.30	0.33	0.26	1,854
				(0.07)***	(0.10)**	
Digital skills index	0.00	0.38	0.49	0.53	0.15	1,794
				(0.05)***	(0.08)*	
Academic achievement						
Math	0.00	-0.04	-0.06	-0.00	0.01	1,897
				(0.04)	(0.07)	
Reading	0.00	-0.09	-0.04	-0.01	0.03	1,793
				(0.06)	(0.09)	
Academic achievement index	-0.01	-0.09	-0.04	0.00	0.05	1,774
				(0.04)	(0.07)	
Cognitive skills						
Raven's progressive matrices	0.00	-0.01	-0.03	-0.05	-0.08	1,902
				(0.06)	(0.10)	
Verbal fluency	0.00	-0.05	-0.08	-0.02	0.02	1,964
				(0.06)	(0.10)	
Executive functioning	0.00	0.05	-0.07	-0.03	-0.10	1,976
				(0.06)	(0.08)	
Coding	0.00	0.05	-0.11	-0.06	-0.12	1,971
				(0.05)	(0.08)	
Working memory	0.00	0.13	-0.03	0.00	-0.15	1,980
				(0.06)	(0.09)	
Spatial reasoning	0.00	-0.01	0.05	0.06	0.04	1,968
				(0.06)	(0.09)	
Cognitive skills index	0.01	0.03	-0.05	-0.01	-0.05	1,821
				(0.04)	(0.05)	
Socio-emotional skills						
Self-esteem Index	0.00	-0.05	0.04	0.07	0.14	1,916
				(0.06)	(0.10)	

Notes: This table presents estimated effects between laptop + internet winners (treatment group), non-winners (control group 1), and laptop-only winners (control group 2) who participated in the laptop lottery. Column (1) presents control group 1 means; column (2) presents control group 2 means; column (3) presents treated group means; column (4) presents estimated adjusted differences and standard errors between the treatment group and control group 1; column (5) presents estimated adjusted differences and standard errors between the treatment group and control group 2. Estimates in columns (4) and (5) result from OLS regressions controlling for class fixed effects and the baseline value of the outcome (when available). OLS regressions are restricted to students who comply with the following requirements: (a) participated in the laptop lottery; (b) third to fifth grade at baseline; (c) answered the specific outcome of interest at baseline and follow-up. All scores are normalized by subtracting the mean and dividing by the standard deviation of non-winners who participated in the laptop lottery. The Digital skills, Academic achievement and Cognitive skills indexes are computed as the average of all tests belonging to each category restricted to students who completed all examinations included in each index. Baseline data were collected in April 2011 and follow-up in November 2012. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 4. Effects on Grades and Teachers' Perceptions

	Raw means			Effects		
	No laptop	laptop-only	Laptop + internet	Laptop + internet	Internet	Observations
	(1)	(2)	(3)	(4)	(5)	(6)
Grades						
Pass grade	0.87	0.88	0.83	-0.02	-0.04	2,107
				(0.02)	(0.03)	
Need summer school	0.11	0.10	0.13	0.01	0.03	2,107
				(0.02)	(0.03)	
Fail grade	0.02	0.02	0.04	0.02	0.01	2,107
				(0.01)	(0.02)	
Percentage of top grades	0.10	0.07	0.08	-0.01	0.01	2,107
				(0.01)	(0.02)	
Teachers' perceptions						
High skills in making friends	0.51	0.46	0.50	-0.01	0.02	2,015
				(0.03)	(0.04)	
High academic effort in class	0.44	0.43	0.40	-0.03	-0.01	2,014
				(0.03)	(0.04)	
Expected to complete university	0.61	0.62	0.57	-0.05	-0.04	2,015
				(0.03)*	(0.04)	

Notes: This table presents estimated effects between laptop + internet winners (treatment group), non-winners (control group 1), and laptop-only winners (control group 2) who participated in the laptop lottery. Column (1) presents control group 1 means; column (2) presents control group 2 means; column (3) presents treated group means; column (4) presents estimated adjusted differences and standard errors between the treatment group and control group 1; column (5) presents estimated adjusted differences and standard errors between the treatment group and control group 2. Estimates in columns (4) and (5) result from OLS regressions controlling for class fixed effects and the baseline value of the outcome (when available). OLS regressions are restricted to students who comply with the following requirements: (a) participated in the laptop lottery; (b) third to fifth grade at baseline; (c) answered the specific outcome of interest at baseline and follow-up. Outcomes obtained from school administrative records include whether the student progressed to the next grade, whether the student needed to attend summer school before progressing to the next grade (when performance during the academic year was neither good enough to pass the grade nor poor enough to fail the grade), whether the student failed the grade, and the percentage of subjects in which the student obtained the top mark. Baseline data were collected in April 2011 and follow-up in November 2012. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 5. Effects by Gender and Baseline Academic Achievement

	Effects by gender				Effects by baseline academic achievement			
	Laptop + internet		Internet		Laptop + internet		Internet	
	Males	Females	Males	Females	<= Median	> Median	<= Median	> Median
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Access								
Computer or laptop at home	0.39	0.42	0.05	0.04	0.39	0.43	0.01	0.02
	(0.03)***	(0.03)***	(0.06)	(0.05)	(0.03)***	(0.03)***	(0.05)	(0.05)
Internet at home	0.29	0.29	0.28	0.33	0.29	0.30	0.36	0.24
	(0.05)***	(0.05)***	(0.07)***	(0.07)***	(0.05)***	(0.05)***	(0.06)***	(0.08)***
Use								
Computer or laptop last week	0.05	0.06	-0.00	-0.04	0.07	0.04	-0.00	-0.03
	(0.02)**	(0.03)**	(0.03)	(0.03)	(0.02)***	(0.03)	(0.03)	(0.03)
Internet last week	0.07	0.04	0.08	0.04	0.05	0.09	-0.02	0.20
	(0.02)***	(0.03)	(0.05)*	(0.05)	(0.03)*	(0.03)***	(0.04)	(0.06)***
Skills								
Digital skills index	0.45	0.60	0.14	0.18	0.42	0.60	0.08	0.09
	(0.08)***	(0.07)***	(0.12)	(0.11)	(0.07)***	(0.07)***	(0.11)	(0.11)
Academic achievement index	-0.06	0.08	0.05	0.06	-0.05	0.06	-0.04	0.20
	(0.06)	(0.06)	(0.10)	(0.09)	(0.06)	(0.05)	(0.10)	(0.09)**
Cognitive skills index	-0.02	-0.01	-0.06	-0.07	-0.04	-0.01	-0.11	0.02
	(0.05)	(0.05)	(0.07)	(0.08)	(0.05)	(0.05)	(0.07)	(0.07)
Socio-emotional skills index	0.08	0.11	-0.14	0.37	0.14	-0.05	0.18	-0.04
	(0.10)	(0.10)	(0.15)	(0.14)***	(0.10)	(0.10)	(0.14)	(0.15)

