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Computers and Student Performance in Thailand

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Abstract

This paper examines the effects of computer use at home and in the classroom on students' performance in Thailand, as measured by science, mathematics, and reading scores available in the 2009 OECD Programme for International Student Assessment (PISA). We find that the impact of using computers at home depends on the type and the intensity of computer activities. Playing games *excessively* can reduce students' performance scores in science subject, while *frequent* browsing of the Internet for schoolwork has a positive impact on students' achievement. We do not find any positive effects on the examination scores from computer use in the classroom. In fact, students who used computers in their classes performed significantly worse than those who did not. Our results raise doubts regarding the effectiveness of the Thai government's policy to increase students' performance via providing schools with Internet and computers. Apparently more work is needed in finding the right approach to make computers a more effective educational tool in the classrooms.

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1. Introduction

Education is important at both micro and macro levels. At the individual (micro) level, enhanced human capital promises higher earnings and better prospects of more rewarding careers; it helps people escape from poverty trap and offers greater social mobility to segments of the population who still remain on the lowest level of the development ladder. At the macro level, education is essential for economic growth. In addition, education helps create an informed and knowledgeable middle class that is considered a driving force for constructive political reforms, particularly in developing countries.

Many countries have taken steps in making education a priority, including Thailand. Thai government has been devoting large shares of its national budget to spending on education. According to the World Bank, it constitutes around 4.1% of the Thai GDP and 20.3% of its government budget, which is well above what its neighbors spend in this sector (China 13%, Indonesia 17.1%, Malaysia 18.9%, and the Philippines 15%).[1] However, according to *The Economist* magazine (June 16th, 2012), the quality of education in Thailand has been deteriorating over the past decade. Even though the education budget has doubled and more children are now attending schools, the performance of Thai students in core subjects has been either stagnant or falling. According to the article, in the Global Competitiveness Report 2011-2012, the World Economic Forum ranked Thailand 83rd in its "health and primary education" indicator, which is below its lower income neighbors, Vietnam and Indonesia. The recent *Trends in International Mathematics and Science Study* (TIMSS) shows that Thai students' test scores have been deteriorating over time and are presently at a lower level than other neighboring countries (Siamwala et.al, 2011).

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[1] Source: http://data.worldbank.org/indicator/SE.XPD.TOTL.GB.ZS .

Figures 1-3 below show the mean scores of Thai students compared to those of students from OECD (Organization for Economic Co-operation and Development), Asian and developing countries in core subjects (science, mathematics, and reading) calculated from the data available in the OECD Programme for International Student Assessment (PISA). As evident, Thai students have been performing poorly on international standardized tests compared to students from other countries; in addition, in absolute terms there was almost no improvement in their scores despite the above-mentioned increases in educational spending. These developments are at odds when compared with other South East Asian countries, like Indonesia, that have recently seen steady improvements in students' scores in all core subjects.

