Can Computers Increase Human Capital in Developing Countries? An Evaluation of Nepal's One Laptop per Child Program

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Abstract

This paper evaluates the effectiveness of the One Laptop per Child (OLPC) initiative in Nepal's primary and lower-secondary schools. This evaluation of the OLPC program in Nepal uses a pre-post test quasi-experimental design that consists of 26 program schools and 39 control schools that are spread across six different districts of the country. A low-cost laptop was provided to each student in grades two, three and six of the program schools at the beginning of the Nepali academic year (May 2009). At the same time, a round of tests in English and mathematics designed specifically for this program was administered to all students in grades two, three, four and six in both program and control schools. The same students were given similar tests in February 2010 and in June/July 2011. The impact of the OLPC program is estimated by analyzing how the program and control schools differ in terms of changes in test scores (double difference comparisons between schools and within schools), attendance rates and measures of non-cognitive skills. The exposure to computer-assisted learning in Nepal had no impact or a negative impact on student learning, non-cognitive skills and attendance. Students from grade 2 in treatment schools did particularly poorly in year-end English tests compared to control school students.

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1. Introduction

This paper focuses on a key challenge facing developing countries intent on enhancing their human capital base—namely, the issue of quality. The goal of most educational initiatives is to improve student learning. Several policies, such as tuition reductions and conditional cash transfers, have been shown to increase enrollment (see the review by Glewwe and Kremer, 2006). Yet much less is known about student learning. This paper evaluates the effectiveness of the One Laptop per Child (OLPC) initiative on students' skills and other educational outcomes in Nepal. This program, and similar programs, are currently being heavily promoted in many developing countries, yet to date there have been hardly any rigorous impact evaluations of their impact on student learning.

Many observers of education claim that "technology is the future," arguing that teaching practices should incorporate information technology as much as possible to enhance student learning. Some individuals and groups have advocated increasing students' access to personal computers in developing countries to improve student learning. This paper evaluates the OLPC Nepal Program, the goal of which is to increase learning among primary school students in Nepal by integrating laptop-based teaching and learning approaches in the regular classroom process. The specific purpose of this research is to fill the wide gap between claims and factual evidence concerning the use of Information and Communication Technology (ICT) in education, especially the dearth of research on very poor developing countries such as Nepal. Specifically, this study estimates the impacts of providing low-cost laptop computers on the acquisition of basic math and language skills among primary school students in Nepal. It assesses the efficacy of an expensive technology that is highly touted as effective.

The impact of the OLPC program is estimated using "difference in differences" estimation methods to analyze how the program and control schools differ in terms of changes in test scores, attendance rates and drop-out rates. After the initial eight months, and then after two years of exposure to computer-assisted learning in Nepal, there is no evidence of a statistically significant positive impact on any of these outcome variables.

2. Education Problems in Nepal

Glewwe and Kremer (2006: 949-958) describe many problems with education in developing countries, some of which are discussed below. Nepal suffers from many of these problems. Nepal's gross enrollment rate (GER) and net enrollment rate (NER) indicate the low effectiveness of the education system in Nepal in terms of getting children into school. In 2008/09, the GER for basic education (grades 1-8) in Nepal was 123, while it was only 40 for the secondary level (Ministry of Education: Nepal, 2009). The NER provides a more dismal picture; the corresponding figures are 73 and 21, respectively.

Moreover, even those students who do complete secondary school do not have the academic skills expected of them. Of those who finish grade 10, less than 50% pass the School Leaving Certificate (SLC) exam,[1] which is the standardized exam taken by all the students who complete grade 10 in Nepal, in their first attempt. These problems are more acute in the public schools of Nepal, which enroll more than two-thirds of secondary level students. The first-time pass rate for private schools is more than 80% for most years, while it is usually less than 40% for public schools.

Bhatta (2005) presents many criticisms of the education system in Nepal, including: lack of proper training for teachers; teaching methods largely based on rote-learning that do not motivate students; lack of many resources for students and teachers that can be used to enhance

[1] Since 2007, the pass rate has been hovering around 60%, partly because the recent exams include materials from only grade 10 as opposed to including materials from both grades 9 and 10, which makes the tests harder.

learning; and late delivery of textbooks in many areas, which forces students to study without them.

Some indicators do point toward progress in the education sector. For example, the self-reported adult literacy rate in Nepal has steadily increased over time. In 1981, the self-reported literacy rate was 23%. In 1991, it increased to 40%, and according to the latest census of 2001, it reached 54% (Central Bureau of Statistics: Nepal, 1981, 1991, 2001). However, these numbers mask a wide disparity in the literacy rate across gender lines. In 1991, the male literacy rate was 55%, while the female literacy rate was only 25%. In 2001, the literacy rate was 65% for males while the corresponding figure was 43% for females. On a more positive note, the gender disparity is narrowing among younger generations. For example, based on the 2001 Population Census, 84% of boys of the 10-14 year age group are reportedly literate, while the corresponding number for girls is 73%. In contrast, for the 50-54 year age group, 45% of males are literate, while only 11% of females are literate.

3. Effects of Computers: The Literature

Many studies, some of which will be discussed below, have looked at the effects of computer-aided instruction methods on students' test scores, but very few have looked specifically at developing countries. Moreover, most studies of the use of computers in both developing and developed countries suffer from estimation problems that lower confidence in their claimed causal relationships. Many studies show a strong correlation between academic performance and computer use, but few control for other potentially confounding variables. Indeed, many variables that could lead to bias if omitted from regression estimates may be almost impossible to observe, such as innate ability and motivation.

Banerjee et al. (2007) wrote one of the very few papers on the use of computers in developing countries. The authors examine the impact of computer use on grade 4 students in

Vadodara, India. In 2002, over 100 schools were randomly divided into a treatment group (55 schools) and a control group (56 schools). Two hours per week of shared computer time were provided to the students in the treatment schools. The focus was on mathematics, so the children were exposed to educational materials designed to improve their understanding of that subject. After one year, standardized test scores in mathematics were found to be significantly higher (0.32 standard deviations of the distribution of test scores) among students from the treatment schools. The score on a language test was similar in both the treatment and control schools, which is not surprising given that the computer software was targeted towards mathematics skills.

Angrist and Lavy (2002) exploited a natural experiment situation to examine the Tomorrow-98 program in Israel. That program installed 35,000 computers in 905 schools between 1994 and 1996. These computers were distributed according to a 'priority list' based on the goal of attaining a computer to student ratio of 1:10 in grades 1-8. The authors use student score data for 1991 and information on schools that had applied for Tomorrow-98 program but did not receive funds. Hebrew and math tests were administered to random samples of 4th and 8th graders in 122 Jewish schools in 1996. A non-linear instrumental variable approach was used to determine the effects. They found that more computers led to more computer use in elementary level, but there were weaker effects in middle school. With regard to test scores, there was little effect. They conclude that either Information and Communication Technology (ICT) is an ineffective input or that it takes some time to improve learning because it disrupts teachers' current style of teaching.

Malamud and Pop-Eleches (2010) employ the regression discontinuity method to look at the effect of home computers on child outcomes in Romania. In 2005, the government of

Romania had provided about 27,000 vouchers worth 200 Euros each, to be used by low-income families to purchase computers for their homes. Since the vouchers were provided based on the simple ranking of household incomes, other households with similar income levels who narrowly were ineligible for vouchers were compared with those who were provided vouchers. They found that though the vouchers increased the chances of families owning a computer by 50%, the students in those families with computers had lower grades in English, Math and Romanian. However, these students had significantly higher scores in a test of computer skills.

Barrera-Osorio and Linden (2009) evaluated Colombia's Computers for Education program. The refurbished computers donated by the private sector were provided to public schools in 2006. Grade three through nine students from 97 schools were part of the study. They found little impact of computers on students' test scores. They attributed this limited effect on student performance to the teachers' failure to incorporate computers in their teachings even though the teachers were provided training and technical assistance which should have made computer use appealing to teachers.

To summarize, providing computers sometimes increases student learning but sometimes had little or no effect. Common sense suggests that the impact of computer use depends on how they are used. In general, provision of computers should be more effective if the computers come with well-designed software for students' use.

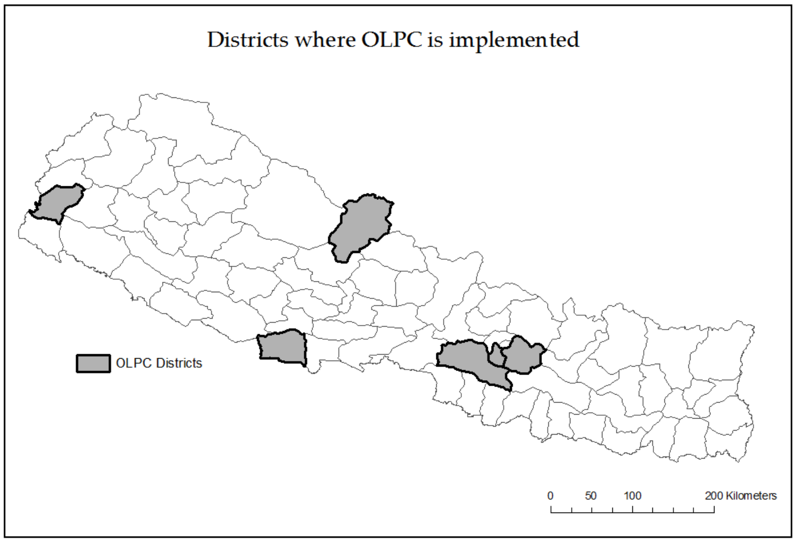
4. Description of the OLPC Nepal Program

The OLPC Nepal Program was a collaboration between Nepal's Department of Education and Open Learning Exchange Nepal (OLE Nepal), a Nepali non-governmental organization to enhance the quality of public schools through the use of ICT-integrated teaching and learning approaches. A laptop computer that costs about US $190 was provided to each student in grades two, three and six in 26 public schools from six districts in Nepal in 2009. To implement the program, teachers were provided laptops and were trained for 10 days (before the laptops were given to students) around the time school year started. Training focused on how to teach different subjects using laptop-based teaching-learning materials. The laptops were equipped with course-specific teaching and learning materials based on the national curriculum developed by the experts at OLE Nepal. During the school year, math and English classes were expected to be taught using laptop-based teaching and learning approaches at least two times per week. Students were allowed to take the laptops home, which may have provided additional benefits to other family members, including other children.