Notes: This table presents evidence on heterogeneous effects. Each cell in Columns (1) to (8) corresponds to the estimated adjusted differences and standard errors between the treatment and control groups for certain sub-sample. OLS regressions control for class fixed effects and the baseline value of the outcome (when available). OLS regressions are restricted to students who comply with the following requirements: (a) participated in the laptop lottery; (b) third to fifth grade at baseline; (c) answered the specific outcome of interest at baseline and follow-up. The Digital skills, Academic achievement and Cognitive skills indexes are computed as the average of all standardized scores in the tests belonging to each category restricted to students who completed all examinations included in each index. Baseline data were collected in April 2011 and follow-up in November 2012. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 6. Longer-Term Effects on Access and Skills

	Raw means			Effects		
	No laptop	laptop-only	Laptop + internet	Laptop + internet	Internet	Observations
	(1)	(2)	(3)	(4)	(5)	(6)
Access						
Computer or laptop at home	0.53	0.88	0.90	0.38	0.03	1,051
				(0.03)***	(0.05)	
Digital skills						
XO test	0.00	1.04	1.02	1.04	0.00	1,099
				(0.08)***	(0.14)	
PC test	0.00	0.07	0.07	0.15	0.07	1,082
				(0.09)*	(0.14)	
Internet test	0.00	0.09	0.25	0.30	0.19	1,082
				(0.08)***	(0.14)	
Digital skills index	0.01	0.47	0.46	0.50	0.05	1,036
				(0.07)***	(0.11)	
Academic achievement						
Math	0.00	-0.16	-0.10	0.01	0.05	1,093
				(0.06)	(0.11)	
Reading	-0.00	-0.14	-0.12	-0.02	-0.00	1,111
				(0.07)	(0.11)	
Academic achievement index	-0.00	-0.15	-0.12	-0.01	0.00	1,096
				(0.05)	(0.09)	
Cognitive skills						
Raven's progressive matrices	-0.00	0.01	0.01	-0.00	-0.07	1,082
				(0.07)	(0.13)	
Socio-emotional skills						
Self-esteem Index	-0.00	-0.13	0.03	0.02	0.18	1,124
				(0.08)	(0.14)	

Notes: This table presents estimated effects between laptop + internet winners (treatment group), non-winners (control group 1), and laptop-only winners (control group 2) who participated in the laptop lottery. Column (1) presents control group 1 means; column (2) presents control group 2 means; column (3) presents treated group means; column (4) presents estimated adjusted differences and standard errors between the treatment group and control group 1; column (5) presents estimated adjusted differences and standard errors between the treatment group and control group 2. Estimates in columns (4) and (5) result from result from OLS regressions controlling for class fixed effects and the baseline value of the outcome (when available). OLS regressions are restricted to students who comply with the following requirements: (a) participated in the laptop lottery; (b) third to fourth grade at baseline; (c) answered the specific outcome of interest at baseline and follow-up. All scores are normalized by subtracting the mean and dividing by the standard deviation of non-winners who participated in the laptop lottery. The Digital skills and Academic achievement indexes are computed as the average of all tests belonging to each category restricted to students who completed all examinations included in each index. Baseline data were collected in April 2011 and follow-up in March 2013. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 7. Effects on Time and Computer Use based on Time Diaries

	Raw means			Effects		
	No laptop	laptop-only	Laptop + internet	Laptop + internet	Internet	Observations
	(1)	(2)	(3)	(4)	(5)	(6)
Use of time (minutes yesterday)						
Sleeping	563.93	558.46	560.46	-4.80	0.62	838
				(8.41)	(11.42)	
Attending school	321.98	331.47	318.32	2.68	0.95	838
				(6.36)	(9.86)	
Watching TV	155.13	166.99	147.21	-9.61	-28.99	838
				(8.27)	(10.85)***	
Doing homework	90.29	93.99	79.93	-8.44	-10.07	838
				(5.10)*	(7.13)	
Play without a computer	68.89	51.40	65.04	-5.76	6.59	838
				(6.16)	(7.63)	
Domestic chores	46.05	48.46	54.32	7.86	2.27	838
				(5.89)	(7.41)	
Using a computer or laptop	20.17	28.32	33.64	12.78	4.66	838
				(3.78)***	(5.60)	
Working outside home	11.64	7.13	17.36	5.15	9.61	838
				(4.60)	(4.94)*	
Reading	9.54	11.12	9.00	0.25	-0.24	838
				(2.15)	(3.35)	
Computer use by place (minutes yesterday)						
Home	14.53	27.48	28.82	13.43	1.14	838
				(3.57)***	(5.41)	
Internet café	5.93	5.66	7.39	1.35	0.62	838
				(1.96)	(2.37)	
Friend's house	1.23	0.00	0.54	-0.59	0.98	838
				(0.55)	(0.54)*	
Computer use by type (minutes yesterday)						
Games	10.63	9.02	16.07	4.91	7.49	838
				(2.74)*	(3.10)**	
Homework	7.37	17.20	14.46	6.89	-3.60	838
				(2.27)***	(4.44)	
Social networks	1.45	2.31	1.61	0.15	-1.07	838
				(0.83)	(1.17)	
Watch videos	0.87	1.47	1.39	0.41	-0.17	838
				(0.67)	(0.91)	
Chat and emails	0.80	0.42	0.86	0.09	0.81	838
				(0.61)	(0.63)	
Music	0.51	2.52	2.04	1.53	-0.49	838
				(0.87)*	(1.27)	

Notes: This table presents estimated effects between laptop + internet winners (treatment group), non-winners (control group 1), and laptop-only winners (control group 2) who participated in the laptop lottery and were randomly selected for application of the time diary. Column (1) presents control group 1 means; column (2) presents control group 2 means; column (3) presents treated group means; column (4) presents estimated adjusted differences and standard errors between the treatment group and control group 1; column (5) presents estimated adjusted differences and standard errors between the treatment group and control group 2. Estimates in columns (4) and (5) result from OLS regressions with class fixed-effects. Activities such as eating, personal care, commuting and shopping were also included as part of the time diary, but they are not reported because we neither expected nor observed impacts. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 8. Effects on Computer and Internet Use by Type of Application Based on Survey Responses