Figure 1

PISA Scores Showing Students' Performance in Science

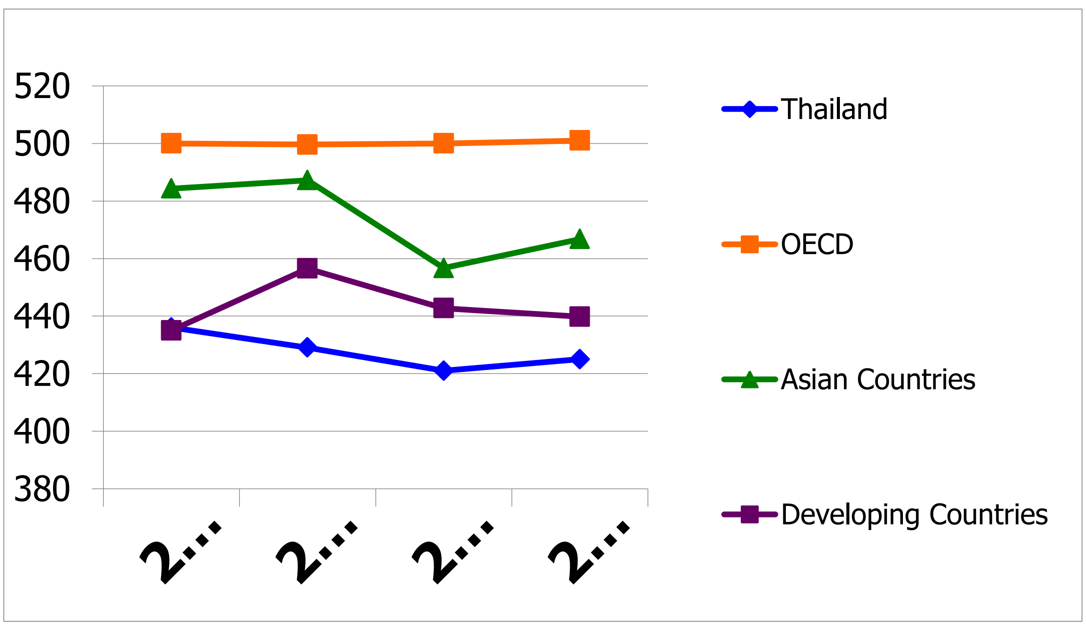


Figure 2

PISA Scores Showing Students' Performance in Mathematics

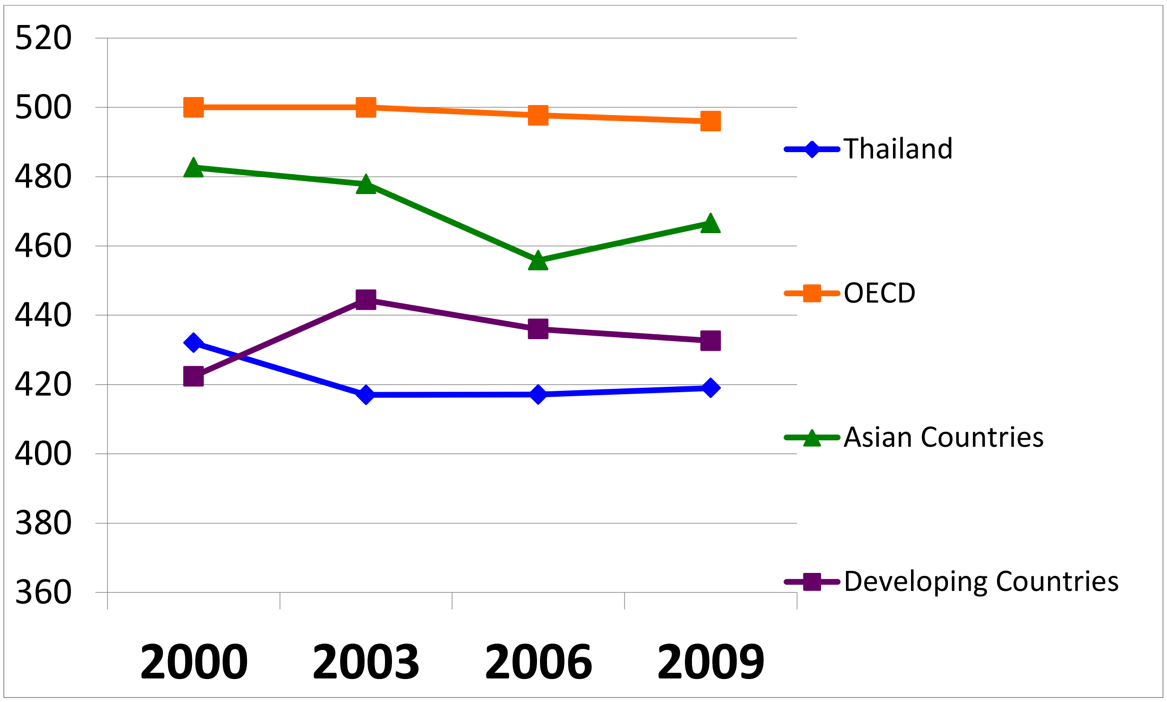
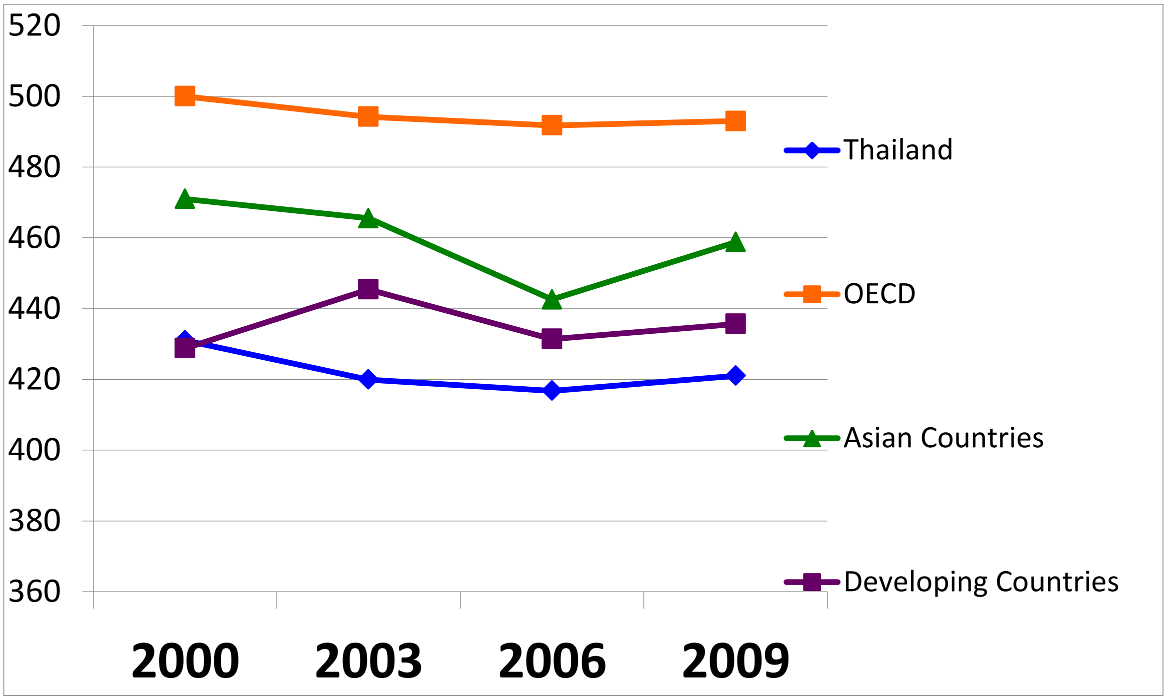


Figure 3

PISA Scores Showing Students' Performance in Reading



The results of the poorly functioning education system in Thailand become evident in difficulties Thai employers face when hiring people. According to the above mentioned *The Economist* article, "positions often go unfilled" due to the lack of job candidates with basic reading and writing skills, "or insufficiently qualified people have to be taken on – productivity suffers as a result."-

To be fair, Thailand is not the only developing country that encounters these problems. According to a survey done by Glewweet. al (2011), many other developing countries spend hundreds of billions of dollars each year on schools, educational materials and teachers, but little is known about how effective these expenditures are at increasing student learning and students' years of completed schooling. Glewwe and Kremer (2006) conclude in their study that school quality in developing countries is low due to the fact that students in most developing countries learn less than their counterparts in developed countries based on the standardized test scores results such as TIMSS and PISA. Woessmann (2001) points out to a body of empirical evidence that overwhelmingly shows that an increase in resources does not generally raise educational performance.