5. Data and Descriptive Statistics

Nepal's government Department of Education and OLE Nepal selected twenty-six schools from six of Nepal's 75 administrative districts as treatment schools. The criteria used to select these schools will be explained below. The program covers all three geographical regions of Nepal—mountains, hills and plains. The locations of these districts are shown shaded in the map below:[2]

[2] The right-most shaded region includes three different districts.



Thirty-nine control schools were then selected from these same six districts, based on their similarity to the 26 treatment schools. The officials at the six District Education Offices (DEO) played a significant role in selecting these schools. They were asked to select comparison schools based on the guidelines used to choose the program schools. It was essential that comparison schools met the requirements so that they could be selected as program schools in subsequent phases of the project.[3] The person in each DEO who knew the most about the schools in the district prepared the preliminary list of comparison schools. Other government officials then commented on the extent to which these schools were comparable. It was agreed in principle that the next phase of the program expansion in these six districts would start with these control schools. The officials were made aware of this preference so that they would be encouraged to select schools responsibly. In some districts, schools closely comparable to

[3] One control school that did not meet the requirement of being connected to a power grid was selected. Since all the program schools in Dadeldhura district had the School Lunch program that was supported by the World Food Program (WFP), the decision was made to select a school that had the School Lunch program but no access to electricity over one that had electricity but was not a WFP-supported school. The School Lunch program is implemented in areas with relatively poorer students.

program schools did not exist. For instance, in a remote district of Mustang, most of the better schools were already selected as program schools. The comparison schools therefore had poorer infrastructure and far fewer students. Because of time and resource constraints, selection of comparison schools from a nearby district was not feasible.

The numbers of program and comparison schools in each district are given in Table 1. The region the particular district is located is given in parentheses.

Table 1: Number of Program and Comparison Schools

	Program schools	Comparison schools
Total number of schools	26	39
Dadeldhura (hilly region)	3	6
Kavre (hilly region)	3	6
Kapilvastu (plains region)	3	5
Lalitpur (hilly region)	5	5
Makawanpur (plains region)	5	10
Mustang (mountain region)	7	7

All grade two, three and six students and four teachers[4] in each treatment school were provided with laptops, and the teachers in these schools were given training on how to incorporate ICT-integrated teaching into their classrooms. Some program schools did not have grade six, in such cases only students in grades two and three in these schools were given laptops. The students and teachers in the treatment schools were provided laptops in May 2009. To provide baseline data, the first round of tests for all students in grades two, three, four and six was administered in both control and treatment schools in May 2009, right after laptops were

[4] Since teachers teach different grades, it was assumed that math and English in program grades would not be taught by more than four teachers.

given out.[5] The next rounds of tests were administered towards the end of the 2009-2010 academic year in February 2010 and in the beginning of third academic year in June/July 2011.

The academic calendar was similar in five of the six districts. The academic year begins in April/May and ends in March. However, Mustang district has a different academic calendar. Because of the harsh winter, the academic calendar is set such that the schools have a two-month winter break. The academic year begins in early February and ends in November. This difference in academic calendar is considered while analyzing the data. For example, the laptop integrated teaching in Mustang was started after three months into the school year. Since the school administered final exam is conducted in late November there, it was decided that the year-end exams in year 1 that are part of the evaluation should be administered before the final exams in this district as well. The program schools in Mustang were therefore exposed to computer based instruction for less than six months when the second round of data was collected, but more than two years for the third round.

A comprehensive baseline survey of students and their households was also conducted. This provides information that will make it possible, among other things, to explore the extent to which the treatment and control groups are similar. Data were also collected on demographic, educational, and economic variables for all household members in the baseline survey, which is useful when estimating the impact of the program, for example to explore whether program effects vary by student type. Baseline teacher, school, and community level surveys were also conducted.

Two additional rounds of tests, as well as student, teacher and school surveys, were administered to both control and treatment households in February 2010 and June/July 2011. The

[5] Since student attendance is very irregular in the first couple of weeks of academic year, the survey was conducted after about three weeks of the new school year so that the attendance would have stabilized by then.

impact of the OLPC program is estimated by comparing the test scores of students in the program and comparison groups between May 2009, February 2010 and July 2011. In addition, the data for grade 4 students will be used to compare changes in test scores between students who receive laptops and students in the same school who do not receive laptops.

The data used in this research, including the tests, were specifically collected to analyze the impact of the OLPC program on students' educational outcomes.[6] The tests were designed by Nepalese experts who were not associated with the school system, and students in program and control schools were given the same tests. Only those students who were registered in school at the beginning of the 2009-2010 school year were part of the study. Information on 6752 students was collected from the school registry. The number of students in different grades in 26 program schools and 39 comparison schools is given in Table 2.

Table 2: Number of Students in Program and Comparison Groups in May 2009

	Program shools	**Comparison schools**
Number of students	**2486**	**4279**
Students in grade two	595	1011
Students in grade three	623	1108
Students in grade four	663	1255
Students in grade six	605	905
Percentage of female students	49.40%	50.70%

Both baseline and year one surveys were administered to students in grades two, three, four and six, while year two surveys were administered to the same students when they were in grade four, five, six and eight respectively. That is, the third round of surveys were conducted at the beginning of year 3. Grade four students in 2009 serve as a comparison group within each school. Table 3 demonstrates the same information in tabular form. For example, a student who had just started grade 4 during the baseline survey would have started grade 6 in the same school

[6] Blitz Media, a survey firm in Nepal, was hired to administer the tests and the surveys.

during the third round of survey, assuming the student has not repeated, transferred to another school or dropped out of the school.

Table 3: Grades surveyed in different rounds

Baseline (Round1)	**Year 1 (Round 2)**	**Year 2 (Round 3)**
Grade 2 beginning	Grade 2 end	Grade 4 beginning
Grade 3 beginning	Grade 3 end	Grade 5 beginning
Grade 4 beginning	Grade 4 end	Grade 6 beginning
Grade 6 beginning	Grade 6 end	Grade 8 beginning

The baseline tests were conducted for English, Math and Nepali, while the year-end tests included only English and Math.[7] The baseline test included materials from the preceding grade's curriculum while the year-end test included materials from the current grade's curriculum. For example, grade 3 baseline exams covered materials from grade 2 while the year-end exams had materials from the grade 3 official curriculum. All test scores were normalized such that the mean test score was 0 with standard deviation 1 for every grade and subject in comparison schools. Tables 4A and 4B show baseline and year-end average normalized and absolute test scores (percentages) in both the program and the comparison schools.

Table 4A: Baseline and Year-end Normalized Test Scores

	Baseline				Year-end			
	Program		Comparison		Program		Comparison	
Normalized average test score: English	**Mean**	**obs**	**Mean**	**obs**	**Mean**	**obs**	**Mean**	**obs**
Students in grade two	0.45	514	0	693	0.10	469	0	653
Students in grade three	0.48	533	0	832	0.34	508	0	788
Students in grade four	-0.12	541	0	975	0.30	516	0	896
Students in grade six	0.47	523	0	701	0.22	476	0	627
Normalized average test score: Math								
Students in grade two	0.17	518	0	707	0.03	471	0	666
Students in grade three	0.27	544	0	850	0.23	504	0	761
Students in grade four	-0.011	563	0	1001	0.005	518	0	903
Students in grade six	0.02	529	0	710	-0.13	465	0	626

Table 4B: Baseline and Year-end Absolute Test Scores

	Baseline				Year-end			
	Program		Comparison		Program		Comparison	
Absolute average test score: English	**Mean**	**obs**	**Mean**	**obs**	**Mean**	**obs**	**Mean**	**obs**
Students in grade two	73.41%	514	64.18%	693	41.32%	469	39.47%	653
Students in grade three	51.49%	533	42.40%	832	35.88%	508	29.21%	788
Students in grade four	55.12%	541	57.24%	975	46.53%	516	40.99%	896
Students in grade six	51.62%	523	44.16%	701	58.14%	476	54.18%	627
Absolute average test score: Math								
Students in grade two	66.39%	518	62.76%	707	45.34%	471	44.70%	666
Students in grade three	56.65%	544	51.28%	850	42.29%	504	38.34%	761
Students in grade four	56.98%	563	57.17%	1001	40.59%	518	40.49%	903
Students in grade six	43.10%	529	42.86%	710	41.95%	465	43.91%	626

These tables provide the average test scores program and comparison school students obtained in English and math by grade. Looking at the baseline data, it is evident that comparison schools are different from treatment schools. There exist statistically significant differences in baseline English test scores for all the grades (at the 1% level for grades 2, 3, and 6, and the 5% level for grade 4), and in baseline Math test scores for grades 2 and 3. Except for

[7] Because of financial constraints, only two subject exams could be administered.

grade 4, baseline test scores were higher in program schools, especially for English. Informal discussions with education experts in the Department of Education and the World Bank's Nepal office did not lead to a better understanding of the reasons behind lower grade 4 test scores in program schools even when these schools were perceived to be of superior quality compared to control schools. It is also evident from the table above that the baseline test scores in both English and mathematics were higher than the year-end test scores for all grades except grade six English in program schools. Since different sets of questions were used in these rounds, it is possible the year-end tests were relatively more difficult than the baseline tests.

Information was also gathered on some aspects of non-cognitive skills, such as interest in studies and confidence level. During the year-end survey, teachers familiar with students in a particular grade were asked about how different dimensions of students' non-cognitive skills changed during the academic year.[8] For each category, three choices were given: the student's skill in the particular category has increased, it is about the same, or it has decreased. In most schools in Nepal, teachers are assigned to teach several grades, so they know students in different grades. Though the data were collected on all the students in grades two, three, four and six, the same teacher was explicitly asked to rank students in both grades three and four. The teacher ratings of the students in grades 2, 3, 4 and 6 are given in Table 5.

[8] Though the students themselves were also asked similar questions, there was little variation among students. Because of this, the student responses are not considered here.