	Raw means			Effects		
	No laptop	laptop-only	Laptop + internet	Laptop + internet	Internet	Observations
	(1)	(2)	(3)	(4)	(5)	(6)
Computer used last week (yes/no)						
Homework	0.72	0.74	0.82	0.10	0.07	1,904
				(0.03)***	(0.04)*	
Games	0.67	0.73	0.78	0.11	0.03	1,902
				(0.03)***	(0.04)	
Music	0.64	0.71	0.61	-0.02	-0.10	1,899
				(0.03)	(0.05)**	
Chat	0.40	0.32	0.39	-0.01	0.06	1,893
				(0.03)	(0.05)	
Watch videos	0.40	0.28	0.42	0.01	0.11	1,891
				(0.03)	(0.05)**	
Internet used last week (yes/no)						
Play online games	0.66	0.65	0.70	0.06	0.06	1,876
				(0.03)**	(0.05)	
Search information	0.56	0.52	0.62	0.07	0.13	1,879
				(0.03)**	(0.05)**	
Watch videos	0.49	0.42	0.53	0.06	0.11	1,877
				(0.03)*	(0.05)**	
Use educational program	0.43	0.50	0.51	0.08	0.02	1,878
				(0.03)**	(0.05)	
Chat	0.34	0.28	0.35	0.03	0.07	1,879
				(0.03)	(0.05)	
Social networks	0.33	0.32	0.32	-0.00	-0.01	1,882
				(0.03)	(0.05)	
Read books or short readings	0.32	0.37	0.36	0.04	0.00	1,879
				(0.03)	(0.05)	
Read email	0.30	0.27	0.29	0.00	-0.01	1,835
				(0.03)	(0.05)	

Notes: This table presents estimated effects between laptop + internet winners (treatment group), non-winners (control group 1), and laptop-only winners (control group 2) who participated in the laptop lottery and were randomly selected for application of the time diary. Column (1) presents control group 1 means; column (2) presents control group 2 means; column (3) presents treated group means; column (4) presents estimated adjusted differences and standard errors between the treatment group and control group 1; column (5) presents estimated adjusted differences and standard errors between the treatment group and control group 2. Estimates in columns (4) and (5) result from OLS regressions with class fixed-effects. OLS regressions are restricted to students who comply with the following requirements: (a) participated in the laptop lottery; (b) third to fifth grade at baseline. Baseline data were collected in April 2011 and follow-up in November 2012. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 9. Effects of Internet on Laptop Use Based on Logs

	laptop-only mean (1)	Internet effect (2)	Observations (3)
Application use (proportion of days opened)			
Any application	0.17	0.11	290
		(0.03)***	
Internet application	0.01	0.16	290
		(0.02)***	
Non-internet application	0.17	0.02	290
		(0.02)	
Non-internet applications by general categories (proportion of days opened)			
Entertainment	0.13	-0.00	290
		(0.02)	
Learning	0.11	0.01	290
		(0.02)	
Information	0.06	-0.00	290
		(0.01)	
Communication	0.04	-0.01	290
		(0.01)	
Top 10 non-internet applications (proportion of days opened)			
Jukebox (entertainment)	0.09	-0.02	290
		(0.02)	
Record (entertainment)	0.05	0.00	290
		(0.01)	
Oficina (communication)	0.04	-0.01	290
		(0.01)	
Speak (information)	0.04	0.00	290
		(0.01)	
Jigsaw puzzle (learning)	0.04	-0.01	290
		(0.01)	
Implode (entertainment)	0.03	-0.00	290
		(0.01)	
Tam tam mini (entertainment)	0.03	-0.00	290
		(0.01)	
Sudoku (learning)	0.03	-0.01	290
		(0.01)	
Memorize (learning)	0.02	-0.00	290
		(0.01)	
Calculate (learning)	0.02	-0.00	290
		(0.00)	

Notes: This table presents estimated effects regarding laptop utilization between laptop-only winners and laptop + internet winners. Outcomes were obtained from computer logs corresponding to the period July to November 2012 (post-internet period). Column (1) presents means for laptop-only winners; column (2) presents estimated coefficients and standard errors on an indicator for winning the laptop and internet lottery. Estimates in column (2) result from OLS regressions with class fixed-effects. OLS regressions include all students who: (a) were in third to fifth grade at baseline; (b) participated in the laptop lottery; (c) won the laptop lottery and received a laptop; and (d) laptop logs were succesfully recovered. Heteroskedasticity robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 10. Internet Use by Selected Sub-Groups Based on Logs

		Gender		Baseline academic achievement		Baseline internet access	
	All	Males	Females	<= Median	> Median	Access	No access
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Websites by general categories (proportion of days opened)							
Entertainment	0.15	0.12	0.17*	0.16	0.15	0.10	0.18***
Communication	0.15	0.10	0.18***	0.15	0.16	0.12	0.18**
Information	0.11	0.08	0.13***	0.10	0.12	0.08	0.13**
Learning	0.06	0.04	0.08***	0.06	0.07	0.05	0.08**
Top 10 websites (proportion of days opened)							
facebook.com (communication)	0.14	0.09	0.17***	0.13	0.15	0.11	0.16**
youtube.com (entertainment)	0.08	0.06	0.10***	0.09	0.08	0.06	0.10**
twitter.com (information)	0.05	0.04	0.06**	0.06	0.06	0.04	0.07**
friv.com (entertainment)	0.04	0.04	0.04	0.05	0.04	0.02	0.06**
gamib.com (entertainment)	0.03	0.04	0.03	0.04	0.03	0.01	0.05**
wikipedia.org (learning)	0.02	0.01	0.03***	0.02	0.02	0.02	0.03*
blogger.com (information)	0.02	0.01	0.03***	0.02	0.02	0.01	0.03*
yahoo.com (information)	0.02	0.01	0.02	0.02	0.02	0.02	0.02
20enmate.com (learning)	0.01	0.00	0.01**	0.01	0.00	0.00	0.01*
dibujosparapintar.com (learning)	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Notes: This table presents statistics on internet use expressed as the proportion of days in which the different categories of applications were opened. It also indicates the statistical significance of differences across subgroups within dimensions analyzed. Outcomes were obtained from computer logs corresponding to the period July to November 2012 (post-internet period). Included students comply with the following requirements: (a) were in third to fifth grade at baseline; (b) participated in the laptop lottery; (c) won the laptop lottery and received a laptop; (d) won the internet lottery and received internet access; (e) had effective internet activity within the post-internet period; and (f) laptop logs were succesfully recovered. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table A1. Attrition by Treatment Arm