Since the educational use of computers is such a controversial issue, it is crucial to systematically analyze the effects of such usage on students' performance in Thailand. The purpose of this paper is to contribute to the debate by examining Thai students' performance in core subjects, conditional on computer use at home and in the classroom. We employ the well-regarded2009 PISA (OECD Programme for International Student Assessment) database that provides students' scores on internationally standardized tests for over 70 countries, including Thailand. The richness of the dataset allows us not only to generally access the impact of computer availability on educational outcomes in Thailand, but also to differentiate between various computer activities and intensities of usage —the precise issues raised in the current debates. Given the scarcity of studies on the subject in Thailand, we believe that our work is a timely and important contribution to the discussion about effective policies in this area. The multivariate analysis that we employ using rich set of student, family and school characteristics from the latest PISA database allows us to minimize possible endogeneity bias and produce more reliable estimates of computer effectiveness on student performance.

Our results show that in our sample of Thai students, the effectiveness of computers as an educational device at home depends on the type and the magnitude of computer activities. We find that browsing the Internet for schoolwork has a positive impact on average students' performance in all subjects when students use computers at least once a week; alternatively, playing online games can negatively affect examination scores in science subject when students play such games intensively. In addition, similar to other findings in the literature (see for example, Angrist and Lavy, 2002, and Rouse, Krueger, and Markman, 2004), our results indicate that computer utilization in the classroom has a negative impact on students' performance. That raises concerns over the appropriateness of large budget allocations toward increasing the supply of computers to schools and highlights the need to search for other venues that would be more effective in improving the education system in Thailand.

The remainder of the paper is structured as follows. Section 2 reviews the existing literature on the effects of computer and Internet utilization on student performance. Section 3 presents recent development in Thai educational policies. Section 4 describes the dataset and selected control variables. Section 5explains the estimation strategy. The results are presented in Section 6. Finally, Section 7 concludes with a summary of the findings and their implications.

2. Literature review

The literature on how computers fare as an educational tool indicates generally positive results for developed countries. Wenglinsky (1998) found a positive relationship between computer use and mathematics test scores of 6,227 4^{th} graders and 7146 8^{th} graders in the U.S. using the 1996 National Assessment of Educational Progress data. Kulik (2003) conducted a comprehensive summary of meta-analyses and other studies on the impact of computer-based applications on content areas of reading, writing, and math in elementary and secondary schools in the U.S. and found the effects to be positive. Rouse, Krueger, and Markman (2004) show that instructional computer programs designed to improve language and reading skills in U.S. schools may improve a few aspects[2] of students' language skills, even though such programs do not appear to increase a broader measure of language or actual reading abilities. The National Center for Educational Statistics (2001), Cox et al. (2003), and Harrison et al. (2002) found positive results for OECD countries. However, for developing countries the outcomes are more ambiguous. For instance, Banerjee et al. (2007) and Linden (2008) found a positive and significant impact of computer utilization on test scores in India. Inamdar's (2004) experimental results indicate that unsupervised group learning through computers in rural India can improve children's performance on school examinations. Researchers from the Rural Education Action

[2] Rouse, Krueger, and Markman (2004) estimate a small positive effect of students being trained on a group of computer software programs known as Fast For Word (FFW) on a composite score from a computer assessment known as Reading Edge but find no effect on other standardized assessments.

Project (REAP) at Stanford University[3] used randomized experiments in rural China and found either a positive or no effect of Computer-Assisted Learning (CAL) and the One Laptop per Child (OLPC) policy in rural China.

Other studies do not find such consistently positive results. Angrist and Lavy (2002) reported that introducing computer-aided instruction in Israeli schools negatively affected fourth graders' mathematics achievement. Rosas et al. (2003) found an improvement in motivation to learn and positive technological transfer of computer use in 1st and 2nd graders in Chile but no significant effect on students' performance in math, reading comprehension, and spelling. Barrera-Osorio and Linden (2009) evaluated a program that integrates computers in teaching language in public schools in Colombia and found no effect on students' academic performance. They suggest that the main reason for such results was the failure to properly incorporate computers into the educational process.

A cross-country study was done by Fuchs and Woessmann (2004), who employed the PISA 2000 dataset to analyze the impact of computer availability on students' educational achievement in 32 developed and developing countries. They show that the results from a simple bivariate analysis suffer from a serious upward bias. Positive correlations between the availability of computers at home and student performance in mathematics and reading reverse to negative relationships once family background characteristics are controlled for in multivariate regressions. Regarding the impacts of various computer activities, they find a positive relationship between student performance and the use of educational software, as well as computer usage for emailing and webpage access at home.

Finally, there is a study by the Thai Institute for the Promotion of Teaching Science and Technology (IPST, 2009) that also finds an inverted U-shape relationship between computer use and the 2003 PISA scores of Thai students. Students who had never used computers and those who had used them every day performed worse than those who had used computers occasionally.

[3]See, for example, Yang et. al (2012), Lai et. al (2012a, b, c), and Mo et. al (2012).

Unfortunately, the IPST study was based on simple mean comparisons and only analyzes the use of educational computer software, but disregards other important computer applications that might potentially benefit or harm students, such as browsing the Internet for information versus playing games.

Our exercise specifically examines the relationship between the use of computers and students' performance in Thailand. In light of sweeping governmental policies in the education sector on one hand and the lack of relevant studies on the subject in Thailand on the other, the need for such a study seems to be very timely. Unlike the IPST (2009) study described above, our multivariate analysis controls for a broad range of student, family and school characteristics. Also, we use the 2009 PISA dataset for Thai students; this dataset contains a much richer selection of variables regarding computer use than those for previous years that were employed in other studies.

3. Recent development in Thai educational policies

Weak educational outcomes prompted the Thai government to embark on a mission of educational reforms. Those include long-term policies aimed at upgrading intangible resources such as teacher quality as well as short-term strategies targeted at increasing schools' tangible resources, particularly basic infrastructure, computers, and high-speed Internet. Increasing the availability of computers and Internet access has become the main focus of policymakers. In 2010, a large budget was allocated to reduce the computer-to-student ratio from 1:40 to 1:10 and to increase access to high-speed Internet in all universities and more than 3,000 schools nationwide. Furthermore, the recently elected government of Prime Minister Yingluck Shinawatra vowed to hand in a free tablet computer to each first grader in Thailand under the "One Tablet Per Child" policy that, according to some observers, was the most "vote-catching" electoral promise. Provision of free computers not only aims at raising educational quality, but also at reducing disparities between rich and poor students.