Table 5: Change in Various Dimensions of Internal Motivation in Students

Compared to last academic year, how has the student's interest in studies changed?								
	Program				**Comparison**			
	1. increased	Prop. increased	2. about the same	3. decreased	1. increased	Prop. increased	2. about the same	3. decreased
Grade 2	346	0.63	174	27	485	0.55	314	81
Grade 3	358	0.63	175	39	491	0.49	438	65
Grade 4	340	0.56	209	53	560	0.50	503	61
Grade 6	282	0.50	215	63	413	0.51	301	93
Compared to last academic year, how disciplined is the student?								
Grade 2	336	0.61	189	22	392	0.45	433	55
Grade 3	338	0.59	217	17	458	0.46	493	43
Grade 4	368	0.61	202	32	567	0.50	500	57
Grade 6	286	0.51	245	29	444	0.55	323	40
Compared to last academic year, how has the student's ability to get along well with others changed?								
Grade 2	344	0.63	174	29	430	0.49	398	51
Grade 3	340	0.59	212	20	509	0.51	446	39
Grade 4	332	0.55	232	38	555	0.49	544	25
Grade 6	318	0.57	213	29	483	0.60	284	40
Compared to last academic year, how has the student's self-confidence changed?								
Grade 2	350	0.64	164	33	353	0.40	465	62
Grade 3	311	0.54	247	14	372	0.37	580	42
Grade 4	305	0.51	246	51	512	0.46	573	39
Grade 6	278	0.50	252	30	454	0.56	296	57

Compared to teachers in comparison schools, program school teachers, in general, perceive more of their students to have improved in many of these internal motivation aspects. The change is greater for lower grades (2 and 3). However, since improvement in internal motivation aspects is also true for grade 4 students who were not provided with laptops, one cannot yet conclude that the change is caused by the program.

The average attendance rates for continuing students in program and comparison schools are given in Table 6:

Table 6: Student Attendance Rates During Baseline and Year One

	Baseline						Year-end					
	Program schools			Comparison schools			Program schools			Comparison schools		
	att. rate	obs	s.d.	att. rate	obs	s.d.	att. rate	obs	s.d.	att. rate	obs	s.d.
Grade 2	70%	433	0.25	60%	792	0.3	81%	423	0.15	71%	772	0.23
Grade 3	73%	511	0.24	69%	923	0.2	80%	494	0.17	73%	893	0.22
Grade 4	73%	530	0.24	70%	971	0.2	78%	531	0.20	76%	970	0.20
Grade 6	77%	432	0.23	72%	689	0.2	80%	436	0.19	76%	687	0.18

For the baseline case, the attendance figures from two months -- May/June (Jestha) and October (between two major festivals Dashain and Tihar) --for the previous academic year (2008/09) are averaged. They indicate the average attendance rates of students in program and comparison schools by grade. Since the schools have the previous year's attendance for only those students who were students in the same school, Table 6 considers only those students who are continuing students. The year-end data also include attendance figures for August/September (Bhadra). Though the average attendance rate for program school students is higher than for comparison school students, this rate is higher in the year-end for both groups of schools.

6. Empirical Model and Identification Strategy

As explained above, not all grades in the program schools were provided with laptops. The students in both program and comparison groups took tests in English and Math. Since unobserved characteristics of a student in a particular school can be similar to those of other students in the same school, adjustments for data clustering by school have been made in all the regression results shown below, except where otherwise noted. Most of these results use the most flexible form of the random effects model, with grade random effects and robust clustering at the school level. These random standard errors allow for unstructured correlation of error terms for students in the same school and school- and grade-specific random effects. In analyses using other forms of clustered analysis (e.g. without random effects), similar results were obtained in that the significance of the results was unchanged. In addition, since the six districts in which the program was implemented are inherently different in many dimensions, such as terrain and urban and rural status, district-level fixed effects are also included in all the estimates presented in this paper.

6.1 Grades 2, 3 and 6: Difference in Differences Estimation (baseline to year 1)

One of the simplest ways to estimate the impact of the program is to compare the baseline and end of year test scores for the first year of students in grades 2, 3 and 6 in both program and comparison schools. Model 1 presents one way to estimate the program impact:

$$T = \beta_0 + \beta_1 Y_1 + \beta_2 P + \beta_3 Y_1{*}P + \beta_4 G_3 + \beta_5 G_6 + \beta_6 E + u \qquad (5)$$

where T is the (normalized) test score the student obtained, Y_1 indicates end-of-year test scores (first year) tests and not baseline tests, P specifies whether the student is in the school where OLPC program was implemented, grade dummies (G) indicate which grade (2, 3 or 6) the student is in; E indicates that the test score is for English as opposed to math, u is the error term, and β_0, β_1, β_2, β_3, β_4, β_5 and β_6 are the coefficients to be estimated. In this equation, each student can have up to four observations -- baseline and end-line test scores in English and math (two for each subject). The coefficient β_3 in the above equation is of particular interest. If there is indeed a positive impact of the program, the estimate for β_3 should be positive. Similarly, the coefficient should be negative if there is a negative impact of the program.

Estimates of equation (5) that combine test scores for English and math, as well as estimate for English and math separately, are shown in Table 7. Column 1 shows the estimates when English and math are considered together, while columns 2 and 3 provide separate estimates for English and math.

Table 7: Estimation Results – Grades 2, 3 and 6 Normalized Test Scores (baseline and year one)

VARIABLES	English and Math test scores	English test score	Math test score
	(1)	(2)	(3)
Year-end test indicator	-0.017	-0.014	-0.017
	(0.080)	(0.072)	(0.115)
Program school (vs. control)	0.169	0.352***	-0.004
	(0.130)	(0.135)	(0.146)
Year-end test*program school	**-0.149**	**-0.217****	**-0.093**
	(0.100)	(0.101)	(0.141)
Grade 3 indicator	0.104*	0.110*	0.097
	(0.053)	(0.065)	(0.060)
Grade 6 indicator	-0.074	-0.072	-0.083
	(0.101)	(0.114)	(0.107)
English	0.104*		
	(0.054)		
Constant	-0.289*	-0.461***	-0.019
	(0.169)	(0.151)	(0.192)
Observations	14,668	7,317	7,351
Number of school grades	173	173	173

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

When the test scores for both math and English are included in the regression, the effect of ICT-based teaching and learning on student test scores is negative and fairly large (-0.15), but not statistically significant. However, when separate regressions are run for math and English, the program impact is still negative, but smaller (-0.09) and insignificant for math. In contrast, it is negative, large and statistically significant for English. The average test scores in program school grades that received laptops decreased by 0.22 standard deviations compared to schools that did not. The direction of this effect is surprising, and the magnitude of the effect on English test scores is substantial. This is all the more puzzling given that many of the digital materials prepared by OLE Nepal are in English.

One could argue that the effect of the program varies across grades. For example, the digital materials included in the laptops are different for different grades. It is also likely that the effectiveness of the program may depend on the age group of the students. Tables 8 and 9 display separate estimates of the impact for each grade.

Table 8: Grade-specific Estimation Results – Both English and Math

VARIABLES	**Normalized test scores** **Grade 2**	**Grade 3**	**Grade 6**
	(1)	(2)	(3)
Year- end test indicator	-0.007	-0.014	-0.031
	(0.109)	(0.117)	(0.131)
Program school (vs.control)	0.133	0.258	0.066
	(0.164)	(0.187)	(0.138)
Year-end test*program school	**-0.238***	**-0.049**	**-0.167**
	(0.132)	(0.200)	(0.152)
English	0.077	0.067	0.173*
	(0.073)	(0.067)	(0.089)
Constant	-0.306	-0.162	0.474*
	(0.188)	(0.185)	(0.255)
Observations	4,691	5,320	4,657
Number of Schools	65	65	43

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

Table 9: Grade-specific Estimation Results – English and Math Separately

VARIABLES	Normalized test scores (English) Grade 2	Grade 3	Grade 6	Normalized test scores (Math) Grade 2	Grade 3	Grade 6
	(1)	(2)	(3)	(4)	(5)	(6)
Year-end test indicator	-0.005	0.003	-0.042	-0.004	-0.028	-0.015
	(0.108)	(0.101)	(0.126)	(0.164)	(0.182)	(0.181)
Program school (vs. control)	0.300*	0.404**	0.326*	-0.022	0.114	-0.178
	(0.173)	(0.183)	(0.192)	(0.186)	(0.224)	(0.157)
Year-end test*program school	**-0.342****	**-0.114**	**-0.199**	**-0.141**	**0.006**	**-0.150**
	(0.161)	(0.190)	(0.153)	(0.201)	(0.261)	(0.226)
Constant	-0.447**	-0.372***	0.454	-0.095	0.113	0.650***
	(0.184)	(0.143)	(0.333)	(0.201)	(0.227)	(0.246)
Observations	2,329	2,661	2,327	2,362	2,659	2,330
Number of Schools	65	65	43	65	65	43

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

The separate estimates by grade in Tables 8 and 9 indicate that the negative impact of the program in this specification is driven by the strong negative impact of the program in English on grade 2 students. The results are statistically significant only in cases where data from grade 2 English is included.

It is also possible that the impact of the program differs by the gender of the student. For example, boys may be more tempted than girls to use the laptops to play computer games. Separate estimates by gender are shown in Table 10.

Table 10: Gender-wise Estimation Results

VARIABLES	English Male	English Female	Math Male	Math Female
	(1)	(2)	(3)	(4)
Year-end test indicator	-0.036	0.014	-0.033	-0.004
	(0.088)	(0.064)	(0.130)	(0.120)
Program school (vs. control)	0.306**	0.398***	-0.069	0.044
	(0.138)	(0.145)	(0.161)	(0.147)
Year-end test*program school	**-0.209***	**-0.244****	**-0.043**	**-0.136**
	(0.127)	(0.096)	(0.160)	(0.150)
Grade 3 indicator	0.079	0.112	0.096	0.092
	(0.072)	(0.069)	(0.074)	(0.063)
Grade 6 Indicator	-0.052	-0.095	0.034	-0.212*
	(0.117)	(0.129)	(0.107)	(0.123)
Constant	-0.331**	-0.576***	0.142	-0.179
	(0.155)	(0.171)	(0.194)	(0.217)
Observations	3,558	3,654	3,571	3,677
Number of School grades	168	173	168	173

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

Of the four estimated impacts in Table 10, both male and female students' English test scores are statistically significant and negative. However, the difference in coefficients for boys and girls is not statistically significant.