	Follow-up: November 2012 Baseline observations: 3rd - 5th grade at baseline			Follow-up: March 2013 Baseline observations: 3rd - 4th grade at baseline		
	Laptop + internet	Internet	Baseline Observations	Laptop + internet	Internet	Baseline Observations
	(1)	(2)	(3)	(4)	(5)	(6)
Overall attrition						
Answered at least 1 instrument	0.02	0.01	2,457	0.01	0.05	1,608
	(0.02)	(0.03)		(0.03)	(0.05)	
Digital skills						
Took XO test	0.00	-0.02	2,350	0.01	0.07	1,532
	(0.02)	(0.03)		(0.03)	(0.05)	
Took PC test	0.01	-0.03	2,350	0.01	0.04	1,532
	(0.02)	(0.04)		(0.03)	(0.05)	
Took Internet test	0.01	-0.03	2,350	0.01	0.04	1,532
	(0.02)	(0.04)		(0.03)	(0.05)	
Academic achievement						
Took Math	0.02	0.01	2,336	0.01	0.04	1,517
	(0.02)	(0.04)		(0.03)	(0.05)	
Took Reading	0.02	-0.01	2,351	0.01	0.02	1,540
	(0.02)	(0.04)		(0.03)	(0.05)	
Cognitive skills						
Took Raven's progressive matrices	0.03	-0.00	2,355	0.01	0.05	1,531
	(0.02)	(0.03)		(0.03)	(0.05)	

Notes: This table presents differential attrition rates between laptop + internet winners (treatment group), non-winners (control group 1), and laptop-only winners (control group 2) who participated in the laptop lottery. Columns (1), and (4) present estimated attrition rates and standard errors between the treatment group and control group 1. Columns (2), and (5) present estimated attrition rates and standard errors between the treatment group and control group 2. Estimates result from OLS regressions with class fixed-effects. Baseline data were collected in April 2011 and follow-up in November 2012 and March 2013. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table A2. Baseline Balance for Full Sample

	Raw means			Adjusted Differences		
	No laptop	laptop-only	Laptop + internet	Laptop + internet	Internet	Observations
	(1)	(2)	(3)	(4)	(5)	(6)
Socio-demographic characteristics						
Age	9.51	9.51	9.40	-0.04	-0.04	2,234
				(0.04)	(0.07)	
Male	0.48	0.52	0.51	0.02	-0.02	2,234
				(0.03)	(0.05)	
Number of siblings in household	2.20	2.38	2.29	0.04	-0.14	2,232
				(0.10)	(0.14)	
Father lives at home	0.78	0.75	0.79	0.02	0.05	2,226
				(0.03)	(0.04)	
Father works outside home	0.88	0.86	0.89	0.01	0.03	2,221
				(0.02)	(0.03)	
Mother works outside home	0.53	0.49	0.51	-0.02	0.04	2,233
				(0.03)	(0.05)	
Phone	0.48	0.46	0.45	-0.04	-0.04	2,196
				(0.03)	(0.05)	
Electricity	0.91	0.89	0.89	-0.01	0.00	2,206
				(0.02)	(0.03)	
Car	0.28	0.26	0.25	-0.03	-0.01	2,181
				(0.03)	(0.04)	
Access						
Computer or laptop at home	0.43	0.43	0.43	-0.01	-0.02	2,336
				(0.03)	(0.04)	
Internet at home	0.35	0.32	0.32	-0.04	-0.03	2,311
				(0.03)	(0.04)	
Use						
Computer or laptop last week	0.86	0.88	0.86	0.01	-0.02	2,322
				(0.02)	(0.03)	
Internet last week	0.79	0.78	0.80	0.01	0.01	2,350
				(0.02)	(0.04)	
Digital skills						
PC and Internet literacy test	0.00	0.02	-0.10	-0.09	-0.11	2,350
				(0.05)	(0.09)	
Self-reported PC and Internet skills	0.00	0.01	0.04	0.06	0.01	2,350
				(0.06)	(0.09)	
Academic achievement						
Math	0.00	-0.08	0.00	0.09	0.13	2,336
				(0.06)	(0.08)	
Reading	0.00	-0.06	-0.04	0.03	0.10	2,351
				(0.05)	(0.09)	
Cognitive skills						
Raven's progressive matrices	0.00	-0.05	0.04	0.12	0.12	2,355
				(0.05)**	(0.08)	
Teachers' perceptions						
High skills in making friends	0.54	0.51	0.52	0.01	0.05	2,424
				(0.03)	(0.04)	
High academic effort in class	0.45	0.47	0.42	-0.01	-0.02	2,424
				(0.03)	(0.04)	
Expected to complete university	0.62	0.66	0.63	0.03	0.01	2,425
				(0.03)	(0.04)	

Notes: This table presents statistics and estimated differences between laptop + internet winners (treatment group), non-winners (control group 1), and laptop-only winners (control group 2) who participated in the laptop lottery. Column (1) presents control group 1 means; column (2) presents control group 2 means; column (3) presents treated group means; column (4) presents estimated adjusted differences and standard errors between the treatment group and control group 1; column (5) presents estimated adjusted differences and standard errors between the treatment group and control group 2. Estimates in columns (4) and (5) result from OLS regressions with class fixed-effects. OLS regressions include all students who participated in the laptop lottery and were in third to fifth grade at baseline. Scores in Digital skills, Academic achievement, and Cognitive skills are normalized by subtracting the mean and dividing by the standard deviation of non-winners who participated in the laptop lottery. Baseline data were collected in April 2011. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table A3. Baseline Differences between Consenters and Non-Consenters

	Non-Consenters	Consenters	Difference	Observations
	(1)	(2)	(3)	(4)
Socio-demographic characteristics				
Age	9.55	9.50	-0.05	4,217
			(0.04)	
Male	0.51	0.48	-0.02	4,221
			(0.02)	
Number of siblings in household	2.32	2.22	-0.10	4,217
			(0.05)**	
Father lives at home	0.77	0.78	0.02	4,205
			(0.01)	
Father works outside home	0.87	0.88	0.01	4,201
			(0.01)	
Mother works outside home	0.54	0.53	-0.01	4,215
			(0.02)	
Phone	0.51	0.47	-0.04	4,143
			(0.02)**	
Electricity	0.92	0.90	-0.02	4,164
			(0.01)**	
Car	0.29	0.28	-0.01	4,098
			(0.01)	
Access				
Computer or laptop at home	0.50	0.43	-0.07	4,462
			(0.01)***	
Internet at home	0.39	0.34	-0.05	4,422
			(0.01)***	
Use				
Computer or laptop last week	0.87	0.86	-0.01	4,439
			(0.01)	
Internet last week	0.79	0.79	-0.00	4,490
			(0.01)	
Digital skills				
PC and internet literacy test	0.01	-0.01	-0.02	4,492
			(0.03)	
Self-reported PC and internet skill	0.01	0.01	0.00	4,492
			(0.03)	
Academic achievement				
Math	-0.02	-0.01	0.02	4,487
			(0.03)	
Reading	-0.07	-0.01	0.06	4,487
			(0.03)**	
Cognitive skills				
Raven's progressive matrices	-0.08	0.00	0.08	4,502
			(0.03)***	
Teachers' perceptions				
High skills in making friends	0.50	0.53	0.03	4,791
			(0.01)*	
High academic effort in class	0.38	0.45	0.07	4,793
			(0.01)***	
Expected to complete university	0.55	0.63	0.08	4,791
			(0.01)***	