The policy generated significant debates among educators, policy makers, and parents in Thailand. First, the policy is expensive. According to Dr. Olarn Chaiprawat, an economic and educational adviser to Prime Minister, the government policy to distribute computer tablets to students from the 1^{st} (Prathom 1) to 12^{th} (Mathayom 6) grades requires a total budget of 30 billion baht (approximately 1 billion U.S. dollars). Second, the availability of computers in the educational process has not always been proven beneficial. (See, for instance, Glewwe et. al (2011) who concludes that the introduction of computers and the Internet has mixed results at best on educational outcomes).

On the positive side, computers allow school children access to books and other educational information not otherwise available to them, especially in developing countries. Second, computers may transform learning from boring memorization into fun interactive activities. Third, they may help in the formation of creative minds and independent thinkers.

On the negative side, playing games and downloading music are distracting, and they can adversely affect student performance. Moreover, it is also possible that using educational software in the classroom could displace more effective means of teaching, resulting in negative impacts of such use on student performance (see, for example, Fuchs and Woessman, 2004). According to Cuban (1993) and Kirpatrick and Cuban (1998), computer use in classrooms does not effectively increase students' performance in general.

In addition, according to an article in *Bangkok Post*,[4] many issues need to be addressed before tablet computers are distributed to students in order to make them an effective educational tool. Among such issues are the careful consideration of relevant digital libraries and computer games allowed to be downloaded, the extent of Internet access, the re-training of teachers, and the regard for intellectual property rights.

4. Data and variables

[4] 'Can PC tablets solve our education woes?' by Suranand Vejjajiva, Bangkok Post, September 9^{th}, 2011: http://www.bangkokpost.com/opinion/opinion/255674/can-pc-tablets-solve-our-education-woes

Our choice of data is the Programme for International Student Assessment (PISA) dataset for the latest available year, 2009. We opt to analyze the data that pertains to Thai students only to pursue our goal of specifically examining the situation in Thailand, where the government has recently embarked on a massive provision of computer tablets to school children.

Through standardized international tests, PISA assesses the extent of students' knowledge and skills in reading, mathematics, and scientific literacy near the end of their compulsory education. See Appendix A for summary statistics of Thai students' scores in 2009. PISA tests evaluate not only mastery of the school curriculum, but also relevant knowledge and skills needed in adult life. Therefore, the test results can also be used to evaluate the preparedness of the future workforce.

After cleaning the data, we end up with 5,187 students in our sample enrolled in 230 schools throughout Thailand. The dataset includes information on the test scores and characteristics of the students' background, as well as information on their families and their schools. The student characteristics are comprised of age (*age*), gender (*female*), grade (*grade*), the special study program the student has attended that is designed to give direct access to the labor market (*iscedd*), the language spoken at home (*homelang*), whether the student lives with parents or not (*withpar*), and whether the student has ever repeated a grade (*repeat*). The school characteristics include the total number of students (*schsize*), school type (i.e., public or private) (*schtype*), location (*location*), the ratio of computers to school size (*iratcomp*), the proportion of computers connected to the Internet (*compweb*), the student-teacher ratio (*stratio*), the proportion of fully certified teachers (*propcert*), the quality of educational resources (*scmatedu*), whether the school organized instruction differently for students with different abilities (*abgroup*), the extra-curricular activities offered by the school (*excuract*), the level of school responsibility for resource allocation (*respres*), the level of school responsibility for curriculum and assessment (*respcurr*), and school selectivity in admittance (*selsch*). The family background attributes are family wealth (*wealth*) and the mother and father's education levels (*misced* and *fisced*).[5] See Appendix B for variables explanation and Appendix C for summary statistics of these variables.

Finally, the PISA dataset also provides information on the frequency of computer use at home and the intensity of computer use in classrooms that we employ to construct treatment and control groups of interest.

5. Econometric Strategy

The common approach to estimate the effects of computer use on educational outcomes is to use an education production function (see for instance, Fuch and Woessmann(2004), Bratti, Checchi, and Filippin (2007), Rangvid (2007), and Hanushek(2008)). We, therefore, adopt this approach to our study. Our education production function controls for student, family, and school characteristics and has an explicit computer usage variable to detect the impact of computer utilization on students' test scores:

$$T_i = \alpha + SB_i\phi + FB_i\delta + SCH_i\lambda + COM_i\beta + \varepsilon_i \quad (1)$$

where T is a subject test score of student i, SB_i is a set of student background variables, FB_i represents a set of family characteristics of student i, SCH_i are characteristics of a school that student i attends, COM_i shows computer usage of student i either at home or at school, and ε_i is the error term.

Since PISA surveys use two-stage stratified sample - schools are sampled first and then students are sampled in the participating schools (see OECD (2009), chapters 3-4 for more details) - final sampling weights and balanced repeated replications (BRRs) weights provided in the PISA dataset must be applied in regressions in order to get unbiased estimates. Second, instead of providing a point estimate for student performance in each subject, PISA reports 5 plausible values, which are randomly drawn from an estimated distribution of a student's scores.

[5] Female, iscedd, with par, repeat, abgroup, schtype, location, misced, and fisced are dummy variables.

Since PISA scores are imputed to individuals, specific procedure is required in order to obtain correct standard errors of the estimates. To properly account for the plausible values, we follow a procedure recommended in OECD (2009) to obtain unbiased OLS coefficients and their unbiased standard errors:

1) For each plausible value, we run a regression of plausible value on computer use and other control variables, using final sampling weights provided in the PISA dataset. Therefore, five coefficients of computer use variable, $\hat{\beta}_1, \hat{\beta}_2, \hat{\beta}_3, \hat{\beta}_4, \hat{\beta}_5$ are obtained for each subject.
2) To calculate a standard error corresponding to each coefficient, $\sigma^2_{\hat{\beta}_1}, \sigma^2_{\hat{\beta}_2}, \sigma^2_{\hat{\beta}_3}, \sigma^2_{\hat{\beta}_4}, \sigma^2_{\hat{\beta}_5}$, the Fay's variant of the balanced repeated replication (BRR) is used. The Fay coefficient is set to 0.5 as suggested by OECD (2009). The final sampling weight and 80 replicate weights provided in the PISA are used in the calculation process.
3) For each subject, the final regression coefficient is $\hat{\beta} = \frac{\hat{\beta}_1 + \hat{\beta}_2 + \hat{\beta}_3, + \hat{\beta}_4 + \hat{\beta}_5}{5}$.