6. 2 Grades 2, 3, 4 and 6: Difference in Differences Estimation from Baseline to Year One (within school comparisons)

The evaluation design also included data collection for grade 4 students in both program and comparison schools in both rounds who were not provided laptops; this information can be used to estimate more precise program impacts. There are two main ways to use the grade 4 data to estimate impacts. One is to compare test scores for grades 2, 3 or 6 with those of grade 4 students in the program schools. The equation of interest in this scenario is:

$$T = \beta_0 + \beta_1 Y_1 + \beta_2 PG + \beta_3 Y_1{*}PG + \beta_4 E + u \qquad (6)$$

where PG indicates program grades (grades 2, 3 and 6). The second approach involves considering both program and comparison school. The equation of interest is:

$$T = \beta_0 + \beta_1 Y_1 + \beta_2 PG + \beta_3 P + \beta_4 Y_1{*}PG + \beta_5 Y_1{*}P + \beta_6 PG{*}P + \beta_7 Y_1{*}PG{*}P + \beta_8 E + u \quad (7)$$

The coefficient β_3 in equation (6) and β_7 in equation (7) estimate the impact of the program on student test scores. The results are provided in the table below:

Table 11: Estimation Results using Grade 4 (baseline and year one)

	Program schools only			All schools		
	Normalized Scores					
VARIABLES	**Both**	**English**	**Math**	**Both**	**English**	**Math**
	(1)	(2)	(3)	(4)	(5)	(6)
Year-end test indicator	0.221	0.430**	0.020	0.004	0.017	-0.009
	(0.150)	(0.179)	(0.172)	(0.127)	(0.134)	(0.160)
Program grades	0.279*	0.496***	0.079	-0.037	-0.059	-0.012
	(0.152)	(0.179)	(0.143)	(0.080)	(0.103)	(0.091)
Program school (vs. control)				-0.166	-0.226	-0.108
				(0.193)	(0.211)	(0.201)
Year-end test*program school				0.218	0.414*	0.028
				(0.195)	(0.222)	(0.234)
Year-end test*program grades	**-0.388*** **	**-0.661*** **	**-0.129**	-0.021	-0.030	-0.007
	(0.135)	(0.177)	(0.148)	(0.122)	(0.123)	(0.167)
Program school*program grades				0.322*	0.561***	0.095
				(0.173)	(0.208)	(0.172)
Year-end test*program grades*program school				**-0.367** **	**-0.631*** **	**-0.121**
				(0.181)	(0.214)	(0.222)
English	0.201*			0.082		
	(0.103)			(0.052)		
Constant	-0.592*	-0.746***	-0.243	-0.136	-0.276*	0.082
	(0.355)	(0.282)	(0.425)	(0.168)	(0.163)	(0.192)
Observations	8,192	4,080	4,112	20,581	10,245	10,336
Number of School grades	99	99	99	237	237	237

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

Because the grade 4 students in program schools did much better on average in English, in terms of changes over time, than the comparison school students, the negative impact of the program in English is more pronounced when using this specification. The effect of the program on math test scores is negative, but still relatively small and statistically insignificant. Section 8.1 provides further discussion on the possible reasons behind the relative increase in grade 4 test scores in English.

6. 4 Student Type and Program Impact

In this section, more explanatory variables are included in the regression equations to check whether the impact of the program can be estimated more precisely. The gender of the student and his or her socio-economic status are added as explanatory variable. During the year-end round, one of the teachers who knew very well the economic status of the students in a particular grade was asked to rank the students in four categories: very well-off, well-off, poor and very poor. These teachers were asked to classify the students evenly into these four categories in an attempt to generate wealth quartiles. Since the education level of the parents can also affect the impact of the program, the education levels of the parents are also included as additional controls. The impact of the program in English is still statistically significant and negative even after controlling for these factors, as shown in Table 14.

Table 14: Estimation Results after Adding More Explanatory Variables

VARIABLES	Year-end normalized math score	Year-end normalized English score
	(1)	(2)
Normalized baseline math score	0.364***	
	(0.026)	
Program school	0.068	0.305*
	(0.195)	(0.164)
Gender	0.151***	0.009
	(0.048)	(0.031)
Mother's education level	0.002	-0.009
	(0.033)	(0.039)
Father's education level	-0.012	0.057*
	(0.034)	(0.033)
Economic condition	-0.033*	-0.038**
	(0.018)	(0.016)
program grades	-0.174	-0.145*
	(0.133)	(0.081)
Program school*program grade	**0.061**	**-0.271****
	(0.166)	(0.123)
Gender*program school	-0.065	-0.035
	(0.071)	(0.052)
Mother's education*program school	-0.033	-0.009
	(0.053)	(0.055)
Father's education*program school	-0.016	-0.051
	(0.055)	(0.049)
Economic condition*program school	-0.004	-0.010
	(0.027)	(0.029)
Normalized baseline English test score		0.532***
		(0.025)
Constant	-0.247*	-0.280***
	(0.128)	(0.098)
Observations	3,343	3,346
Number of school grades	237	237

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

7. Estimation Results after Two Years

The third round of data was collected in June/July 2011, slightly more than two years after laptops were first distributed to the students. The tests and surveys were administered to students who were in grades four, five, six and eight in 2011. Unfortunately, data could not be collected on about thirty percent (2108) of the students who were in the first two rounds. Among the attriters, the majority are from grade four in the baseline. Since twenty-two of the sixty-five schools in our sample have only five grades, grade four students from those schools are no longer in these schools unless they repeated either grade four or five. Furthermore, since the enrollment rate was very low in one of the control schools, the government decided to shut down that school. It is likely that many of the attriters among those who were in grade six in 2009 may have transferred to a better secondary school in preparation for the School Leaving Certificate (SLC) exam taken after grade 10.

In addition to these dropouts, many new students have enrolled in these schools, particularly in grade six, due to students transferring from schools that go up only to grade 5. Primary schools in Nepal have 5 grades while Nepalese lower secondary level schools have up to grades seven or eight. Once students get promoted from these grades, they transfer to a different school.

Students who repeated a grade in 2010-2011 or in 2011-2012[9] were asked to take exams in the grades they are in, not in the grade they would have been in had they not repeated. Except for the grade four and five tests, there are no common questions for tests in different grades. Without an adequate number of common questions in tests for different grades, comparing test scores in different grades is extremely difficult, if not impossible.

In one of the program districts, Dadeldhura, the OLPC program has been expanded to two of the control schools. In initial discussions between District Education Offices and comparison schools, the program implementers had assured the comparison schools that they would be given priority over others when selecting new program schools in those districts. This promise was kept in Dadeldhura where two schools initially in the comparison group were provided with laptops at the beginning of the 2010/11 academic year. These new program schools were perceived to be better than the other comparison schools in that district and the baseline test scores in these two new schools were on average better than the test scores in the remaining control controls in that district.

Considering the complexities in the data mentioned above, the analysis in this section includes only schools that did not change their treatment group status, and includes only students who have not repeated grades in the last two years and have been surveyed in all three rounds. In other words, students in the two schools that were initially in the control group but that became part of treatment group in the 2010/2011 school year, grade 4 students in schools without grade 6, and drop-outs, grade repeaters and new students, are not included in this analysis. To the extent that the data allow, those left-out schools and students are included in the next section. For example, more than one-fourth of the English test questions asked for grades 4 and 5 in 2011 were same, so a weighted score for grade four students who are repeating the grade can be calculated. Initial results (given below) for students in grades two and three in 2009 suggest that students in program schools are less likely to repeat grade.

Table 15: Estimated Program Impact on Drop-out and Repetition

VARIABLES	**dropout**	**Repeat grade**
	(1)	(2)
Program indicator	**-0.062***	**-0.067*****
	(0.036)	(0.026)
Constant	0.313***	0.169***
	(0.028)	(0.019)
Observations	3,337	2,399

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

7.1 Grades 4, 5 and 8: Difference in Differences Estimation (baseline to year two)

As in Section 6.1, one way to estimate the impact of the program after two years of program implementation is to compare baseline and second year test scores of students who are

[9] The third round of data was collected at the beginning of the 2011/2012 academic year.

now in grades 4, 5 and 8. These students were in grades 2, 3 and 6 when the laptops were provided. The modified equation (5) is:

$$T = \beta_0 + \beta_1 Y_2 + \beta_2 P + \beta_3 Y_2{*}P + \beta_4 G_5 + \beta_5 G_8 + \beta_6 E + u \qquad (5')$$

where Y_2 indicates that the data for the end of year two (in fact the beginning of year 3). The descriptions of other variables were given in Section 6.1

A slight variation of the above equation is to separately estimate the impact of the program on English and Mathematics. The combined results and the subject-specific results are provided in Table 16.

Table 16: Estimation Results – Grades 4, 5 and 8 Normalized Test Scores (Baseline and Year Two)

VARIABLES	English and Math test scores	English test scores	Math test scores
	(1)	(2)	(3)
Year two test indicator	0.008	0.009	0.008
	(0.116)	(0.110)	(0.147)
Program school (vs. control)	0.109	0.286**	-0.051
	(0.144)	(0.144)	(0.163)
Year two test*program school	**-0.324***	**-0.408*****	**-0.244**
	(0.166)	(0.154)	(0.209)
Grade 5 indicator	0.039	0.048	0.034
	(0.052)	(0.060)	(0.067)
Grade 8 indicator	0.002	0.005	-0.000
	(0.104)	(0.116)	(0.110)
English	0.082		
	(0.053)		
Constant	0.034	-0.262	0.398**
	(0.180)	(0.204)	(0.166)
Observations	9,509	4,752	4,757
Number of School grades	162	162	162

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

The impact of the program is large (-0.32), negative and marginally significant when the test scores for English and math are combined, while the estimate is even more negative (-0.41) and statistically significant for English when the estimation is done separately for English and math. This result is consistent with those when the baseline and year one data were considered.

To see whether the impact of the program differs across grades, the model is estimated separately for each grade and subject. Table 17 provides these estimates.

