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Does computer-assisted learning improve learning outcomes? Evidence from a randomized experiment in migrant schools in Beijing

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ABSTRACT

The education of the disadvantaged population has been a long-standing challenge to education systems in both developed and developing countries. Although computer-assisted learning (CAL) has been considered one alternative to improve learning outcomes in a cost-effective way, the empirical evidence of its impacts on improving learning outcomes is mixed. This paper uses a randomized field experiment to explore the effects of CAL on student academic and non-academic outcomes for students in migrant schools in Beijing. Our results show that a remedial CAL program held out of regular school hours improved the student standardized math scores by 0.15 standard deviations and most of the program effect took place within 2 months after the start of the program. Students with less-educated parents benefited more from the program. Moreover, CAL also significantly increased the students' interest in learning.

1. Introduction

The education of poor and disadvantaged population has been a long-standing challenge to education systems in both developed and developing countries (e.g. Glewwe & Kremer, 2006; Planty et al., 2008; World Bank, 2004). In confronting the challenge, efforts have been made to provide adequate educational inputs such as textbooks and school facilities for disadvantageous populations in both developed and developing countries. Unfortunately these initiatives seem to have been unsuccessful in advancing learning outcomes (e.g., Glewwe & Moulin, 2002; Glewwe & Zitzewitz, 2004; Hanushek, 1986, 1995). As a consequence, researchers are actively exploring other ways of delivering educational inputs in order to better improve learning outcomes.

Computer-assisted learning (CAL) is one such alternative (e.g., Banerjee, Cole, Duflo, & Linden, 2007; Barrow, Markman, & Rouse, 2008; Linden, 2008). Computer-assisted learning

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involves the use of computers and modern computing technologies, embodied in both software and hardware devices, to enhance learning via computerized instruction, drills and exercises (Kirkpatrick & Cuban, 1998; Present's Committee of Advisors on Science and Technology, 1997). For students that live in vulnerable populations who often have to go to schools that are poor in quality, CAL can be a good substitute for teachers when the teachers are not available or have too little training and/or motivation to provide adequate instruction to the students either during or after school hours. CAL can also provide remedial tutoring services when commercialized services are either not available or not affordable. Finally, CAL can provide help that parents who are illiterate or too busy cannot provide. In these senses, CAL can be particularly effective in developing countries, where schools are plagued with poor facilities and unqualified teachers and computer technologies are relatively new and may be beyond the purchase options for most families.

Despite its promise, the empirical evidence on the effectiveness of CAL in promoting learning is mixed (e.g. Angrist & Lavy, 2002; Fuchs & Woosmann, 2004; Goolsbee & Guryan, 2006). An important limitation of these early studies is that they usually examined CAL as a form of an educational input with little attention to how computers were used in the schools. Later studies improved on these early studies by evaluating well-defined individual CAL programs using randomized experiments also found mixed evidence of the effectiveness of CAL (e.g., Barrow et al., 2008; Dynarski, 2007; Rouse & Krueger, 2004).

The existing literature has several limitations that have contributed to the ambiguous assessment of the effectiveness of CAL programs. First, the majority of CAL evaluations have been done in the context of developed countries, where educational resources may be abundant and computers are not novel to the students. Thus, it may not to be surprising that many studies have found no significant beneficial effects of CAL on learning outcomes. However, there are few evaluations of CAL in the context of developing countries—where educational resources are highly constrained and access to technologies is limited. In the rare cases in which CAL programs in developing countries have been evaluated, most show positive effects on student test scores (Banerjee et al., 2007; He, Linden, & MacLeod, 2008; Linden, 2008). Second, instead of being supplementary to regular school time, many of the CAL programs in the existing literature often interfere with the regular school curriculum (as students are pulled out of class for CAL sessions). As a consequence, part of the full impact of CAL may be offset by the negative effects of missing classes, creating a downward bias in the estimation of the genuine impacts of the CAL intervention (Angrist & Lavy, 2002; Linden, 2008; Rouse & Krueger, 2004). Finally, besides academic performance, CAL might also have beneficial effects on non-academic outcomes. These non-cognitive outcomes, to our knowledge, have seldom been examined in the literature.

The overall goal of this paper is to explore the nature of the effects of CAL on not only student academic outcomes but also non-academic outcomes among underserved student populations in a developing country. In pursuit of this goal, we identify four particular objectives. First, we examine the immediate impacts of a CAL math program implemented out of regular school hours on student academic performance in math (as measured by standardized test scores). Second, we examine how the program effects change over time and across students with different academic and family backgrounds. Third, we examine the spillovers of a math-focused CAL program on student academic performance in other subjects (in our case, language class). Finally, we investigate the impacts of CAL on non-academic student outcomes, an effect that has almost never been reported in the literature. Specifically, we examine the effect of the CAL intervention on the interest that students have in learning; student self-confidence; and self-efficacy in studying.

To meet this goal, in this paper we present the results of a randomized field experiment of a CAL program involving over 4000 third-grade students, mostly aged 9 and 10, from poor migrant families, in 43 migrant schools in Beijing. Migrant schools are private-run for-profit schools specifically serving migrant children. These schools are unregulated by the state and are typically thought to provide low quality education. Urban residents never send their children to migrant schools. Students in migrant schools are vulnerable in the sense that their teachers are busy and underpaid and almost never offer out of class tutoring; parents of the students are often poor and inadequately educated and, thus, can neither afford commercial tutoring nor are they able to effectively tutor their own children.

While our research design for computer-assisted learning is similar in many ways to Banerjee et al. (2007) and Linden (2008), there remain several differences. The most important feature of our research design is that we include an additional set of control schools to detect any program spillovers onto the control group. Second, we used within school (between class) randomization to both eliminate school-level confounding influences and improve the efficiency of the estimation. Third, our CAL program was implemented out of the regular school hours and thus was able to avoid any downward bias of the estimation of the treatment effect due to substitution effects.

Our results show that a remedial CAL program held out of regular school hours improved the student standardized math scores by 0.15 standard deviations and most of the program effect took place within 2 months after the start of the program. Students with less-educated parents benefited more from the program. The CAL program also significantly increased the interest of students in learning. We observe no significant spillovers of CAL program in math onto Chinese language test scores. Our results are also shown to be robust to the potential threats of the program spillovers.

The rest of the paper is organized as follows. The first section briefly lays out the context of the study—migrant schools and migrant education in Beijing. The next section reviews the study's approach, including the research design and sampling, an explanation of the intervention, a description of the data and an explanation of the statistical approach. The following sections present the results, discuss the findings and conclude.

2. Migrant schools and migrant education in Beijing

As China's economy has grown over the past 30 years, the number of rural-to-urban migrants has increased to