   The final sampling variance estimate is $\sigma^2_{\hat{\beta}} = \frac{\sigma^2_{\hat{\beta}_1} + \sigma^2_{\hat{\beta}_2} + \sigma^2_{\hat{\beta}_3} + \sigma^2_{\hat{\beta}_4} + \sigma^2_{\hat{\beta}_5}}{5}$.
4) The imputation variance is $\sigma^2(imp) = \frac{1}{4}\sum_{i=1}^{5}(\hat{\beta}_i - \hat{\beta})^2$.
5) The final error variance is $\sigma^2(err) = \sigma^2_{\hat{\beta}} + 1.2(\sigma^2(imp))$.
6) The final standard error is $= \sqrt{\sigma^2(err)}$.

A crucial assumption to obtain unbiased ordinary least squared (OLS) estimates of the effects of computer use on student learning outcome is that the computer use must be uncorrelated with the error term(computer use is exogenous) to avoid selection bias. Selection bias stems from the failure to control for variables that influence use of computers and educational outcomes at the same time. For example, students with better innate abilities might have higher examination scores as well as spend more hours working with computers at home. It is also possible that those types of students choose to attend schools and classes that utilize computers more intensively. Moreover, it could be the case that the government chooses to supply more computers to its country's premier schools (those with more able students) as a showcase. In these cases, the effect of computer use will be upward biased if students' abilities are not controlled for. Alternatively, it might be the case that the government decides to target poorer schools (those with less able students)and to provide computers to improve the quality of instruction there. Or, teachers might selectively use computer programs in classes with less able students, hoping that it will improve their performance. A downward bias is then expected in these cases. To avoid the bias, it is important to control for students' abilities in the regression. However, it is very unfortunate that data on students' abilities are missing from the PISA dataset.

An obvious solution to the selection bias problem is to use instrumental variables. Unfortunately, as many studies using PISA indicate (see, for instance, Rangvid (2007), Bratti, Checchi, and Filippin (2007), Fuchs and Woessman (2004)) precise and credible instrumental variable is not available in the PISA dataset. Instead of using an instrument variable approach, these papers proceed with an alternative strategy that is to control as many as possible variables that affects students' abilities, in hopes of lessening the selection bias.

We try our best to include the variables that would proxy, however imperfect, for the innate ability of students. For example, variable *repeat* indicates whether a student has ever repeated a grade and can at least differentiate low-ability students from the rest of the sample. Parents' educational levels can also suggest the family traits inherited through genes. Finally, the variable *abgroup* indexes schools according to whether they organize instructions based on students' abilities, that we hope captures some of the unobserved student characteristics. In addition, variable *iscedd* – whether a program gives students direct access to the labor market – is included to capture motivation a student might have to prepare him/herself for the future job market.

In addition, we include a broad range of school characteristics that capture quality of teachers, size, location, type (government or private, etc.) and selectivity of the school, student-to-teacher ratio, level of administrative responsibility, school's education resources and extra-curricular activities – that we hope will take care of most of selection bias. Nonetheless, our results should not be interpreted as causal effects but robust correlations.

6. Results

Our analysis is comprised of two parts- we differentiate the effects of computer usage at *home* and in the *classroom* on the test scores of Thai students.

- *Computer Use at Home*

Computer is a multi-purpose tool. Different types of computer activities at home could have a different impact on students' performance. Constructive use such as browsing the Internet for information on schoolwork, preparing essays, or presentations could enhance students' learning and improve their test scores. On the other hand, activities such as playing online or offline games could adversely affect students' standing at school. We therefore investigate the impact of using computers and the Internet by differentiating constructive activities from unconstructive ones. In each of the two cases, students are divided into four groups based on the intensity of their use of computers, particularly, "never or hardly ever,""once or twice a month,""once or twice a week," and "every day or almost every day." In this case the "never or hardly ever" set serves as the control group.

Tables 1 and 2 present the results. In the case of constructive use of computer at home, coefficients are positive and become statistically significant when students start using computers moderately (once or twice a week) to intensively (every day or almost every day). The size of the coefficients in all subjects increases as more time are spent on using computer constructively implying a strong positive correlation between constructive use of computer at home and student performance.

Table 1

Estimates of the effects of the constructive use of computers at home on student performance

(e.g., browsing the Internet for school work at home, preparing an essay or presentation)

	Once or twice a month	Once or twice a week	Every day or almost every day
Science	-7.07	18.93***	20.35***
Math	-5.86	15.85***	22.10***
Reading	-6.13	16.30***	16.49***

Note: ***, **, and * denote 1 percent, 5 percent, and 10 percent significance levels, respectively.

Table 2

Estimates of the effects of the unconstructive use of computers at home on student performance

(playing collaborative online games at home)

	Once or twice a month	Once or twice a week	Every day or almost every day
Science	2.60	-2.12	-10.48**
	(4.70)	(4.90)	(5.00)
Math	2.23	-2.35	-7.50
	(5.30)	(4.57)	(5.19)
Reading	2.25	-1.49	-5.65
	(4.18)	(4.27)	(4.04)

Note: ***, **, and * denote 1 percent, 5 percent, and 10 percent significance levels, respectively

For the case of unconstructive computer use interestingly, playing games (an activity that might be very destructive to learning) does not appear to affect students' performance even when students engage in it every day or almost every day with the exception of the science subject. In this case, students' test scores are10.48 points lower in science than those who hardly ever use computers to play games. If students hardly play computer games or play computer games moderately (i.e., once or twice a month or a week or lower), the difference in test scores is statistically insignificant.