Table 17: Grade-specific Estimation Results –English and Math Separately

	Normalized test scores (English)			Normalized test scores (Math)		
VARIABLES	**Grade 4**	**Grade 5**	**Grade 8**	**Grade 4**	**Grade 5**	**Grade 8**
	(1)	(2)	(3)	(4)	(5)	(6)
Year two test indicator	0.034	-0.000	-0.005	0.046	0.002	-0.017
	(0.206)	(0.106)	(0.174)	(0.202)	(0.257)	(0.216)
Program school (vs. control)	0.254	0.326*	0.235	-0.032	0.106	-0.309
	(0.188)	(0.178)	(0.248)	(0.192)	(0.245)	(0.236)
Year two test*program school	**-0.513****	**-0.460*****	**-0.245**	**-0.339**	**-0.372**	**-0.012**
	(0.245)	(0.175)	(0.260)	(0.264)	(0.330)	(0.357)
Constant	-0.298	-0.156	0.193	0.410**	0.376*	-0.109
	(0.252)	(0.177)	(0.196)	(0.197)	(0.207)	(0.227)
Observations	1,504	1,654	1,594	1,503	1,658	1,596
Number of Schools	62	60	40	62	60	40

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

Though the sign of the impact of the program on math test scores is negative, the results are not statistically significant. However, the program impact is statistically significant, negative and quite large (-0.51 and -0.46) for grades 4 and 5 English test scores.

7.2 Grades 4, 5, 6 and 8: Difference in Differences Estimation from Baseline to Year Two (within school comparisons)

In this subsection, students who are now in grade 6 are also considered. These are the students who were in grade 4 when the program was introduced. They were not provided with personal laptops for the first two years, that is when they were in grades 4 and 5. However, by the time the tests were administered in their schools, these students in the control group within program schools had been provided with laptops for about two months. When these students reached grade six, all students in grades two to six in program schools had laptops. Thus the within school and between school comparisons that also includes current grade six students should be interpreted slightly differently in this context. More specifically, the comparison in the program schools will be between those who have been exposed to computer assisted learning for more than two years and those with personal laptops for less than three months.

The program impacts will be estimated using two different methods. The first uses only students in the program schools, while all students in grades 4, 5, 6 and 8 in both program and comparison schools will be considered next. The equations of interest are:

$$T = \beta_0 + \beta_1 Y_2 + \beta_2 PG + \beta_3 Y_2{*}PG + \beta_4 E + u \qquad (6')$$

and

$$T = \beta_0 + \beta_1 Y_2 + \beta_2 PG + \beta_3 P + \beta_4 Y_2{*}PG + \beta_5 Y_2 P + \beta_6 PG{*}P + \beta_7 Y_2{*}PG{*}P + \beta_8 E + u \qquad (7')$$

The estimates of the program are given in Table 18:

Table 18: Estimation Results using Grade 6 (baseline and year 2)

	Program schools			All schools		
	Normalized Scores					
VARIABLES	Both	English	Math	Both	English	Math
	(1)	(2)	(3)	(4)	(5)	(6)
Year two test indicator	-0.053	0.063	-0.159	0.016	0.021	0.006
	(0.245)	(0.271)	(0.231)	(0.166)	(0.179)	(0.195)
Program grades	0.257	0.468**	0.060	0.019	0.034	-0.013
	(0.214)	(0.236)	(0.184)	(0.118)	(0.153)	(0.130)
Program school				-0.140	-0.187	-0.098
				(0.205)	(0.240)	(0.209)
Year two test*program grades	**-0.263**	**-0.462**	**-0.077**	-0.008	-0.013	0.002
	(0.274)	(0.308)	(0.260)	(0.147)	(0.178)	(0.169)
Year two test*program school				-0.068	0.042	-0.164
				(0.294)	(0.322)	(0.300)
Program school*program grades				0.258	0.477*	0.063
				(0.212)	(0.255)	(0.213)
Year two test*program grades*program school				**-0.256**	**-0.450**	**-0.079**
				(0.308)	(0.353)	(0.308)
English	0.116			0.048		
	(0.098)			(0.050)		
Constant	-0.361	-0.777**	0.197	0.052	-0.269	0.424**
	(0.324)	(0.327)	(0.287)	(0.195)	(0.231)	(0.193)
Observations	5,255	2,628	2,627	12,596	6,274	6,322
Number of School grades	93	93	93	206	206	206

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

None of estimates in the above table shows a statistically significant program impact. This is in contrast to the estimates from year 1 where there were negative program impacts for English. However, it needs to be noted here that the point estimates are similar to those in Table 11; the lack of significance is due to the imprecision of the estimates.

7.4 Change in test scores between Year -1 and Year 0 (Placebo Regression)

Since this study is not a randomized control trial, it is possible that the divergent trends in test scores for program and control schools are due to non-random selection of program schools. If so, one would expect to see this divergence before the program was impacted. For example, since the average test scores in program schools were higher than those of comparison school students, one could argue that the test scores in program schools would have decreased over time anyway, so the negative or no impact on test scores seen in this study is the result of the convergence of test scores. To address this concern, the normalized baseline test scores and the normalized final exam total scores obtained from the schools for the *preceding* academic year are compared. If the test scores between program and comparison schools had a divergent trend before the program started, the coefficient of the interaction term baseline test*program school should not be close to zero. The estimates are shown in Table 21.

Table 21: Estimation Results using Normalized Test Scores (Between Year -1 and Year 0)

	Normalized test scores		
VARIABLES	**English**	**Math**	**English and math combined**
	(1)	(2)	(3)
Baseline test indicator	-0.053	-0.069	-0.070
	(0.095)	(0.094)	(0.093)
Program school (vs. control)	0.268*	0.156	0.212
	(0.141)	(0.138)	(0.138)
Baseline test*program school	**-0.047**	**-0.194**	**-0.097**
	(0.146)	(0.156)	(0.147)
Constant	0.073	0.336***	0.179
	(0.145)	(0.117)	(0.133)
Observations	10,640	10,750	10,460
Number of school grades	238	238	238

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

It is reassuring to see that the interaction term is not statistically significant on any of the regressions run here. Furthermore, the fact that the coefficient of the interaction term is close to zero in column (3) in Table 21 suggests that the slope of the test scores was similar in the program and comparison schools before the program was launched. In other words, a convergence of test scores before the program started is not likely to be the source of change that is seen in student learning between year 0 and year 1 (and year 2) in the program and comparison groups.

7.5 Further discussion on impact of program by type of students and schools

One could argue that the program impact differs across students. For example, the OLPC impact may be larger for students at either the top or bottom of their classes. Others may argue that the impact may be seen on students who have taken advantage of the digital materials in the laptops. This sub-section focuses on these sub-groups of population.

Table 22 shows the estimates of the program impact separately for the top and bottom twenty percent of the students. This categorization of students is based on the baseline test scores in English from 2009.[10] Schools that had less than five students in one grade, which included control schools in Mustang district, and students with no baseline test scores in English are dropped from the analysis. In order to minimize attrition bias resulting from involuntarily leaving the school after grade 5, only grade four and five students in 2011 are considered in the analysis here.

[10] Since not all students have baseline test scores for both English and math and the program impact was more pronounced in English, the categorization was based on baseline English test scores.

Table 22: Estimation Results by Quintile of Test Scores (Baseline and Year two)

VARIABLES	Normalized test scores					
	Top quintile		Middle quintile		Bottom quintile	
	Both English and math	English	Both English and math	English	Both English and math	English
	(1)	(2)	(3)	(4)	(5)	(6)
Year two test indicator	-0.382***	-0.584***	0.076	-0.025	0.350*	0.580***
	(0.140)	(0.136)	(0.166)	(0.153)	(0.191)	(0.179)
Program school	0.139	0.211	0.159	0.251	0.327	0.494**
	(0.166)	(0.160)	(0.189)	(0.180)	(0.206)	(0.206)
Year two test*program school	**-0.229**	**-0.241**	**-0.451****	**-0.399****	**-0.405**	**-0.545****
	(0.175)	(0.165)	(0.215)	(0.197)	(0.259)	(0.230)
Grade 5 indicator	0.224***	0.224***	-0.036	-0.055	0.092	0.077
	(0.081)	(0.086)	(0.077)	(0.087)	(0.075)	(0.075)
English	0.373***		0.073		-0.305***	
	(0.069)		(0.076)		(0.062)	
Constant	0.372**	0.444**	-0.191	-0.348*	-0.716***	-1.436***
	(0.173)	(0.190)	(0.169)	(0.190)	(0.219)	(0.221)
Observations	1,202	607	1,209	611	1,104	564
Number of school grades	110	110	110	110	104	104

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

The negative impact of the program is more pronounced for students who were near the average or bottom in the baseline English tests. For the students in the top quintile, the impact of the program was smaller and not statistically significant.

One would also expect that students who had regularly referred to the educational materials developed by OLE Nepal are more likely to have improved their test scores. In order to test this assertion, only students who said they used, on average, digital materials prepared by OLE Nepal more than once were included in the sample and compared with comparison school students. The estimates are provided in Table 23. There still exists negative program impact on student test scores. In fact, the coefficient is slightly larger than from the one with all students.

Table 23: Estimation Results Comparing Students Who Used Digital Materials Developed by OLE Nepal More Than Once (Baseline and Year two)

VARIABLES	Normalized test scores		
	Both English and math	English	Math
	(1)	(2)	(3)
Year two indicator	0.019	0.016	0.022
	(0.141)	(0.135)	(0.177)
Program school	0.171	0.297*	0.069
	(0.168)	(0.168)	(0.193)
Year two test*program school	**-0.355***	**-0.434****	**-0.279**
	(0.187)	(0.173)	(0.238)
Grade 5 indicator	0.017	0.019	0.022
	(0.058)	(0.069)	(0.072)
English	0.021		
	(0.058)		
Constant	0.061	-0.245	0.386**
	(0.188)	(0.211)	(0.180)
Observations	4,710	2,346	2,364
Number of school grades	117	117	117

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

Similar results were obtained after ignoring all the schools from two districts (Mustang and Lalitpur) that supposedly did not have comparable control schools.

However, removing schools from two districts that did not allow students to take laptops home provided different results (statistically insignificant but positive for Math), as indicated in Table 24. It is tempting to suggest that students do well if students are allowed to take laptops home. However, since these two districts are very different from the other program districts, additional information would be required to reach a firm conclusion on this issue.