Notes:This table presents estimated differences between lottery participants (consenters) and lottery non-participants (non-consenters) at baseline. The sample includes students in third to fifth grade in April 2011. Columns (1) and (2) present means. Column (3) presents estimated coefficients and standard errors on an indicator for participating in the laptop lottery from OLS regressions. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table A4. Fraction Treated with Internet Access by Random Order

Random order for internet offer	Received internet	Fraction
(1)	(2)	(3)
Panel A: All students in 3rd-5th grade at baseline		
1	102	40.00%
2	97	38.04%
3	43	16.86%
4	13	5.10%
Total	255	100.00%
Panel B: Students in 3rd-5th grade at baseline and observed in November 2012		
1	101	40.40%
2	95	38.00%
3	42	16.80%
4	12	4.80%
Total	250	100.00%

Notes: This table presents the number of children that received internet access (and the fraction from the total) by the order in which they were randomly sorted to receive this intervention.

Table A5. Effects on Access, Use, and Skills without Controlling for Baseline Outcome

	Raw means			Effects		
	No laptop	laptop-only	Laptop + internet	Laptop + internet	Internet	Observations
	(1)	(2)	(3)	(4)	(5)	(6)
Access						
Computer or laptop at home	0.54	0.90	0.94	0.40	0.03	1,896
				(0.02)***	(0.03)	
Internet at home	0.44	0.42	0.72	0.29	0.32	1,898
				(0.03)***	(0.05)***	
Use						
Computer or laptop last week	0.90	0.97	0.95	0.05	-0.02	1,913
				(0.02)***	(0.02)	
Internet last week	0.87	0.87	0.92	0.07	0.06	1,886
				(0.02)***	(0.03)*	
Digital skills						
XO test	0.00	0.91	0.94	0.97	0.09	2,003
				(0.07)***	(0.11)	
PC test	0.00	0.13	0.15	0.19	0.04	1,932
				(0.06)***	(0.10)	
Internet test	0.00	0.05	0.29	0.30	0.24	1,932
				(0.06)***	(0.10)**	
Digital skills index	0.00	0.36	0.48	0.51	0.13	1,870
				(0.05)***	(0.08)	
Academic achievement						
Math	0.00	-0.04	-0.05	0.02	0.07	1,980
				(0.06)	(0.09)	
Reading	0.00	-0.09	-0.04	-0.01	0.11	1,874
				(0.06)	(0.10)	
Academic achievement index	0.00	-0.08	-0.03	0.01	0.13	1,787
				(0.05)	(0.09)	
Cognitive skills						
Raven's progressive matrices	0.00	-0.05	-0.04	-0.01	0.03	1,985
				(0.06)	(0.10)	
Verbal fluency	0.00	-0.05	-0.08	-0.04	0.01	1,964
				(0.06)	(0.10)	
Executive functioning	0.00	0.05	-0.07	-0.04	-0.10	1,976
				(0.06)	(0.08)	
Coding	0.00	0.05	-0.11	-0.07	-0.12	1,971
				(0.05)	(0.08)	
Working memory	0.00	0.13	-0.03	-0.01	-0.15	1,980
				(0.06)	(0.09)*	
Spatial reasoning	0.00	-0.01	0.05	0.04	0.04	1,968
				(0.06)	(0.09)	
Cognitive skills index	0.01	0.03	-0.04	-0.02	-0.06	1,821
				(0.03)	(0.05)	
Socio-emotional skills						
Self-esteem Index	0.00	-0.05	0.04	0.06	0.14	1,916
				(0.06)	(0.10)	

Notes: This table presents estimated effects between laptop + internet winners (treatment group), non-winners (control group 1), and laptop-only winners (control group 2) who participated in the laptop lottery. Column (1) presents control group 1 means; column (2) presents control group 2 means; column (3) presents treated group means; column (4) presents estimated adjusted differences and standard errors between the treatment group and control group 1; column (5) presents estimated adjusted differences and standard errors between the treatment group and control group 2. Estimates in columns (4) and (5) result from OLS regressions controlling for class fixed-effects. OLS regressions include all students who participated in the laptop lottery, were in third to fifth grade at baseline, and answered the specific outcome of interest at follow-up (regardless of whether the student was interviewed at baseline). All scores are normalized by subtracting the mean and dividing by the standard deviation of non-winners who participated in the laptop lottery. The Digital skills, Academic achievement and Cognitive skills indexes are computed as the average of all tests belonging to each category restricted to students who completed all examinations included in each index. Baseline data were collected in April 2011 and follow-up in November 2012. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table A6. Effects by Baseline Computer and Internet Access

	Effects by baseline computer access				Effects by baseline internet access			
	Laptop + internet		Internet		Laptop + internet		Internet	
	Access	No access	Access	No access	Access	No access	Access	No access
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Access								
Computer or laptop at home	0.22	0.54	0.05	0.02	0.23	0.48	0.08	0.02
	(0.03)***	(0.03)***	(0.05)	(0.04)	(0.04)***	(0.03)***	(0.06)	(0.04)
Internet at home	0.20	0.37	0.28	0.37	0.13	0.38	0.16	0.40
	(0.04)***	(0.04)***	(0.07)***	(0.06)***	(0.05)***	(0.04)***	(0.08)**	(0.06)***
Use								
Computer or laptop last week	-0.01	0.09	-0.03	-0.01	-0.03	0.09	-0.06	0.00
	(0.03)	(0.02)***	(0.03)	(0.02)	(0.04)	(0.02)***	(0.04)	(0.02)
Internet last week	0.06	0.06	0.03	0.08	-0.01	0.09	-0.05	0.11
	(0.03)**	(0.03)**	(0.04)	(0.05)*	(0.03)	(0.02)***	(0.05)	(0.04)**
Skills								
Digital skills index	0.48	0.59	0.20	0.10	0.43	0.59	0.10	0.18
	(0.09)***	(0.07)***	(0.13)	(0.11)	(0.10)***	(0.06)***	(0.16)	(0.09)*
Academic achievement index	0.03	-0.01	0.05	-0.01	-0.01	0.01	0.07	-0.00
	(0.06)	(0.05)	(0.10)	(0.09)	(0.07)	(0.05)	(0.12)	(0.08)
Cognitive skills index	0.01	-0.01	0.01	-0.09	0.02	-0.02	0.01	-0.07
	(0.05)	(0.05)	(0.08)	(0.07)	(0.06)	(0.05)	(0.10)	(0.06)
Socio-emotional skills index	-0.05	0.10	0.05	0.15	0.02	0.05	0.03	0.12
	(0.10)	(0.09)	(0.16)	(0.13)	(0.11)	(0.08)	(0.19)	(0.12)