In summary, according to our estimation results, the type of computer use at home and its intensity matter for children's achievement at school. If computers are at least moderately used to research for school-related materials, or for preparing presentations and essays, students' test scores tend to be higher in comparison to when students are engaged in such types of activities less often. However, intensive use of computers to play games does negatively impact student performance in science, while it does not seem to have an impact on math and reading.

Computer Use in the Classroom

We differentiate computer utilization in the classroom according to different intensities. Students are divided into four groups based on the amount of time computers are used during lessons, particularly, "no time,""0-30 minutes a week,""31-60 minutes a week," and "more than 60 minutes a week" groups. Therefore, Table 3 shows estimates for pair-wise comparisons of different intensities of computer use with "no time."

Table 3

Estimates of the effects of time spent on using computers in classrooms on student performance

	0-30 minutes a week	31-60 minutes a week	More than 60 minutes a week
Scienc	-6.32	-7.10	-5.19
Math	-22.13***	-17.34***	-13.03
Readi	-19.63***	-32.50***	-20.70***

Note: ***,**, and * denote 1 percent, 5 percent, and 10 percent significance levels, respectively.

Our results do not uncover any positive effects of computer utilization in the classroom, at least for those intensities available in the dataset. For science, using computer in the classroom does not appear to have any effect on students' performance. For Math, using computer in the classroom has a large negative impact if the length of time use is less than 60 minutes a week. For reading, the relationship between the length of time computers are used during lessons and students' test scores has a U-shape, which implies that the moderate use of computers produces the worst outcome in comparison with other intensities. Interestingly, even though the most intensive computer use in our dataset (more than 60 minutes a week) has a significant negative impact on reading skills, the effects on science and math test scores are not statistically different from zero. It would be interesting to see the direction of the relationship for even longer use of computers in the classroom. It should be noted that the intensity of computer use does not directly relate to *how* teachers use computers during lessons; in this case, we cannot distinguish between productive and non-productive utilization of computer time.[6]

7. Conclusion and discussion

Large proportions of the government budget in Thailand are devoted to supplying computers and Internet access to schools in the hope of improving the educational system and eventually helping to alleviate poverty in the country. Particularly, the new Pheu-Thai-led coalition government promised to hand in a tablet computer to each 1st (and possibly 6th) grader for free under the One Tablet per Child policy. Such a massive provision of computers to children (nearly one million) generated substantial debates among the Thai public and, therefore, calls for a thorough evaluation of the policy effectiveness. We could not find any reliable studies that evaluated the impact of computer use at home and in the classroom in Thailand; therefore, this paper tries to fill the void.

Although our paper does not address any particular government educational policy, we try to shed light on how effective and productive the use of computers in Thailand has been thus far. Our findings show that the effect of using a computer at home depends on the types of activities and the intensity of use. Regular and constructive computer work, such as browsing the Internet for schoolwork and preparing essays and presentations, has a positive impact on students' test scores, while *frequent* playing of games reduce scores in science subject. Using computers at school do not appear to benefit learning in our exercise; at best, we find no statistically significant effect of such use and for most of the cases, the impact was negative. Therefore, we remain unconvinced about the effectiveness of computers as an educational tool in Thai schools. Apparently, more work should be done to discover better methods and

[6] For example, computers could have been used purely for presentation purposes and effective educational software might not have been utilized.

techniques for computer use as well as to create and disseminate appropriate educational software that would benefit learning. Since some studies mentioned in the literature review section have found that computer training at school can have positive effects, ways to better utilize computers in the classroom probably exist.

In addition, since computer tablets given to schoolchildren in Thailand will be used not only at school, but also at home, parental supervision becomes crucial. Parents need to make sure that computers are used for constructive activities as opposed to possible harmful ones.

Reference:

Angrist, Joshua and Victor Lavy. 2002. "New Evidence on Classroom Computers and Pupil Learning," Economic Journal 112 (482), 735-765.

Banerjee, Abhiit V., Shawn Cole, Esther Duflo, and Leigh Linden. 2007. "Remedying Education: Evidence from Two Randomized Experiments in India," *The Quarterly Journal of Economics* 122(3), 1235-1264.

Barrera-Osorio, Felipe and Leigh L. Linden. 2009. "The Use and Misuse of Computers in Education: Evidence from a Randomized Experiment in Colombia," *Policy Research Working Paper No.4836*. The World Bank.

Bratti, Massimiliano, Daniele Checchi and Antonio Filippin. 2007. "Territorial Differences in Italian Students' Mathematical Competencies: Evidence from PISA 2003," *IZA Discussion Papers 2603*, Institute for the Study of Labor (IZA).

Cox, Margaret, Chris Abbott, Mary Webb, Barry Blakeley, Tony Beauchamp and Valerie Rhodes. 2003. "ICT and Attainment," *ICT in Schools Research and Evaluation Series No.17*. British Educational Communication and Technology Agency.

Cuban, Larry. 1993. "Computers Meet Classroom: Classroom Wins," *Teachers College Record* 95(2), 185-210.

The Economist. 2012. "Let them eat tablets: Trying to stop the rot in Thailand's schools by giving out tablet computers," Bangkok: The Economist, June 16th 2012. http://www.economist.com/node/21556940

Fuchs, Thomas and Ludger Woessmann. 2004. "Computers and Student Learning: Bivariate and Multivariate Evidence on The Availability and Use of Computers At Home and At School," *CESIFO Working Paper* NO.1321. Category 4: Labour Markets.

Glewwe, Paul, and Michael Kremer. 2006. "Schools, Teachers, and Education Outcomes in Developing Countries," *Handbook of the Economics of Education, Vol. 2* (Eric A. Hanushek and Finis Welch, Eds.). Elsevier.