Table 24: Estimation Results Excluding Districts that did not Allow Students to take Laptops Home (Baseline and Year two)

VARIABLES	Normalized test scores		
	Both English and math	English	Math
	(1)	(2)	(3)
Year two test indicator	0.027	0.030	0.022
	(0.133)	(0.110)	(0.172)
Program school	-0.380**	-0.032	-0.723***
	(0.193)	(0.200)	(0.229)
Year two test* program school	**0.102**	**-0.242**	**0.448**
	(0.242)	(0.206)	(0.337)
Grade 5 indicator	-0.019	-0.078	0.047
	(0.083)	(0.084)	(0.120)
English	0.122		
	(0.127)		
Constant	-0.274	-0.529***	0.096
	(0.187)	(0.191)	(0.167)
Observations	2,452	1,224	1,228
Number of School grades	65	65	65

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

8. Possible Reasons for No Effect (or Negative Effects) on Test Scores

Before the program was implemented, the expectation was that there would be a large positive impact of the laptop provision on students' test scores. In fact, the expectation was that the impact would be at least 0.32 standard deviations of the distribution of test scores, the impact that Banerjee et al. found in their computer use study in India. The results, however, suggest that there was no statistically significant effect on math test scores, and a large and statistically significant *negative* impact on English test scores. This is surprising because many of the digital materials in the computers developed by education experts at OLE Nepal are in English. If the digital materials are not catering to the interests and needs of the students, teachers may not integrate them into their classroom teachings and students may not refer to them. Furthermore, if these materials are not of high quality, there may not be much improvement in student learning.

Yet, both teachers and students in both the year one and year two surveys said that they liked the digital contents. The teachers also felt that the interests, level and capacity of the students were taken into account in the development of these digital materials. All the teachers surveyed in year two reported that they found help files, lesson descriptions, lesson plans, exercises and lessons in the digital materials useful. The results from the year one survey are also very similar. The teachers in the test schools were extensively consulted while developing the initial digital contents (during the academic year 2008/09). This suggests that the quality of the materials is highly unlikely to be the cause of the lack of positive program impact. Other possible reasons, which are admittedly speculative in nature, for this unexpected result are explored here.

Playing games

If the students with laptops are spending more time on games and other academically unproductive activities and thereby focusing less on materials that help with their studies, the provision of laptops could have a negative impact on student test scores. Since the log files in individual laptops, which have details on how the computer was used, could not be obtained despite several attempts, it is difficult to ascertain the extent of the problem. The self-reported responses by teachers and students, which should be taken with a grain of salt, do provide some indication on laptop use. When the students were asked about the activities they engage most in their laptops, only two-thirds of the students in grades 4 and 5 in year two said that they use it to read educational digital materials developed by OLE Nepal and other books in the e-library. For a self-reported figure, this is a fairly low proportion. When the same question was asked about their closest friend in the class, 59% responded that their friends use it for digital educational contents and e-library books. Almost a quarter of the students said that both they and their best friends use the computer to play games and take pictures. These responses suggest that the “dosage” of the program may have been inadequate. If the students do not use the digital educational materials in the computer extensively, the impact of laptop on student learning could be minimal and if they instead spent time engaging in educationally unproductive activities, the effect could even be negative.

Program Duration

The other equally conceivable reason for the results we obtained, at least for the first year, is that it takes time to have a positive impact on student performance. Five to eight months of computer use may have been too short a time to see a noticeable change in students’ academic performance. In the short-run, it is likely that students’ performance could deteriorate, especially if students and teachers alike are having a difficult time adjusting to the new technology and teaching-learning approach. However, the fact that the program impact is still negative in the second year suggests that this is not a major driving force behind the negative results.

Timing of Tests

One could argue that the way the tests and surveys were administered may have contributed to the results. Because of the way the survey had to be conducted, students in some schools were exposed for up to one month of computer use before the baseline tests. It is likely that these students were very eager to check educational materials beforehand, which may have resulted in higher baseline English test scores in grades two, three and six in program schools. However, the fact that program impact from year 1 to year 2 was also not positive and that baseline Nepali test scores were similarly distributed (higher in program schools) makes this argument less convincing because the Nepali materials included in the laptop were not very well developed. Moreover, school-administered final exam scores for the year before the baseline survey was conducted (details in Appendix A) also suggest that students in program schools are academically better than in comparison groups. Though the exam papers differed between schools and were graded by the school teachers themselves, there was nothing that suggested that program school exams were easier or were graded leniently.

Variation in exam difficulty

Looking at the absolute test scores for students in both program and comparison schools, the year-end exams appear to have been harder since the average test scores (in percentage terms) were lower during year-end exams. One could argue that this discrepancy may have disproportionately hurt the students in program schools. The argument is as follows: the baseline tests were relatively easy, so the students in program schools were able to answer more of those questions. However, since the year-end exams were relatively difficult, even students in program schools had a hard time answering them correctly. This may have led to a spurious convergence of test scores between program and comparison schools. To address this concern, questions that were deemed hard were removed from the year two exams and the main regressions were estimated again. The fact that there still was no positive program impact in second year suggests that a hard exam was not the primary reason behind students in program schools not performing well in their year-end exams.

Convergence of scores

On a related note, since the baseline test scores of program school students, on average, were higher than those of comparison school students, one could argue that the test scores would have converged anyway. The negative impact of the program could partly be explained by this phenomenon. Yet the argument would have been more convincing if the impact of the program had been similar in both English and math (that is both of them were negative). The estimates from Section 7.4 also suggest that convergence in test scores is probably not the main reason behind the lack of a positive program impact.

Not teaching to the test

The tests that were administered to students were based on the national curriculum. One possible explanation for the discrepancy in test scores between program and comparison schools seen in the data is that the digital materials developed by OLE Nepal are comprehensive and are not necessarily focusing on ‘teaching to the tests’. If there were positive effects in dimensions other than those based on national curriculum, the true impact of the program may be underestimated. For example, most teachers in program schools opined that students’ English speaking skills have improved after the program was implemented. The tests given to students did not include any questions on students’ pronunciation skills. To address this concern, a separate ‘standardized’ exam and speaking test could be given to students.

More questions on non-cognitive skills that are likely to vary across students could also be included in subsequent rounds of data collection. One additional simple test was administered in the third round of survey. In that round, students were asked to write down as many words starting with R in the allocated two minutes. Column (1) in Table 25 indicates whether the scores for grades four and five students were different in program and comparison schools. Though the coefficient on program school indicator is positive and greater than the coefficient on normalized English score (year two), it is not statistically significant. Moreover, the positive coefficient may just reflect the fact that program school students were, on average, better than the comparison school students. In fact, Column (3) indicates that the average baseline English test score of students in the program schools was much higher than those of comparison school students. In light of these facts, the evidence is insufficient to suggest that program school students improved their vocabulary.

Table 25: Estimation Results Comparing Normalized R Word Score with Normalized English Test Scores in baseline and Year Two

VARIABLES	Normalized R word score (year two)	Normalized English score (year two)	Normalized English score (baseline)
	(1)	(2)	(3)
Program school indicator	**0.158**	**0.014**	**0.459****
	(0.208)	(0.222)	(0.204)
Grade 3 indicator	0.172	0.039	0.048
	(0.125)	(0.096)	(0.102)
Constant	0.089	0.129	0.085
	(0.144)	(0.164)	(0.135)
Observations	1,159	1,164	1,164
Number of school grades	109	110	110

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

Teachers' focus on non-program grades

Similarly, it is possible that teachers may have taken equity considerations into account. If teachers believed that Computer Assisted Learning (CAL) would increase student learning, they may have focused their teaching on other grades that do not have computers. However, the data from the teacher's survey in 2011 provides some evidence that this is not the case. When the teachers teaching English and math were asked to report the grade they devote the most time teaching (both preparation and in-class instruction time), the responses of teachers in program and comparison schools are very similar (the difference is not significant). The estimation results are shown in Appendix D.

Not addressing increased workload on teachers

One of the main stakeholders who must be persuaded to make the program effective is teachers. Without their active support, this program would not reap the full benefit of the initiative. It is possible that teachers have resisted implementing new instructional practices because this innovation increased the complexity of a teacher's work life by expecting them to use different instructional materials, new teaching methods and learning new curriculum (Chapman and Mahlck, 2004). Most teachers who were surveyed said that their workload increased significantly. It is reasonable to assume that they reverted, to a large extent, to traditional ways of teaching and ignored the materials in the laptop. Under such circumstances, the effect of laptops with educational content on student learning would be minimal.

Inadequate teacher training

One goal of the OLPC program in Nepal was to train teachers teaching laptop-integrated classes. The belief was that with adequate training, teachers may be comfortable integrating the curriculum based digital materials into their teaching. However, twenty-five percent (27 teachers) surveyed in year two reported not taking that original training[11] and a vast majority of these 27 teachers also did not attend the refresher training. Of those teachers who attended the training, roughly one-third said that the training was inadequate. This is indeed a serious concern. If more than half of the teachers teaching laptop integrated classes either had no training to teach the laptop integrated classes effectively or deemed their training to be inadequate, it is not surprising that the effect is small or nonexistent.

Monitoring of the extent to which teachers are translating what they learned about ICT-integrated teaching during their teacher training into classroom teaching has not yet been done properly. If teachers do not substantially change their teaching styles, their students' learning outcomes may not significantly increase. A stronger teacher support mechanism that monitors as well as provides feedback on how to effectively integrate laptops in classrooms may be needed.

[11] The program did train an adequate number of teachers from each school. But in some schools, untrained teachers were assigned to teach ICT-integrated classes.

Structure of lessons inconsistent with use of technology in teaching

As has been repeatedly mentioned in this paper, the digital materials developed by OLE Nepal are interactive in nature. The expectation is that students will find this aspect enjoyable and informative, hence they will use the digital materials regularly. However, the education system in Nepal that emphasizes rote learning may be inconsistent with the use of information technology in teaching. One can therefore make a reasonable claim that the present institutional framework is not suited to ensuring effectiveness of OLPC and similar programs.