Notes: This table presents evidence on heterogeneous effects. Each cell in Columns (1) to (8) corresponds to the estimated adjusted differences and standard errors between the treatment and control groups for certain sub-sample. OLS regressions control for class fixed-effects and the baseline value of the outcome (when available). OLS regressions are restricted to students who comply with the following requirements: (a) participated in the laptop lottery; (b) third to fifth grade at baseline; (c) answered the specific outcome of interest at baseline and follow-up. The Digital skills, Academic achievement and Cognitive skills indexes are computed as the average of all standardized scores in the tests belonging to each category restricted to students who completed all examinations included in each index. Baseline data were collected in April 2011 and follow-up in November 2012. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table A7. Effects by Baseline Grade

	Laptop + internet			Internet		
	3rd	4th	5th	3rd	4th	5th
	(1)	(2)	(3)	(4)	(5)	(6)
Access						
Computer or laptop at home	0.41	0.39	0.41	-0.01	0.01	0.08
	(0.04)***	(0.03)***	(0.04)***	(0.06)	(0.06)	(0.06)
Internet at home	0.28	0.32	0.28	0.34	0.38	0.27
	(0.05)***	(0.05)***	(0.06)***	(0.08)***	(0.09)***	(0.08)***
Use						
Computer last week	0.08	0.05	0.03	0.02	-0.03	-0.04
	(0.02)***	(0.03)	(0.03)	(0.04)	(0.04)	(0.03)
Internet last week	0.10	0.04	0.06	0.12	0.03	0.03
	(0.03)***	(0.04)	(0.03)*	(0.06)**	(0.07)	(0.05)
Skills						
Digital skills index	0.55	0.50	0.53	0.32	-0.11	0.17
	(0.09)***	(0.10)***	(0.09)***	(0.15)**	(0.15)	(0.13)
Academic achievement index	-0.01	-0.00	0.11	0.00	0.13	0.25
	(0.09)	(0.09)	(0.10)	(0.16)	(0.15)	(0.14)*
Cognitive skills index	-0.04	-0.01	0.04	-0.09	-0.05	-0.01
	(0.06)	(0.06)	(0.07)	(0.09)	(0.08)	(0.09)
Socio-emotional skills index	0.13	-0.00	0.06	0.43	0.20	-0.19
	(0.11)	(0.10)	(0.12)	(0.16)***	(0.17)	(0.17)

Notes: This table presents evidence on heterogeneous effects. Each cell in Columns (1) to (6) corresponds to the estimated adjusted differences and standard errors between the treatment and control groups for certain sub-sample. OLS regressions include class fixed-effects. The Digital skills, Academic achievement and Cognitive skills indexes are computed as the average of all standardized scores in the tests belonging to each category restricted to students who completed all examinations included in each index. Baseline data were collected in April 2011 and follow-up in November 2012. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table A8. Spillovers on Friends: Effects of Laptop Winners on Non Winners

	Raw means			Spillover Effects		
	Non-Winners without Winner Friends	Non-Winners with laptop-only Winner Friends	Non-Winners with Laptop + internet Winner Friends	Laptop + internet	Internet	Observations
	(1)	(2)	(3)	(4)	(5)	(6)
Access						
Computer or laptop at home	0.52	0.57	0.56	0.03	0.02	1,404
				(0.04)	(0.05)	
Internet at home	0.42	0.44	0.46	0.01	0.05	1,393
				(0.04)	(0.05)	
Use						
Computer or laptop last week	0.89	0.90	0.91	0.03	0.02	1,489
				(0.02)	(0.03)	
Internet last week	0.87	0.85	0.87	0.01	0.01	1,468
				(0.02)	(0.03)	
Digital skills						
XO test	-0.07	0.05	0.07	0.09	0.04	1,494
				(0.06)	(0.08)	
PC test	-0.07	0.02	0.07	-0.01	0.03	1,445
				(0.06)	(0.09)	
Internet test	-0.11	-0.02	0.13	0.07	0.12	1,445
				(0.06)	(0.09)	
Digital skills index	-0.08	0.02	0.09	0.05	0.08	1,402
				(0.05)	(0.06)	
Academic achievement						
Math	-0.08	0.10	0.06	-0.03	-0.04	1,482
				(0.06)	(0.08)	
Reading	-0.07	0.00	0.08	0.07	0.10	1,394
				(0.07)	(0.09)	
Academic achievement index	-0.08	0.06	0.06	0.01	0.02	1,378
				(0.06)	(0.08)	
Cognitive skills						
Raven's progressive matrices	-0.03	0.05	0.03	-0.06	-0.03	1,474
				(0.06)	(0.09)	
Verbal fluency	-0.02	0.08	-0.00	-0.02	-0.00	1,529
				(0.06)	(0.08)	
Executive functioning	0.01	-0.06	0.00	-0.10	0.12	1,540
				(0.07)	(0.08)	
Coding	-0.04	0.06	0.02	-0.03	-0.02	1,534
				(0.06)	(0.07)	
Working memory	-0.03	-0.01	0.04	0.00	-0.00	1,539
				(0.06)	(0.08)	
Spatial reasoning	-0.02	-0.02	0.03	-0.01	0.07	1,527
				(0.07)	(0.09)	
Cognitive skills index	-0.01	0.03	0.03	-0.04	0.01	1,420
				(0.04)	(0.05)	
Socio-emotional skills						
Self-esteem Index	0.01	-0.03	0.00	-0.00	0.11	1,491
				(0.07)	(0.09)	

Notes: This table presents estimated spillover effects between non-winners with laptop+internet lottery winner friends (treatment group), non-winners without winner friends (control group 1), and non-winners with laptop-only winners (control group 2) who participated in the laptop lottery. Column (1) presents control group 1 means; column (2) presents control group 2 means; column (3) presents treated group means; column (4) presents estimated adjusted differences and standard errors between the treatment group and control group 1; column (5) presents estimated adjusted differences and standard errors between the treatment group and control group 2. Estimates in columns (4) and (5) result from OLS regressions controlling for class fixed-effects and the total number of friends who participated in the lottery. OLS regressions are restricted to students who comply with the following requirements: (a) participated in the laptop lottery; (b) third to fifth grade at baseline; (c) answered the specific outcome of interest at baseline and follow-up. Friends are defined using baseline data on social networks. All scores are normalized by subtracting the mean and dividing by the standard deviation of non-winners who participated in the laptop lottery. The Digital skills, Academic achievement and Cognitive skills indexes are computed as the average of all tests belonging to each category restricted to students who completed all examinations included in each index. Baseline data were collected in April 2011 and follow-up in November 2012. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table A9. Baseline Characteristics of Laptop Receivers with and without Computer Logs