Glewwe, Paul, Eric Hanushek, Sarah Humpage, and Renato Ravina. 2011. "School Resources and Educational Outcomes in Developing Countries: A Review of the Literature from 1990 to 2010," NBER Working paper #17554.

Hanushek, Eric A. 2008. "Education Production Functions," *The New Palgrave Dictionary of Economics* (Steven N. Durlauf and Lawrence E. Blume, Eds.). Basingstoke: Palgrave Macmillan.

Harrison, Colin, Chris Comber, Tony Fisher, Kaye Haw, Cathy Lewin, Eric Lunzer, Angela McFarlane, Diane Mavers, Peter Scrimshaw, Bridget Somekh, and Rob Watling. 2002. "ImpaCT2: The Impact of Information and Communication Technologies on Pupil Learning and Attainment," *ICT in Schools Research and Evaluation Series No.7*. British Educational Communication and Technology Agency.

Inamdar, Parimala. 2004. "Computer skills development by children using 'hole in the wall' facilities in rural India," *Australian Journal of Education Technology* 20(3), 337-350.

The Institute for the Promotion of Teaching Science and Technology. 2009. "The quality of Learning of Thai Students: Analysis of PISA 2006 and TIMSS 2007". The Institute for the Promotion of Teaching Science and Technology (in Thai language).

Kirkpatrick, Heather and Larry Cuban. 1998. "Computers Make Kids Smarter- Right?," *Technos Quarterly* 7(2) [http://www.technos.net/tq_07/2cuban.htm].

Kulik, James A. (2003) Effects of using instructional technology in elementary and secondary schools: What controlled evaluation studies say. Arlington, VA: SRI International. http://www.sri.com/policy/csted/reports/sandt/it/Kulik_ITinK-12_Main_Report.pdf

Lai, Fang, Renfu Luo, Linxiu Zhang, Xinzhe Huang, and Scott Rozelle. 2012a. "Does Computer-Assisted Learning Improve Learning Outcomes? Evidence from a Randomized Experiment in Migrant Schools in Beijing," Rural Education Action Project Working paper #228, Stanford University.

Lai, Fang, Linxiu Zhang, Yaojiang Shi, Matthew Boswell, and Scott Rozelle. 2012b. "Computer Assisted Learning as Extracurricular Tutor? Evidence from a Randomized Experiment in Rural Boarding Schools in Shaanxi," Rural Education Action Project Working paper #235, Stanford University.

Lai, Fang, Linxiu Zhang, Qinghe Qu, Xiao Hu, Yaojiang Shi, Matthew Boswell, and Scott Rozelle. 2012c. "Does Computer-Assisted Learning Improve Learning Outcomes? Evidence from a Randomized Experiment in Public Schools in Rural Minority Areas in Qinghai, China," Rural Education Action Project Working paper #237, Stanford University.

Linden, Leigh. 2008. "Complement or Substitute? The Effect of Technology on Student Achievement in India," Working Paper No.17, 2008.The World Bank.

Mo, Di, Johan Swinnen, Linxiu Zhang, Hongmei Yi, Qinghe Qu, Matthew Boswell, and Scott Rozelle. 2012. "Can One Laptop per Child Reduce the Digital Divide and Educational Gap? Evidence from a Randomized Experiment in Migrant Schools in Beijing," Rural Education Action Project Working paper #233, Stanford University.

National Center for Educational Statistics. 2001. *The nation's report card: Mathematics 2000.* Washington, D.C.: National Center for Educational Statistics.

OECD. 2009. PISA Data Analysis Manual SPSS, Second Edition. Paris: OECD

Rangvid, Beatrice S. 2007. "School Composition Effects in Denmark: Quantile Regression Evidence from PISA 2000," *Empirical Economics*, 33(2), 359 – 388.

Rosas, Ricardo, Miguel Nussbaum, Patricio Cumsille, Vladimir Marianov, Monica Correa, Patricia Flores, Valeska Grau, Francisca Lagos, Ximena Lopez, VeronicaLopez, Patricio Rodriguez, and Marcela Salinas. 2003. "Beyond Nintendo: design and assessment of educational video games for first and second grade students," *Computers & Education* 40, 71-94.

Rouse, Cecilia E., Alan B. Krueger, and Lisa Markman. 2004. "Putting Computerized Instruction to the Test: A Randomized Evaluation of a "Scientifically-based" Reading Program," *Economics of Education Review* 23, 323-338.

Siamwala, Ammar, Somkiat Tangkitvanich, and Dilaka Lathapipat. 2011. "Revamping Thai Education System: Quality for All," TDRI Year End Conference Paper, Thailand Development Research Institute.

Vejjajiva, Suranand. 2011. "Can PC tablets solve our education woes?" Bangkok: Bangkok Post, September 9th, 2011. http://www.bangkokpost.com/opinion/opinion/255674/can-pc-tablets-solve-our-educational-woes.

Wenglinsky, Harold. 1998. "Does it compute? The relationship between educational technology and student achievement in mathematics," *Policy Information Report*, Educational Testing Service Policy Information Center.

Woessmann, Ludger. 2001. "Why Students in Some Countries Do Better," *Education Matters*, 1(2), 67-74.

Yang, Yihua, Linxiu Zhang, Junxia Zeng, Xiaopeng Pang, Fang Lai, and Scott Rozelle. 2012. "Computers and the Academic Performance of Elementary School-Aged Girls in China's Poor Communities," Rural Education Action Project Working paper #238, Stanford University.

Appendix A

Table A1: Means and standard errors of Thai students' PISA scores in 2009

Subject	*Mean*	*Standard Deviation*
Science	429.30	79.02
Math	422.58	79.25
Reading	425.02	71.68

Note: Using the same samples as in the regression analyses. Final sampling weights provided in the PIAS dataset are applied.