To summarize, of all the "conjectures" mentioned here, students playing games, not addressing increased workload on teachers, inadequate teacher training, and structure of lessons inconsistent with use of technology in teaching are still plausible explanations for no positive effect of OLPC program on student test scores.

8.1 Possible Reasons for High Grade Four English Test Scores

In Table 4B, the average normalized English test scores for grade 4 students in the program schools were lower in the baseline tests, but higher for the year-end tests. Since grade four students were not provided laptops, one would expect the baseline and year-end test score differences between program and comparison schools to be statistically insignificant. However, the results suggest that laptop provision at the school level has had a positive effect on grade 4 student test scores in treatment schools in English (shown in Table 11). Possible reasons for this increase in test scores are spillover effects and limited distraction from using academically unproductive materials in computers. Among teachers who were surveyed in the second round (78), 42% of them said that they sometimes used the laptops and digital materials developed for grades 2, 3 and 6 to teach students in other grades, including students in grade 4. These superior materials, coupled with the fact that grade four students have limited computer access, may have meant that there was a more focused use of computers for academic purposes.

If grade 4 students in program schools had siblings studying in grades 2, 3 or 6 in the same school, they were likely to have access to those laptops at home. In order to test whether the test scores of grade 4 students with siblings in grades 2, 3 or 6 were different from those students who did not have siblings in these grades, the following variant of equation (5) was estimated for grade 4 students in program schools:

$$T = \beta_0 + \beta_1 Y_1 + \beta_2\, SPG + \beta_3\, Y_1 * SPG + \beta_6 E + u \qquad (5''')$$

where SPG indicates whether the grade 4 student had siblings in grade 2, 3 or 6 (program grades). The results are provided in Table 26. It appears the test scores of grade 4 students in program schools did not depend on whether their siblings were in the program grades in their schools.

Table 26: Estimation Results Comparing Program School Grade 4 Students Who Have and Do Not Have Siblings in Program Grades

VARIABLES	**Normalized test score**
Year-end test indicator	0.051
	(0.110)
Siblings in program grades	0.031
	(0.067)
Year-end test*siblings in program grades	**-0.074**
	(0.101)
English	-0.004
	(0.092)
Constant	-0.012
	(0.167)
Observations	1,642
Number of schools	22

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

It is also possible that curriculum in grade 4 emphasized English. If that's the case, one could see year-end test scores in English for grade 4 higher than for other grades. Since English test scores for grade 4 students in both treatment and control schools should increase, this emphasis does not convincingly explain the observation that grade 4 students in program schools performed better than students in comparison schools.

The other possibility is that the grade 4 students in program schools may have become more motivated to work harder since they were denied laptops, commonly known as the John Henry effect in the literature. If this were the case, there should be program effects in both English and math. Considering the fact that the difference in math scores between baseline and year-end in both the program and comparison groups is not significant, this possibility seems unlikely.

8.2 Further Discussion

The second and third rounds of data collection revealed areas that need to be improved. The majority (59%) of teachers who were surveyed said that the 10-day residential and in-school training given at the beginning of school year was insufficient to enable them to properly integrate laptops into the regular classroom instruction process. If teachers are not confident that they can use computers effectively, they may decide not to use them in the classroom. Furthermore, 79% of teachers indicated that their workload increased after the program was introduced. This is a matter of serious concern. If the teachers continue to feel that laptop provision has increased their workload unnecessarily, there is a danger that they may minimize the use of laptop-integrated instruction in regular teaching once the initial enthusiasm of receiving laptops fades away. Steps to reduce workload and encourage laptop use in classrooms need to be devised carefully. One option is to accept as reality that teacher workload is bound to increase so compensate teachers for the extra work they put it. If necessary, some performance indicators may be tied to compensation. However, providing incentives to teachers might not be very feasible. For example, one needs to agree on the format of the payment scale. The decision also needs to be made on whether to compensate all the teachers in a given school or only the teachers teaching certain subjects (and the head teacher). The latter option will substantially reduce the cost, but might also create conflict among teachers. Moreover, since the cost of this initiative is already very high, it may make more sense to explore other alternatives. There are many ways to make teachers' lives easier in classrooms, such as better integration of textbook and digital materials in the laptop, including 'sample' lesson plans for at least those lectures that use activities developed by OLE Nepal which teachers can follow if they prefer. Providing refresher trainings to teachers on a regular basis on different ways to use laptops/digital materials and the concerns of teachers are addressed, or facilitating support groups for laptop using teachers to figure out how best to use the digital materials, are other alternatives. To a large extent, OLE Nepal has adopted these measures, but apparently with little success. Hiring additional teachers to compensate for the additional workload to spread the increased workload among more teachers may be a way to circumvent providing bonuses to teachers. This obviously also has cost implications, but it may be required to encourage teachers to use digital materials in classrooms and improve student performance.

One channel through which provision of laptops could improve student test scores is the opportunity to independently play with the high-quality, curriculum-specific digital learning materials installed in the laptops. It was expected that students would benefit from reviewing these materials at their own pace and as many times as needed. In general, it was expected that students would review each digital exercise multiple times both during the ICT-integrated classes and at home. However, 33% of the grade six students who were surveyed in year 1 reported that they have not used digital materials prepared by OLE Nepal more than once outside of the classroom. This tendency appears not to have decreased in year two. Forty-three percent of grade 4 and 5 students in year 2 said that they examine digital materials only once outside of classrooms. This low level of usage is an important potential explanation for the observed ineffectiveness of program in raising student test scores.

8.3 Maintenance and repair of laptops

Out of the 906 students in grades 4 and 5 who were surveyed in 2011, 126 (14%) mentioned that their laptops had stopped working at least once. Nineteen percent of those that had broken laptops said this happened as a result of their dropping the laptops accidentally, while another fifteen percent said it was the result of the students falling down or someone stepping on the laptops. Twenty-three of the students (206) reported that they were having some problems with their laptops at the time of the survey.

Of the 28 schools that have the OLPC program, 18 reported that they have encountered instances where laptops have stopped working. The details on the number of laptops that have stopped working are given in Table 27.

Table 27: Details on Laptops that have Stopped Working

Number of laptops that stopped working	Number of schools that had ever had this problem	Number of schools that currently has this problem
1-5 laptops	12	10
6-15 laptops	4	2
16-65 laptops	4	4

When the schools were asked how long it took for the broken laptop to be repaired, slightly more than half (15) schools said it took at least 5 weeks on average to repair the laptops. Eight reported this number to be more than 10 weeks. These delays in maintenance may have dissuaded teachers from regularly using the OLPC laptops in classrooms.

In contrast, few laptops were lost in the last two years. Only fourteen laptops from five schools have been reported lost or stolen. Eleven students from four schools who have either left the school or are in non-laptop integrated classes had not returned laptops at the time of the survey.

9. Impact of the program on other outcomes

One could make a very compelling case that there are other things besides test scores that are affected by computer assisted instruction and learning. This section deals with some of these outcomes.

9.1 Non-cognitive Skills

This mode of teaching may have profound impacts on the intrinsic motivation, which is one aspect of the more general concept of non-cognitive skills. Unfortunately, there are no universally accepted standardized measures to capture these skills. Because these skills are largely based on perceptions, care should be taken when making comparisons. The fact that teachers in Nepal regularly teach more than one grade in a given academic year allows one to take into account the personal biases of the respondents. Teachers who taught both grades 3 and 4 during the 2009/10 academic year were asked to rate their students in these grades on various non-cognitive skills questions. Since the program school teachers would be rating one grade that is exposed to the program (grade 3) and another grade that is not provided with laptops (grade 4), comparing their ratings for grade 3 students against grade 4 students should indicate the impact of the OLPC program on non-cognitive skills.

As mentioned in Section 6.2, during the year-end survey, four questions related to intrinsic motivation of students in grades 3 and 4 were posed to the teachers: interest in studies, discipline, how well the student got along with others, and their confidence level. The teachers were asked to compare the extent of the change in these aspects at the beginning of the academic year (when the laptops had not yet been given to the students). They were to circle one of the three options: increased (3), about the same (2) or decreased (1).[12]

This model takes advantage of this information to estimate

$$NS = \beta_0 + \beta_1 G_3 + \beta_2 P + \beta_3 Gender + \beta_4 Gender*P + \beta_5 P*G_3 + u \qquad (8)$$

where NS indicates an non-cognitive skills. An ordered logit specification that allowed school level clustering of the error terms was used to estimate the impact of the program on non-cognitive skills. Since a higher rating meant that student's intrinsic motivation improved as the year progressed, a statistically significant positive coefficient would signify a positive impact of the program on these sets of non-cognitive skills.

Table 28 provides the estimates for equation (8) using data on grade 3 and 4 students:

Table 28: Estimates for Non-cognitive Skills

VARIABLES	**Interest in studies**	**Discipline**	**Getting Along**	**Self-confidence**	**Average of all four**
	(1)	(2)	(3)	(4)	(5)
Grade 3 indicator	-0.010	-0.139	0.035	-0.321	-0.129
	(0.163)	(0.295)	(0.347)	(0.299)	(0.260)
Program school	0.365	0.585*	0.334	0.209	0.441
	(0.308)	(0.351)	(0.372)	(0.344)	(0.366)
Program school*grade 3	**0.307**	**0.125**	**0.217**	**0.603**	**0.394**
	(0.295)	(0.396)	(0.438)	(0.468)	(0.394)
Observations	3,292	3,292	3,292	3,292	3,292

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

When the clustered nature of the data is taken into account, the effect is not statistically significant. However, if clusters are ignored, there are statistically significant positive impacts (positive sign of the interaction term program school*grade 3) on interest in studies and students' self confidence. The last column takes the average of all four questions. The resulting coefficient is still not statistically significant.