	No logs mean (1)	Difference with logs (2)	Observations (3)
Socio-demographic characteristics			
Age	9.47	-0.06	463
		(0.08)	
Male	0.55	-0.01	463
		(0.05)	
Number of siblings in household	2.47	-0.21	463
		(0.17)	
Father lives at home	0.72	0.10	463
		(0.05)**	
Father works outside home	0.88	-0.02	459
		(0.04)	
Mother works outside home	0.48	-0.03	463
		(0.06)	
Phone	0.46	0.06	449
		(0.05)	
Electricity	0.86	0.03	454
		(0.03)	
Car	0.29	-0.04	449
		(0.05)	
Access			
Computer or laptop at home	0.39	0.10	488
		(0.05)*	
Internet at home	0.29	0.07	484
		(0.05)	
Use			
Computer or laptop last week	0.86	0.03	483
		(0.04)	
Internet last week	0.81	-0.01	492
		(0.04)	
Digital skills			
PC and Internet literacy test	-0.12	0.11	492
		(0.10)	
Self-reported PC and Internet skills	0.06	0.02	492
		(0.10)	
Academic achievement			
Math	-0.04	-0.08	481
		(0.10)	
Reading	-0.05	-0.15	487
		(0.09)*	
Cognitive skills			
Raven's progressive matrices	0.01	-0.07	493
		(0.09)	
Teachers' perceptions			
High skills in making friends	0.53	-0.04	506
		(0.05)	
High academic effort in class	0.43	-0.02	507
		(0.05)	
Expected to complete university	0.64	-0.00	507
		(0.04)	

Notes: This table presents statistics and estimated baseline differences between laptop receivers without computer logs and laptop receivers with computer logs. Column (1) presents means for laptop receivers without computer logs; column (2) presents estimated coefficients and standard errors on an indicator for having succesfully obtained the computer log. Estimates in column (2) result from OLS regressions with class fixed-effects. Sample is restricted to: (a) students in third to fifth grade at baseline; (b) received a laptop; and (c) that answered to the baseline variables reported in the table. Baseline data were collected in April 2011. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table A10. Baseline Balance for Internet Lottery between Students with Computer Logs

	laptop-only mean (1)	Internet difference (2)	Observations (3)
Socio-demographic characteristics			
Age	9.42	0.01	271
		(0.10)	
Male	0.45	-0.00	271
		(0.08)	
Number of siblings in household	2.20	-0.12	271
		(0.26)	
Father lives at home	0.79	-0.01	271
		(0.07)	
Father works outside home	0.83	0.04	268
		(0.05)	
Mother works outside home	0.50	0.00	271
		(0.08)	
Phone	0.46	-0.05	267
		(0.07)	
Electricity	0.92	0.01	266
		(0.04)	
Car	0.25	-0.00	265
		(0.07)	
Access			
Computer or laptop at home	0.45	0.05	274
		(0.08)	
Internet at home	0.33	0.05	273
		(0.07)	
Use			
Computer or laptop last week	0.88	0.03	271
		(0.05)	
Internet last week	0.72	0.07	277
		(0.06)	
Digital skills			
PC and internet literacy test	0.05	-0.31	277
		(0.15)**	
Self-reported PC and internet skills	-0.07	0.20	277
		(0.15)	
Academic achievement			
Math	-0.08	0.13	274
		(0.16)	
Reading	-0.04	0.13	272
		(0.15)	
Cognitive skills			
Raven's progressive matrices	-0.04	0.10	281
		(0.13)	
Teachers' perceptions			
High skills in making friends	0.52	0.12	286
		(0.07)*	
High academic effort in class	0.46	0.04	286
		(0.07)	
Expected to complete university	0.70	0.02	286
		(0.06)	

Notes: This table presents statistics and estimated baseline differences between laptop-only winners and laptop + internet winners with computer logs. Column (1) presents means for laptop-only winners; column (2) presents estimated coefficients and standard errors on an indicator for having won the internet lottery. Estimates in column (2) result from OLS regressions with class fixed-effects. Sample is restricted to: (a) students in third to fifth grade at baseline; (b) received a laptop; (c) logs were succesfully recovered; and (d) answered to the baseline variables reported in the table. Baseline data were collected in April 2011. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table A11. Effects of Internet on Laptop Use by Gender and Baseline Academic Achievement based on Logs

	Effects by gender				Effects by baseline academic achievement			
	laptop-only mean		Internet effect		laptop-only mean		Internet effect	
	Males	Females	Males	Females	<= Median	> Median	<= Median	> Median
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Application use (proportion of days opened)								
Any application	0.20	0.15	0.06	0.13	0.16	0.19	0.14	0.10
			(0.05)	(0.04)***			(0.04)***	(0.05)**
Internet application	0.00	0.01	0.15	0.17	0.01	0.01	0.16	0.19
			(0.03)***	(0.03)***			(0.03)***	(0.03)***
Non-internet application	0.20	0.14	-0.01	0.03	0.15	0.19	0.06	-0.00
			(0.04)	(0.03)			(0.04)	(0.04)
Non-internet applications by general categories (proportion of days opened)								
Entertainment	0.16	0.11	-0.03	0.01	0.12	0.15	0.04	-0.04
			(0.04)	(0.03)			(0.03)	(0.03)
Learning	0.13	0.10	0.00	0.00	0.11	0.13	0.04	-0.01
			(0.03)	(0.02)			(0.03)	(0.03)
Information	0.06	0.05	-0.01	-0.00	0.05	0.06	0.01	-0.00
			(0.01)	(0.01)			(0.02)	(0.01)
Communication	0.04	0.03	-0.01	-0.00	0.04	0.04	0.00	-0.01
			(0.01)	(0.01)			(0.01)	(0.01)
Top 10 non-internet applications (proportion of days opened)								
Jukebox (entertainment)	0.11	0.06	-0.05	-0.01	0.07	0.10	0.00	-0.06
			(0.03)	(0.02)			(0.03)	(0.03)**
Record (entertainment)	0.05	0.04	0.00	-0.00	0.04	0.05	0.02	-0.02
			(0.01)	(0.01)			(0.01)	(0.01)
Oficina (communication)	0.04	0.03	-0.01	-0.00	0.04	0.04	0.00	-0.01
			(0.01)	(0.01)			(0.01)	(0.01)
Implode (entertainment)	0.04	0.02	-0.01	-0.01	0.03	0.03	0.02	-0.01
			(0.02)	(0.02)			(0.02)	(0.01)
Speak (information)	0.04	0.03	-0.00	0.01	0.03	0.04	0.02	-0.00
			(0.01)	(0.01)			(0.01)*	(0.01)
Jigsaw puzzle (learning)	0.04	0.04	-0.01	-0.01	0.04	0.03	0.00	-0.01
			(0.01)	(0.01)			(0.01)	(0.01)
Tam tam mini (entertain)	0.03	0.02	-0.00	-0.01	0.03	0.03	0.00	-0.00
			(0.01)	(0.01)			(0.01)	(0.01)
Sudoku (learning)	0.02	0.03	-0.01	-0.01	0.02	0.03	0.01	-0.02
			(0.01)	(0.01)			(0.01)	(0.01)**
Memorize (learning)	0.02	0.03	0.01	-0.01	0.02	0.03	0.01	-0.01
			(0.01)	(0.01)			(0.01)	(0.01)
Calculate (learning)	0.02	0.02	0.00	-0.01	0.02	0.01	-0.00	0.00
			(0.01)	(0.00)			(0.01)	(0.01)