Appendix B

Explanation of the Control Variables

age: The age of a student.

iscedd: A dummy variable indicating whether or not the student is in a study program designed to give direct access to the labor market.

grade: The student's grade level.

female: A dummy variable indicating a female student.

homelang: A dummy variable indicating that the language speaking at home is the same as the language of assessment.

withpar: The index is categorized as follows: (1) the student is living with both mother and father, (2) the student is living with either mother or father, (3) otherwise. (withpar2 is a dummy variable equal to 1 if the student is living with either the mother or the father and withpar3 is a dummy variable if the student is living with neither the mother nor the father.)

repeat: A dummy variable equal to 1 if the student has never repeated a grade and 0 otherwise.

abgroup: School principals were asked to report the extent to which their school organizes instruction differently for students with different abilities. An index of ability grouping between or within classes was derived from the two items by assigning schools to three categories: (1) schools with no ability grouping for any subjects, (2) schools with at least one of these forms of ability grouping for some subjects, and (3) schools with at least one of these two forms of ability grouping for all subjects. (abgroup2 is a dummy variable equal to 1 if the student attends school with at least one of the forms of ability grouping for some subjects, and abgroup3 is a dummy variable equal to 1 if the student attends school with at least one of the two forms of ability grouping for all subjects.)

compweb: The ratio of computers connected to the Internet to the total number of computers available at the school.

iratcomp: The number of computers available for instruction per student.

propcert: The ratio of teachers who have a post graduate degree to the number of teachers in the school.

schsize: The size of the school that the student attends measured by the total enrollment in the school.

schtype: The index on school type has three categories: (1) public schools controlled and managed by a public education authority or agency, (2) government-dependent private schools controlled by a non-government organization or with a governing board not selected by a government agency, which receive more than 50% of their core funding from government agencies, (3) government-independent private schools controlled by a non-government organization or with a governing board not selected by a government agency, which receive less than 50% of their core funding from government agencies. (schtype2 is a dummy variable equal to 1 if the school that student attends fits category 2, and schtype3 is a dummy variable equal to 1 if the school that student attends fits category 3.)

selsch: An index for school selectivity, ranging from 1 to 3: 1 signifies schools in which neither of the two factors is considered for student admittance; 2 signifies schools that consider at least one of the two factors; 3 signifies schools in which at least one of these two factors is a prerequisite for student admittance. The two factors are students' academic records (including placement tests) and the recommendation of feeder schools.

stratio: A student-teacher ratio that is obtained by dividing the school size by the total number of teachers.

excuract: An index of extra-curricular activities offered by the school. Higher values on the index indicate larger numbers of extra-curricular school activities. The index was standardized to having an OECD mean of zero and a standard deviation of one.

respcurr: An index of the relative level of responsibility of school staff in issues relating to curriculum and assessment. Higher values indicate relatively higher levels of school responsibility in this area. The index was standardized to having an OECD mean of zero and standard deviation of one.

respres: An index of the relative level of responsibility of school staff in allocating resources. Higher values indicate relatively higher levels of school responsibility in this area. The index was standardized to having an OECD mean of zero and standard deviation of one.

scmatedu: An index on the school's educational resources was computed on the school principal's perceptions of potential factors hindering instruction in the school. Higher values indicate higher level of resources.

location: School location index describes the community in which the school is located. It has five categories: (1) a village with fewer than 3,000 people, (2) a small town with 3,000 to about 15,000 people, (3) a town with 15,000 to about 100,000 people, (4) a city with 100,000 to about 1,000,000 people, and (5) a large city with over 1,000,000 people.

fisced and misced: The father and mother's educational levels are categorized as follows: (0) None, (1) primary education, (2) lower secondary, (3) vocational/pre-vocational upper secondary, (4) upper secondary and/or non-tertiary post-secondary, (5) vocational tertiary, (6) theoretically-oriented tertiary and post-graduate, (9) missing data.

wealth: An indicator of family wealth possessions.

Appendix C

Summary Statistic of Control variables

Variable	Observations	Mean	Standard Deviation	Min	Max
age	5187	15.71	0.29	15.25	16.17
Iscedd_3	5187	0.19	0.39	0	1
grade	5187	-0.21	0.48	-3	1
female	5187	0.57	0.50	0	1
homelang	5187	0.50	0.50	0	1
withpar_2	5187	0.20	0.40	0	1
withpar_3	5187	0.21	0.41	0	1
repeat	5187	0.65	0.41	0	1
Abgroup_2	5187	0.51	0.50	0	1
Abgroup_3	5187	0.19	0.40	0	1
compweb	5187	0.88	0.24	0	1
iratcomp	5187	0.41	0.23	0.06	1.38
propcert	5187	0.95	0.12	0.31	1
schsize	5187	1881.48	1271.79	101	5714
Schtype_2	5187	0.12	0.33	0	1
Schtype_3	5187	0.04	0.20	0	1
selsch	5187	2.62	0.64	1	3
stratio	5187	22.63	7.28	5.05	48.94
excuract	5187	1.04	1.01	-1.28	2.95
respcurr	5187	0.76	0.84	-1.14	1.36
respres	5187	0.27	1.07	-0.84	2.45
scmatedu	5187	-0.44	0.98	-2.65	1.93
Location_2	5187	0.19	0.39	0	1
Location_3	5187	0.37	0.48	0	1
Location_4	5187	0.17	0.38	0	1

Cont.

Vaiable	Observations	Mean	Standard Deviation	Min	Max
Location_5	5187	0.09	0.28	0	1
Fisced_1	5187	0.43	0.50	0	1
Fisced_2	5187	0.13	0.33	0	1
Fisced_3	5187	0.04	0.19	0	1
Fisced_4	5187	0.19	0.39	0	1
Fisced_6	5187	0.15	0.36	0	1
Misced_1	5187	0.49	0.50	0	1
Misced_2	5187	0.11	0.32	0	1
Misced_3	5187	0.03	0.17	0	1
Misced_4	5187	0.17	0.37	0	1
Misced_6	5187	0.13	0.34	0	1
wealth	5187	-1.25	0.95	-5.09	2.12

Note: Using the same samples as in the regression analyses. Final sampling weights provided in the PISA dataset are applied.