9.2 Perception of the Program

Although the effect of computer assisted learning on student test scores has thus far been discouraging, students and teachers in program schools appear to be very satisfied with the program. Seventy-seven of the seventy-eight teachers surveyed in the program schools in five districts in year one said that the computer has made teaching much easier, and that it helps students to understand difficult concepts.[13] The teachers also perceive that providing laptops to students has increased school attendance. The vast majority of the students in both year one and year two said that the computer is easy to use and that they now find it easier to understand the subject matter being taught. These questions were asked of students in grades 2, 3 and 6 in year one, and grades 4 and 5 in year two. The details are provided in the table below. Out of 906 students with laptops in grades 4 and 5 in year two, 862 (95%) say the laptops are easy to use and 93% say that they can use it well. Almost all of them reported that they know how to use educational materials developed by OLE Nepal and said that it is now easier for them to understand what has been taught. The overwhelming majority say that study is now more enjoyable and that they are now more motivated to study harder. The positive responses in the year one survey provided some hope that the lack of measurable positive impact on student

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[12] In the questionnaire, 1 signified increase while 3 indicated decreased. The recoding was done here to make it less confusing.

[13] These questions were not asked for teachers and students in Mustang district in year one. Since Mustang follows a different academic calendar, student and teacher surveys were not ready then.

learning may a result of temporary disruption in teaching and learning. Unfortunately, these positive perceptions of the program have yet to be transformed into higher student test scores.

Table 29: Program School Students' Perception of the Program

	Percentage of students who said yes	
	Year 1	Year 2
The computer is easy to use	98.1%	95.1%
It is now easier to understand what is being taught	95.5%	96.2%
It is now more enjoyable to study	93.9%	94.9%

9.3 Spillover Effects

Though the laptops are given to individual students, other family members are also using the laptops and benefitting from their use. In the second round of the survey, almost 70% of grade two and three students, and more than 80% of the grade six students, who were surveyed said that at least one other family member uses their laptop at home. In the third round of the survey, 63% of the grade 4 and 5 students reported that others in their family also use their laptops. Their siblings are the ones who use their laptops the most. Forty-nine percent in year two said that they have taught their parents to use the computer. During teacher training, and in subsequent interactions with teachers and students, OLE Nepal has repeatedly emphasized that both teachers and students should encourage their friends and family members to use the laptops. Their philosophy was that expanding the user base for the laptops would positively contribute to the educational environment of the whole family and community. The findings discussed above suggest that the laptops are indeed having a significant positive spillover effect as envisioned by the program. However, there has been no spillover onto test scores yet. The test scores of grade 4 students in program schools who have siblings with laptops were not statistically different from those without siblings with laptops, as shown in Table 26.

9.4 E-library and Students' Reading Habits

The e-library (http://www.pustakalaya.org/) developed by OLE Nepal provides access to a decent collection of children's literature (both Nepali and English), other books, interactive educational software and other multimedia materials. As a copy of the e-library is installed locally in a server in each program school, students in these schools can access the e-library wirelessly from their individual laptops. The school server (XS) is also a repository for all the digital materials developed by OLE Nepal, and new materials can be remotely transferred to the server. This way, internet access will not be needed; students who want to read those materials can easily read them.[14] During the 2011 survey, 24 schools reported they were able to access the e-library, of which 20 said it is fairly regular.

A quarter of the grade four and five students in program schools in 2011 said that they regularly used the e-library, and a further 55% reported sometimes using the e-library. About one-third of the students said that they have read five or more books from the e-library. The reading habits of grade 4 and 5 students in program schools appear to be different from that of students in the control schools. In the program schools, students on average read 5.1 books besides textbooks while the corresponding number was 3.3 in the control schools. However, the reading habits of grade 4 and 6 students appeared to be different even during the baseline survey in 2009[15]. When these students were asked whether they have read books other than textbooks, 78% of the program school's grade 4 and 6 students stated an affirmative response. The

[14] In 2011, twelve schools out of twenty-eight program schools reported that they had internet connection in school, of which five said it is regular. Another eight stated that they had previously had internet access, but no longer had it.

[15] Since the students who were now in grades 4 and 5 in 2011 were in grades 2 and 3 in 2009, a decision was made not to ask the questions on books other than textbooks because of the concern that they would not be able to distinguish textbooks and other books.

corresponding figure for comparison school students was 66%. There is not sufficient evidence to suggest that the reading habits of students who received laptops improved.

9.5 Students' Computer Skills

Twenty-four percent of the students in grade 4 and 5 in program schools in 2011 say they can use the internet well, while only two percent say so among students in comparison schools. Similarly, 66 % of the program school students said they type well while only 9% said so in comparison schools. Eighty-nine of the program school students say they know how to use a computer—the corresponding figure for comparison school students is 15%. Though the benefits of these skills in the immediate future are unknown, one would expect these sets of skills to be useful later in life. However, assessing the benefits of these potential gains is beyond the scope of this paper.

10. Conclusion

Both the second and third rounds of the data suggest that the first two years of exposure to computer assisted learning in Nepal has had no statistically significant positive impact on student learning, non-cognitive skills or attendance as reported in school records. However, the perceptions of the teachers and students in the program schools, and anecdotal evidence based on field visits, suggest that there could be positive effects of the program that this study has failed to capture.

For the OLPC Nepal program to have an impact on student learning, three disturbing aspects seen in the second and third round should be minimized. First preliminary evidence suggest that many students may be spending more time playing games on the computers rather than reading educational materials on their laptops. When that happens, the goal of improving student learning may be defeated. In addition, students also are not referring to the digital materials as intensively as required. A significant percentage of students in program schools stated that they have used each of those materials developed by OLE Nepal only once. This raises the possibility that while the content provided by the program might even be adequate, the program "dosage" consumed by the students is not adequate.

Second, teachers play a crucial role in making the OLPC program a success. Though almost all of the teachers in the survey state that they believe the program has helped improve student learning, some anecdotal evidence suggests that either the teachers have not yet bought in to the program or that they have not fully understood their role in the program. The major complaint, based on informal discussions with the author, appears to be that they are not being compensated for the extra effort they put into the program. Though OLE Nepal has taken ample steps to minimize the effort exerted by teachers, it cannot be denied that their workload, either perceived or actual, has increased after the introduction of this program.

Similarly, more than 25% of the teachers assigned to teach laptop integrated classes in program schools in the second year of the program had not taken the training on how to integrate laptops into their daily teaching. Likely reasons include that the school administrators did not believe that the training was essential to teach these classes effectively, or that the teachers who took the training the previous year did not want to teach those classes the following year. The fact that many teachers had no training on computer assisted learning, and the increase in teachers' workloads, may have led to less use of digital materials in the classroom. If teachers had encouraged students to regularly refer to digital materials, ensured that students were reviewing the digital materials multiple times, or had overseen whether the students were in fact using the laptops for educational purposes, the educational outcomes may have been different, other things equal.

Thirdly, the organization implementing the OLPC program in Nepal should increase the frequency of their contact with individual teachers in program schools. This would serve two major purposes. The organization would not only understand realities on the ground better, but it also would allow OLE Nepal to address maintenance issues more promptly. Many schools appeared to be unhappy with the maintenance structure in place. As the computers get old, maintenance problems are bound to increase. The program implementing agency may also want to look at ways to reward teachers for their extra effort.

The results suggest that the OLPC model is not the best approach to improve primary education in public schools in Nepal. However, if policymakers in Nepal and elsewhere are convinced that digital devices are the future for improving educational outcomes, then other alternatives such as computer labs and eReaders should also be explored.[16] One concern with the OLPC program is that students may be spending large amounts of time on video games and other educationally unproductive activities. This problem could be avoided to a large extent with computer labs and eReaders. Installing games on eReaders is not easy, and computer labs can be better monitored to ensure students do not spend large amounts of time on educationally unproductive activities. In addition, because these alternatives, especially computer labs which can be shared by many grades, are less costly than the OLPC program, more schools could be served for the given amount of resources.

[16] The author is involved in the on-going evaluation of the eReader intervention in Nigeria. Students in Junior Secondary Level in Lagos received eReaders in August 2011.

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Appendix A: Pre-baseline Normalized Test Scores

Normalized average test score: total	Pre-baseline Program Schools Mean	obs	Comparison Schools Mean	obs
Students in grade two	0.43	427	0	826
Students in grade three	0.32	480	0	885
Students in grade four	0.18	553	0	1016
Students in grade six	0.430	428	0	713

Appendix B: Student Responses for Various Non-Cognitive Skills questions (Baseline)[17]

	Baseline (control)				Baseline (program)			
	grade 2	grade 3	grade 4	grade 6	grade 2	grade 3	grade 4	grade 6
Enjoy going to school	(626)	(688)	(718)	(478)	(459)	(475)	(464)	(446)
Always	70%	75%	71%	78%	73%	73%	66%	83%
Mostly	27%	22%	27%	17%	24%	25%	32%	15%
Sometimes	1%	2%	1%	3%	2%	2%	2%	0%
Not really	1%	1%	0%	1%	1%	0%	0%	1%
Get along with others to study and play								
Always	61%	64%	62%	70%	65%	59%	57%	77%
Mostly	29%	32%	34%	24%	28%	35%	32%	18%
Sometimes	9%	3%	4%	5%	6%	7%	9%	4%
Not really	1%	1%	0%	1%	1%	0%	1%	1%

[17] The number of responses from each grade are given in parentheses.

Appendix C: Student Responses for Various Non-Cognitive Skills questions (Year-end)[18]

	Year-end (control)				Year-end (program)			
	grade 2	grade 3	grade 4	grade 6	grade 2	grade 3	grade 4	grade 6
Enjoy going to school	(560)	(615)	(657)	(456)	(365)	(387)	(370)	(303)
Always	63%	49%	80%	76%	65%	65%	75%	76%
Mostly	32%	46%	18%	21%	35%	32%	23%	22%
Sometimes	4%	4%	2%	2%	0%	2%	1%	1%
Not really	0%	1%	0%	1%	0%	1%	1%	0%
Get along with others to study and play								
Always	52%	36%	63%	66%	49%	60%	49%	65%
Mostly	37%	47%	28%	22%	41%	31%	44%	24%
Sometimes	10%	15%	9%	10%	7%	7%	5%	9%
Not really	1%	2%	1%	2%	2%	1%	2%	2%

Appendix D: Estimated Program Impact on Teachers' Spending More or Less Time in Program Grades

VARIABLES	(1) **Most time in program grades**	(2) **Least time in program grades**
Program school indicator	**-0.115**	**-0.089**
	(0.146)	(0.133)
Constant	0.059	0.334***
	(0.104)	(0.100)
Observations	283	283

[18] The number of responses from each grade are given in parentheses.