Notes: This table presents estimated heterogeneous effects regarding laptop utilization between laptop-only winners and laptop + internet winners. Outcomes were obtained from computer logs corresponding to the period July to November 2012 (post-internet period). Columns (1), (2), (5) and (6) present means for laptop-only winners; columns (2), (3), (7) and (8) present estimated coefficients and standard errors on an indicator for winning the laptop and internet lottery. Estimates in columns (2), (3), (7) and (8) result from OLS regressions with class fixed-effects. OLS regressions are restricted to students who comply with the following requirements: (a) were in third to fifth grade at baseline; (b) participated in the laptop lottery; (c) won the laptop lottery and received a laptop; and (d) laptop logs were succesfully recovered. Baseline data were collected in April 2011. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table A12. Effects of Internet on Laptop Use by Baseline Computer and Internet Access based on Logs

	Effects by baseline computer access				Effects by baseline internet access			
	laptop-only mean		Internet effect		laptop-only mean		Internet effect	
	Access	No access	Access	No access	Access	No access	Access	No access
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Application use (proportion of days opened)								
Any application	0.16	0.18	0.08	0.16	0.16	0.16	0.07	0.14
			(0.04)**	(0.04)***			(0.04)*	(0.03)***
Internet application	0.01	0.01	0.15	0.20	0.01	0.01	0.11	0.21
			(0.03)***	(0.03)***			(0.03)***	(0.03)***
Non-internet application	0.16	0.18	-0.00	0.06	0.15	0.15	0.01	0.04
			(0.03)	(0.04)			(0.04)	(0.03)
Non-internet applications by general categories (proportion of days opened)								
Entertainment	0.13	0.14	-0.02	0.02	0.11	0.11	-0.01	0.01
			(0.03)	(0.03)			(0.04)	(0.03)
Learning	0.10	0.13	0.00	0.03	0.10	0.10	0.01	0.02
			(0.02)	(0.03)			(0.03)	(0.02)
Information	0.05	0.06	-0.01	0.00	0.05	0.05	0.01	-0.01
			(0.01)	(0.01)			(0.01)	(0.01)
Communication	0.03	0.04	-0.01	-0.00	0.03	0.03	-0.01	-0.01
			(0.01)	(0.01)			(0.01)	(0.01)
Top 10 non-internet applications (proportion of days opened)								
Jukebox (entertainment)	0.08	0.09	-0.02	-0.02	0.07	0.07	-0.01	-0.03
			(0.03)	(0.02)			(0.03)	(0.02)
Record (entertainment)	0.04	0.05	-0.01	0.01	0.04	0.04	0.00	0.00
			(0.01)	(0.01)			(0.01)	(0.01)
Oficina (communication)	0.03	0.04	-0.01	-0.00	0.03	0.03	-0.01	-0.01
			(0.01)	(0.01)			(0.01)	(0.01)
Implode (entertainment)	0.04	0.03	-0.01	-0.01	0.03	0.03	0.02	-0.01
			(0.01)	(0.01)			(0.02)	(0.01)
Tam tam mini (entertain)	0.03	0.03	-0.01	0.00	0.02	0.02	-0.00	-0.01
			(0.01)	(0.01)			(0.01)	(0.01)
Speak (information)	0.03	0.04	0.01	0.01	0.03	0.03	0.01	0.00
			(0.01)	(0.01)			(0.01)	(0.01)
Jigsaw puzzle (learning)	0.03	0.04	-0.01	-0.01	0.03	0.03	-0.00	-0.01
			(0.01)	(0.01)			(0.01)	(0.01)
Sudoku (learning)	0.02	0.03	-0.01	-0.00	0.02	0.02	-0.01	-0.00
			(0.01)	(0.01)			(0.01)	(0.01)
Memorize (learning)	0.02	0.03	-0.00	0.00	0.02	0.02	-0.00	0.00
			(0.01)	(0.01)			(0.01)	(0.01)
Calculate (learning)	0.02	0.02	-0.00	0.00	0.02	0.02	-0.00	0.00
			(0.00)	(0.00)			(0.01)	(0.00)

Notes: This table presents estimated heterogeneous effects regarding laptop utilization between laptop-only winners and laptop + internet winners. Outcomes were obtained from computer logs corresponding to the period July to November 2012 (post-internet period). Columns (1), (2), (5) and (6) present means for laptop-only winners; columns (2), (3), (7) and (8) present estimated coefficients and standard errors on an indicator for winning the laptop and internet lottery. Estimates in columns (2), (3), (7) and (8) result from OLS regressions with class fixed-effects. OLS regressions are restricted to students who comply with the following requirements: (a) were in third to fifth grade at baseline; (b) participated in the laptop lottery; (c) won the laptop lottery and received a laptop; and (d) laptop logs were succesfully recovered. Baseline data were collected in April 2011. Heteroskedasticity-robust estimated standard errors reported in parentheses. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Figure A1. Project Timeline

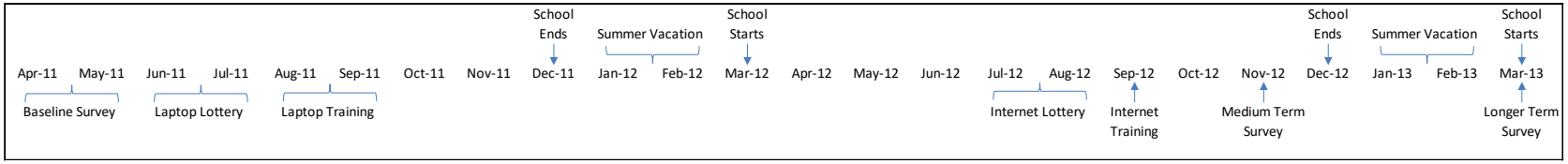

Figure A2. Sample Composition (Longer-Term Effects)